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FOSTERING TRUST IN AI SYSTEMS: A COMPREHENSIVE FRAMEWORK FOR HUMAN-CENTERED DESIGN AND EVALUATION

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ABSTRACT

Human-Centered Design (HCD) is a user-centric approach that prioritizes understanding and meeting end-users needs throughout the design and evaluation process. This comprehensive framework outlines critical stages to ensure the development of effective, efficient, and satisfying products, services, or systems. Beginning with thorough research and discovery, the framework progresses through problem definition, ideation, prototyping, implementation, and evaluation, emphasizing iterative design and continuous improvement. Launch and post-launch strategies, documentation, and ethical considerations are integral components. This framework guides designers and teams, fostering adaptability, inclusivity, and a commitment to user satisfaction, privacy, and security. Embracing this holistic approach facilitates the creation of solutions that address current user needs and evolve in tandem with changing requirements and technological advancements.

Keywords: *Human-computer interaction, Classification systems, Interaction design, User interface design*

I. INTRODUCTION

Research in design, human factors, and ergonomics (HFE) has focused on the connections between HCD and sustainability in the context of current worldwide discussions on social and economic concerns [1]. This is shown by the abundance of research addressing critical issues at global and micro levels and intangible and physical forms of intervention. There may have been a lot of studies and experiments done in various fields, but nothing stood out as an explanation of the disciplinary and interdisciplinary research connections.

The term 'Sustainable Development' gained popularity throughout several scientific groups with the release of the Brundtland Report [2] and subsequent advances derived from it [3, 4]. “Researchers in the design field have utilized the concept of sustainability to highlight the social, economic, and ecological aspects of designable artifacts and, more generally, the impact of designers' work on creating sustainable solutions [5].” The Hierarchy of Needs (HCD) has recently gained popularity as a design paradigm for meeting human needs [6]. Eco-friendly and inclusive solutions that aim to benefit society and consumers may be developed with the aid of HCD. Giacomin [7] states that disciplines such as HFE, Computer Science, and Artificial Intelligence are the foundations of HCD. This approach prioritizes the "human element" in design. It guarantees that people using the product or service are engaged in its development via co-design. As an

additional definition, HCD is described by ISO [8] as "an approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying HFE and usability knowledge and techniques." This helps to make the systems more user-friendly.

In the context of moving towards more sustainable and inclusive lifestyles, the design communities engaged in the HFE domain have intuitively and naturally worked to align discussions about the future of our planet with the necessity to create enjoyable and usable solutions [9]. Internatito indications have recognized the need for organizations that work for organizations that seek to reduce their negative impact on the environment [10]. “To aid society in its transition to more conscientious ways of living and using resources, it is imperative that new generations of sustainable and human-centered artifacts be developed [11].” It has been suggested that HCD might be pivotal in promoting and assisting the shift towards producing environmentally friendly artifacts, such as goods, services, solutions systems, structures, urban environments, etc. As a result, there has been a shift in HCD-related efforts due to the growing body of evidence showing that designs without human factors consideration often lead to adverse societal outcomes, including heightened health risks, environmental degradation, and economic losses.

Researchers and analysts of cultural and design consequences find the possibility of sustainability and HCD working together intriguing [12]. “In contrast to the International Ergonomics Association's (IEA) official definition of HFE, which states that HFE works at the holistic interaction between human behaviors, innovative design techniques, and the sustainability of the environments in which actions are performed [13], this phenomenon appears to be crucial. Sustainability and human-centered design (HFE) express common interests and values when they are part of the same design domain or scenario [14].” It is also widely recognized that people who make decisions based on information from well-designed solutions systems in clearly defined contexts of use are a vital consideration [15]. Therefore, it is evident that sustainability and HCD are interdependent. “To make the most of what is known about the field, conducting a comprehensive literature review on the dynamics that govern the connections between sustainability and HCD would be beneficial.” This will help the design and HFE communities conduct studies that combine their respective fields of study. Important points to address include the following: the current state of the field, the methods used, the successes and failures of previous efforts, the dynamics of the past and present, and the ways forward for this developing multidisciplinary field of study.

Although there has always been a cultural interest, it is only very recently that the HFE community has officially stated the need to map sustainability contributions into HFE [16, 17]. “Even though there is an obvious desire among HFE researchers to do research in a design-led fashion, no studies have been undertaken to investigate the connections between sustainability and HCD [16].”

II. CLASSIFICATION: A REQUIREMENT

Models supported by robust categorization systems are necessary to systematically examine potential human-computer interactions. In order to facilitate praxis (the integration of theory and practice) and invention (the elucidation of the connections between entities and interaction solutions), its creation and use are crucial [19].

Advanced conceptualization, reasoning, language, or data analysis cannot exist without classification, which groups entities into classes based on their similarity, looking for the minor variations within each group and the maximum variations between different groups [20].

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III. CLASSICAL HCI MODELS: THE HUMAN DOMINANCE PARADIGM

Understanding the information received from the other side and the processes and communication mechanisms inherent to the interface is necessary for effective two-way communication between users and computerized systems, as interfaces act as mediators at the heart of this interaction [21]. "Because both agents inevitably have limited knowledge about the other and their natural communication ways, interfaces play the role of intermediary between them regardless of human development or technological limitations at the time of their creation."

An established goal of human-computer interaction (HCI) [22] is the development of more innovative interfaces that can improve the efficiency and naturalness of interactions while also combining the advantages of adaptability, context suitability, and task development support. Another goal is to make the interface as transparent as possible, especially as an immediacy feature that leads to more realistic and natural interactions [23].

Remembering the structure and purpose of the interface, which is to integrate software and hardware to link the user to the functional centre of the computer system, is vital, as demonstrated in Nigay's fundamental HCI design (Fig. 1) [24]. "Even if the interface is establishing itself as a facilitator of interactions, the simplicity of the model obscures the nature of the processes occurring between the two actors." A more comprehensive Pipe-Lines Model is proposed in [25] as a result of this (Fig. 2).

In the Pipe-Lines Model, the input interface for the user acts as an interpreter, and the output interface for the computer system acts as a renderer; both functions are functionally equivalent.

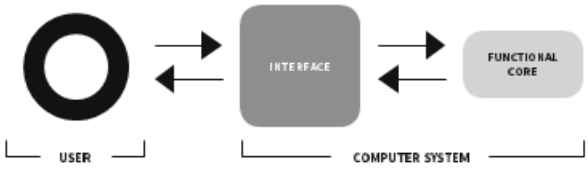

Fig. 1. Interactive connection between user and computer

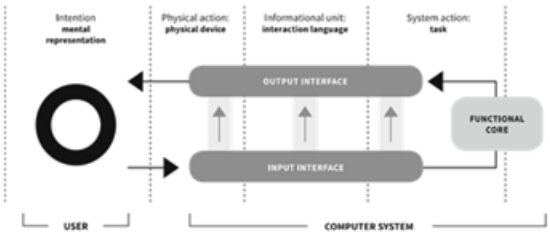

Fig. 2. Hetero-Pipeline HCI Model

The interface is seen as a computerized element. However, it is limited to the realm of the computer system. It needs to consider the congregational and associative nature of the various input and output channels utilized by the system and the user [25]. "Furthermore, the placement of each agent generates conceptual role distinctions between the two HCI agents: the user sends out a request, which the computer system acquires and processes; and the computer system then sends back a response to the user." Therefore, the user takes charge of the HCI via the action sequence while the computer system's functional core reacts.

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The generic model for investigating human-computer communication processes is another famous example of an HCI model (Fig. 3).

Looking at the model graphically makes it seem like it does not provide the human with a complete picture of the interaction, which leads one to believe that it needs to be based entirely on his perspective. An intriguing schematic placement decision favoring the computer over the human depicts a functional and cognitive similarity between the two.

The explanation of the model, however, dampens such feelings. An action by a person is used to initiate the HCI, and then the computer provides a response [26]. "Human-computer interaction (HCI) is still conceptualized as an event-sequence in which the user acts as master of the computer, with the emphasized processes of perception and control evolving on the user's level."

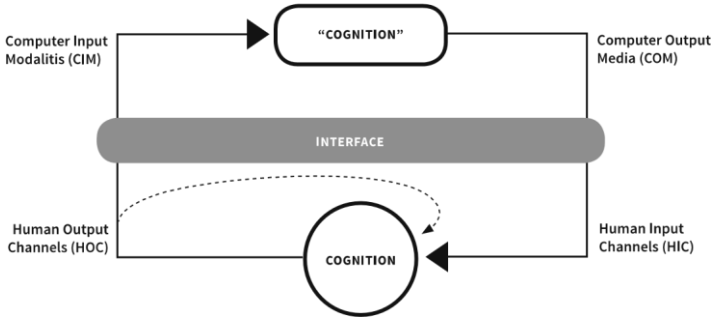

Fig. 3. An approach to defining fundamental steps in the HCI life cycle

Interestingly, the opposite is true in [12], which asserts that both agents engage in comparable cognitive or computational processes and states that the study is conducted from a human process viewpoint. The interface is also no longer shown as a computer component, which is noteworthy.

Adding the viewpoint of computational processes [27] broadens the model's applicability (Fig. 4), drawing attention to the fact that feedback and acquisition occur as symmetrical control and perception processes.

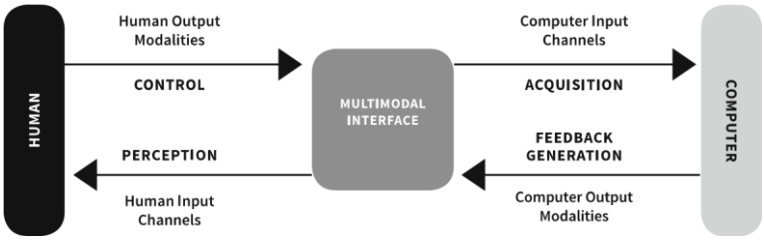

Fig. 4. As it pertains to human-computer interaction, the multimodal

Although the various process names imply otherwise, symmetrical does not mean identical. "In addition, the distinctions pointed forth lead us to believe that humans are in charge, as the request is inherently a part of the user's prompted process (the input flow), and the answer is a part of the computer's prompted process (the output flow)."

For example, in [26] we noted the distinctions between human output channels and computer output media; in [27] we note the differences between human output modalities and computer output channels; however, many of the words used in [26] improve the functional and cognitive proximity of the acquisition and emission processes that humans and computers have created.

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Even though it's used a lot, the human dominance paradigm has never been challenged in HCI research at the academic level.

The labeling of user and computer information transmission, acquisition, and interpretation processes is the same in [28], which stipulates that humans and computers are equally crucial in HCI model analysis (Fig. 5). This conclusion is based on concepts that help people see that different professions have similar functional skills.

Fig. 5. The user-system dialogue is multi-modal.

However, the "top-to-bottom and left-to-right" reading process prevalent in the West emphasizes the user making a request and the computer responding, reflecting a lingering bias towards humans being the primary agents in HCI. “Computer systems' historical and current technical and perceptual limitations give rise to the academic human dominance paradigm in HCI, which suggests that academic analysis has given in to engineering constraints.” However, academic analysis should disrupt potential technological and conceptual implementations and question computers and humans' current psychosomatic and sensorimotor limitations.

IV. TOWARDS A NEUTRAL POSITIONING HCI MODEL

Research on human-computer interaction (HCI) should follow the traditional Shannon-Weaver communication model, as shown in Figure 6, as it elucidates the fundamental ideas behind technical communication processes [29].

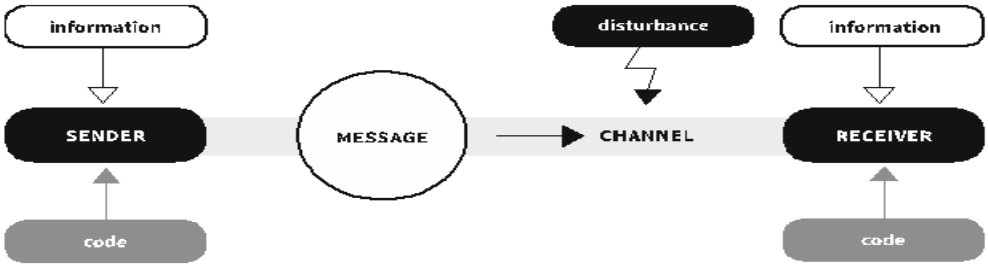

Fig. 6. Model by Shannon and Weaver

By avoiding the automatic assignment of a sender and a receiver function to the Human Agent (HA) and the Computer Agent (CA), respectively, the Shannon-Weaver Model immediately outshines conventional HCI models due to its use of non-restrictive terms. “One definition of a CA is a computer system that can perform one or more of the following interaction roles”:

- Whether the data came from a person, another CA, the environment, an animal, etc., the agent that receives it and processes it sends it back to the source as an answer.
- On the other hand, the agent that sends the data to the external source also receives and processes the data that the source sends back to him as an answer.

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A well-developed CA may do both of the above interactions.

Furthermore, the Shannon-Weaver Model does not differentiate between agents since it was first designed to characterize the communication mechanisms that have evolved amongst people.

Nevertheless, this model illustrates the idea of a traditional one-way communication process, which conceals the dynamism of a two-step interaction (request and response). Representing a two-flow sequence experience was an obvious restructuring possibility [19] (Fig. 7).

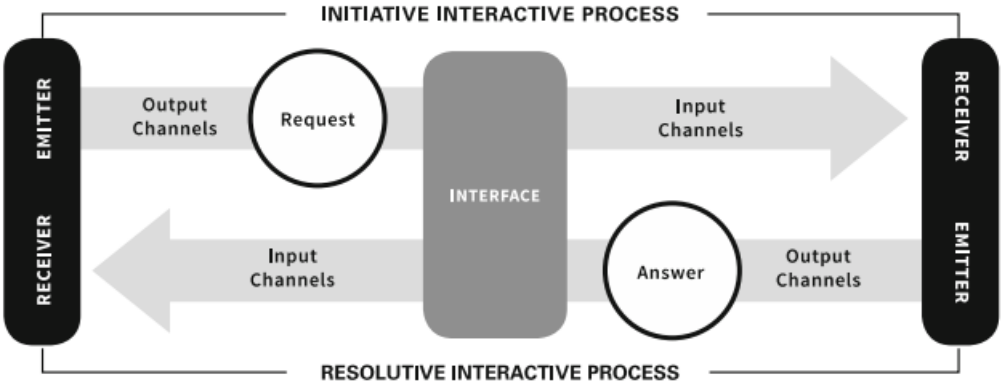

Fig. 7. Basic HCI model

To avoid the assumption of HA control over the produced HCI, the Basic HCI Model refuses to give roles to HA and CA, demonstrating its positional neutrality. This suggests that agents either ask for something and get the desired response or get a request and give it back.

Human-computer interaction (HCI) results from a series of bidirectional communicational events called Interactive Processes (IP):

- To begin, there is the Initiative Interactive Process (IIP), in which a request is made by an emitter over one or more output channels and then received by a receiver through one or more input channels;
- The next step is the Resolutive Interactive Process (RIP), in which the person who was previously receiving the request now acts as an emitter and uses one or more output channels to provide an answer. This answer is then acquired by the original emitter, now acting as a receiver, using one or more input channels.

A. Simple and Complex HCIs

One definition of a simple HCI is an HCI like the one shown in Figure 7, which consists of an emitter agent making a single request and a receiving agent promoting a single answer event. “This type of interaction is known as an Interactive Processes' Conjugated Pair (IP'CP) because the interaction objectives are not instantly satisfied by the establishment of a single request and response sequence; a back-and-forth message exchange flow sequence must occur in a complex HCI (Fig. 8).” This means that two or more IP'CPs must be developed.

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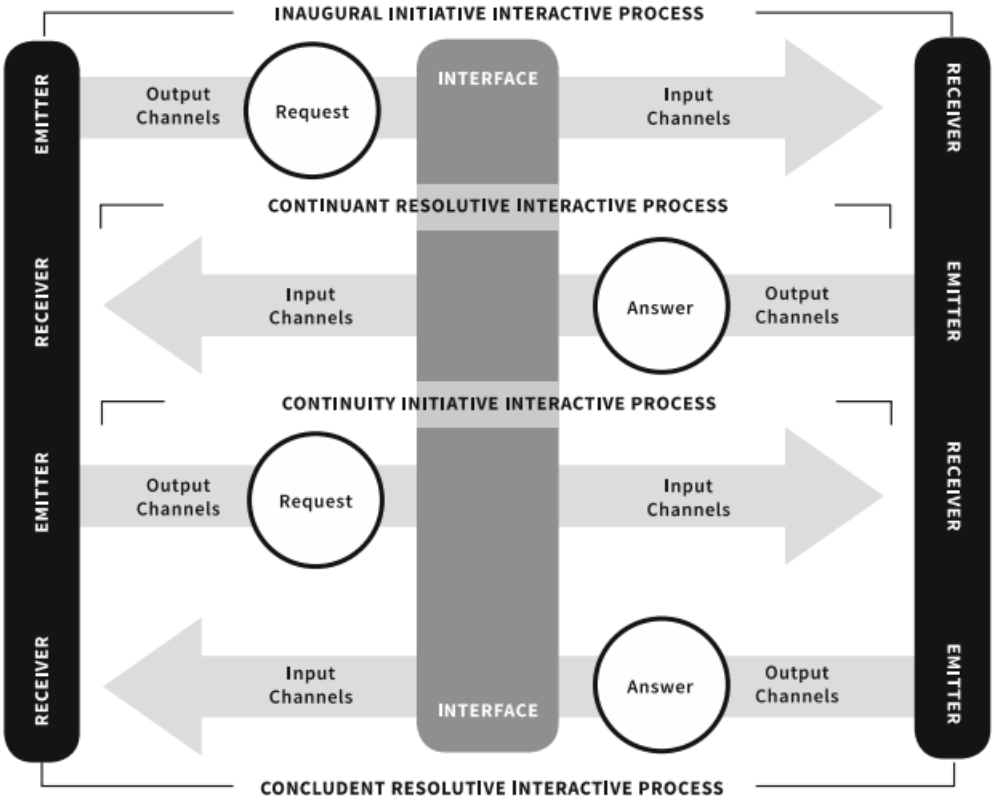

Fig. 8. Advanced HCI, with two IP'CPs

The interaction objectives will be built up methodically throughout this IP exchange flow sequence, with each IP'CP achieving a set of functionally sequenced goals. The Inaugural IIP initiates the HCI, but the Continuant RIP that follows needs to be revised to achieve the interaction's objectives.

As a result, the entity responsible for emitting the Inaugural IIP will provide more IIPs, known as Continuant IIPs. After receiving the Inaugural IIP, the recipient continues receiving RIPs in the same sequence, except for the last RIP, a Concludent RIP.

B. Complex HCI versus Sequence of Autonomous HCIs

A more and more common HCI habit is being fostered by the pervasiveness of digital gadgets in everyday life. Therefore, it is necessary to continuously analyze the actual circumstances in which HCIs are being produced, since another, and so on, often follow one HCI.

To start, keep in mind that not everything shiny is gold. Multiple IP'CPs between HA and CA are not always one Complex HCI (like the one in Fig. 8) but a series of independent HCIs that work together to accomplish their respective purposes. A series of self-contained HCIs might include either Simple or Complex HCIs or a mix of the two. “Furthermore, two options should be evaluated in light of the potential for complete parity between the HA's and CA's technological and cognitive capacities in HCI development (e.g., with the ability to begin an HCI or to specify the objectives of the interaction):”

(1) A chain of self-operating HCIs started by the same person (Fig. 9);

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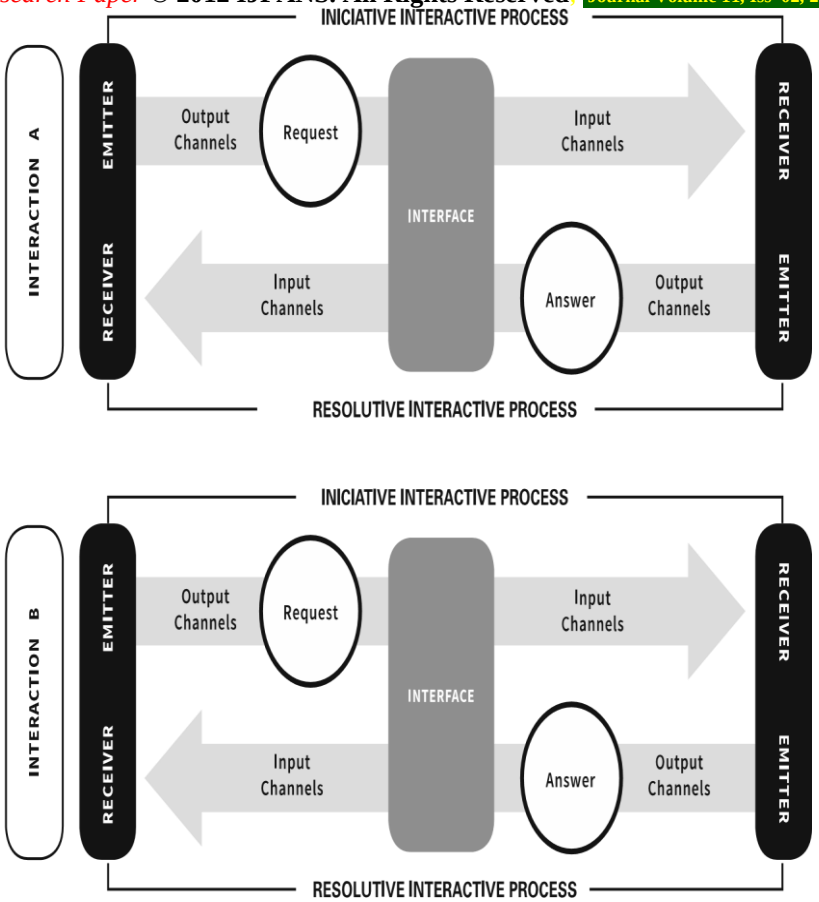

Fig. 9. A pair of independent Simple HCIs started by the same agent

(2) Alternatively, a series of independent HCIs launched by separate entities.

Regardless of who starts the sequence's autonomous HCIs, we must still identify:

(1) Completely independent IP creation (Fig. 10);
(2) Intertwined IPs, with some overlap in their implementation (Fig. 11).

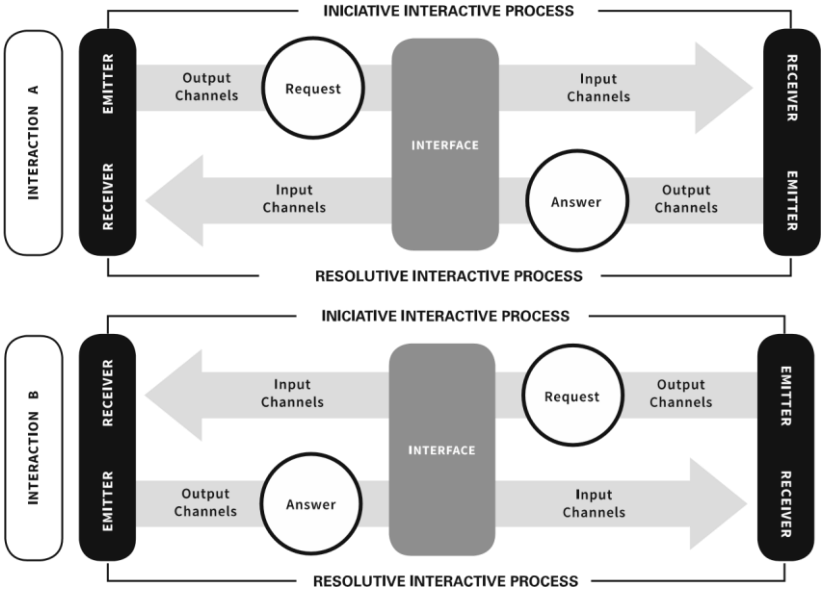

Fig. 10. Two separate, independent Simple HCIs launched by competing entities

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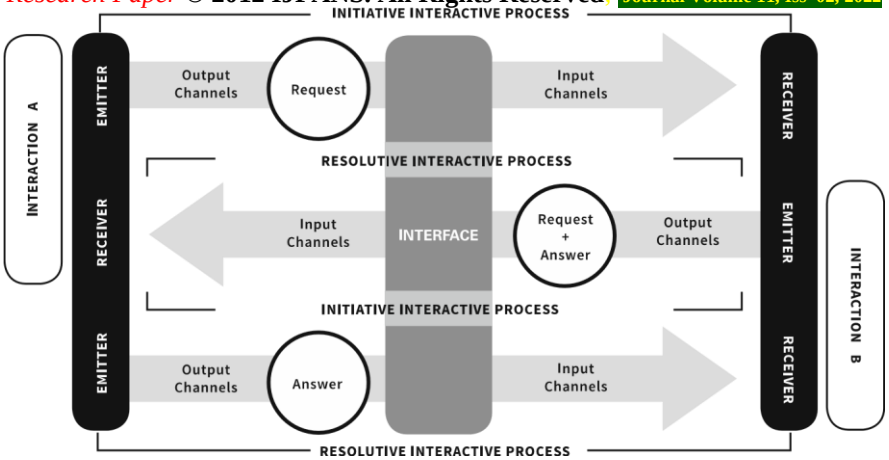

Fig. 11. Two separate but interdependent Simple HCIs with overlapping IPs

Each scenario depicts two separate HCIs, each with its own set of objectives for the interaction; however, the entanglement in the second scenario shows that a single communicational event can play two roles at once; that is, a message can be both an answer and a request.

V. CONCLUSION

Ultimately, the thorough framework provided by Human-Centered Design and Evaluation is an excellent resource for developing and improving systems, goods, or services that prioritize the requirements and desires of end users. This framework offers a systematic method that improves the user experience and fosters flexibility and long-term success by combining comprehensive research, empathic understanding, and iterative design.

Starting with user research and discovery, contextual inquiry and ethnographic investigations highlight the necessity of understanding user viewpoints. A more targeted and user-centric ideation phase follows the formulation of precise issue statements and mapping user journeys, which guide the design process.

Crucial to the design process, prototyping, and usability testing enable designers to materialize ideas into experiences and collect insightful feedback for improvements. Working in tandem with development teams, the implementation phase guarantees an exact realization of the design concept while upholding a dedication to accessibility and diversity.

Usability tests and iterative design are part of the evaluation phase, laying the groundwork for a successful product or service launch. A culture of continual improvement is established via post-launch monitoring, documentation, and information sharing.

Privacy, security, inclusion, and diversity are emphasized as ethical factors that permeate the whole process. A comprehensive view like this acknowledges that good designs are dynamic and adapt to new technology and user demands.

Encapsulating the concepts of Human-Centered Design, this framework promotes a user-focused attitude and keeps the end-users at the center of design and assessment. By adopting this all-encompassing method, design teams may successfully traverse the design landscape's intricacies, producing solutions that solve current problems and endure over time.

VI. REFERENCES

[1]. Thatcher, A. Green Ergonomics: Definition and Scope. Ergonomics 2011, 56, 389–398. [Google Scholar] [CrossRef] [PubMed]

[2]. World Commission on Environment and Development. Our Common Future; Oxford University Press: Oxford, UK, 1987. [Google Scholar]

[3]. United Nations. Report of the World Summit on Sustainable Development Johannesburg, South Africa (26 August—4 September 2002); United Nations: New York, NY, USA, 2002.

[4]. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development; United Nations: New York, NY, USA, 2015.

[5]. Ceschin, F.; Gaziulusoy, I. Evolution of Design for Sustainability: From Product Design to Design for System Innovations and Transitions. Des. Stud. 2016, 47, 118–163. [Google Scholar] [CrossRef]

[6]. Zhang, T.; Dong, H. Human-Centred Design: An Emergent Conceptual Model; Royal College of Art: London, UK, 2009. [Google Scholar]

[7]. Giacomin, J. What Is Human-Centred Design? Des. J. 2014, 17, 606–623. [Google Scholar] [CrossRef]

[8]. ISO 9241-210:2010; Ergonomics of Human-System Interaction—Part 210: Human-Centred Design for Interactive Systems. International Organization for Standardization: Geneva, Switzerland, 2010.

[9]. Sevaldson, B. Beyond User-Centric Design. In Proceedings of the Relating Systems Thinking and Design 2020 (RSD9), Turin, Italy, 23–28 October 2018; pp. 516–525. [Google Scholar]

[10]. Manzini, E.; Jégou, F.; Meroni, A. Design Oriented Scenarios: Generating New Shared Visions of Sustainable Product Service Systems. In Design for Sustainability: A Step-by-Step Approach; Crul, M.R.M., Diehl, J.C., Ryan, C., Eds.; United Nations Environment Programme; Delft University of Technology: Delft, The Netherlands, 2009; p. 1532. [Google Scholar]

[11]. Martin, K.; Legg, S.; Brown, C. Designing for Sustainability: Ergonomics—Carpe Diem. Ergonomics 2013, 56, 365–388. [Google Scholar] [CrossRef] [PubMed]

[12]. Attaianese, E.; Rossi, E. Themes of a Research Agenda for Sustainable Human Centred Design. In Ergonomics and Nudging for Health, Safety and Happiness. SIE 2022; Bellandi, T., Albolino, S., Bilancini, E., Eds.; Springer: Cham, Switzerland, 2023; pp. 168–178. [Google Scholar] [CrossRef]

[13]. International Ergonomics Association. Available online: https://iea.cc/what-is-ergonomics/ (accessed on 14 May 2022).

[14]. Thatcher, A.; Yeow, P.H.P. A Sustainable System of Systems Approach: A New HFE Paradigm. Ergonomics 2016, 59, 167–178. [Google Scholar] [CrossRef]

[15]. Drury, C.; Hancock, P.A. For a Sustainable World, What Should HFE Optimise? In Human Factors for Sustainability: Theoretical Perspectives and Global Applications; Thatcher, A., Zink, K.J., Fischer, K., Eds.; CRC Press: Boca Raton, FL, USA, 2019; pp. 35–50. [Google Scholar]

[16]. Bolis, I.; Sigahi, T.F.; Thatcher, A.; Saltorato, P.; Morioka, S.N. Contribution of Ergonomics and Human Factors to Sustainable Development: A Systematic Literature Review. Ergonomics 2022, 66, 303–321. [Google Scholar] [CrossRef]

[17]. Rathore, B.; Biswas, B.; Gupta, R.; Biswas, I. A Retrospective Analysis of the Evolution of Ergonomics for Environmental Sustainability. Ergonomics 2022, 66, 730–748. [Google Scholar] [CrossRef]

[18]. International Ergonomics Association. Available online: https://iea.cc/member/human-factors-and-sustainable-development/ (accessed on 15 May 2022).

[19]. Rafael, S.: Para uma Taxonomia da Multimodalidade na Interacção Homem-Computador. Proposta Aberta de Classificação Pluridimensional. [Towards a taxonomy of multimodality in human-computer interaction. An open and pluridimensional classification proposal]. Ph. D. thesis. Lisbon University of Lisbon, Portugal (2015)

[20]. Bailey, K.D.: Methods of Social Research. FreePress, New York (1994)

[21]. Chignell, M.H., Hancock, P.A.: Intelligent interface design. In: Helander, M. (ed.) Handbook of Human-Computer Interaction, pp. 969–991. Elsevier Science Publishers, Amsterdam (1988)

[22]. Maybury, M., Wahlster, W.: Intelligent user interfaces: an introduction. In: Maybury, M.E, Wahlster, W. (eds.) Readings in Intelligent User Interfaces. Morgan Kaufmann Publishers (1998)

[23]. Bolter, J.D., Grusin, R.: Remediation: Understanding New Media. The MIT Press, Cambridge (2000)

[24]. Nigay, L.: Conception et modélisation logicielles des systèmes interactifs: application aux interfaces multimodales. [Software design and implementation of interactive systems: a case study of multimodal interfaces]. Ph.D. thesis. Université Joseph Fourier – Grenoble 1 (1994)

[25]. Nigay, L., Coutaz, J.l.: Multi feature systems: the CARE properties and their impact on software design. In: Intelligence and Multimodality in Multimedia Interfaces. AAAI Press (1997)

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 02, 2022

[26]. Schomaker, L., Nijtmans, A.J., Camurri, F. Lavagetto, P., Morasso, C., Benoit, T., et al.: A taxonomy of multimodal interaction in the human information processing system. Multimodal Integration for Advanced Multimedia Interfaces (MIAMI). ESPRIT III, Basic Research Project 8579 (1995)

[27]. D'Ulizia, A.: Exploring multimodal input fusion strategies. In: Grifoni, P. (ed.) Multimodal Human-Computer Interaction and Pervasive Services, pp. 34–57. IGI Global, Hershey, New York (2009)

[28]. Caschera, M.C., Ferri, F., Grifoni, P.: Multimodal interaction systems: information and time features. Int. J. Web Grid Serv. 3(1), 82–99 (2007)

[29]. Emsenhuber, B.: Scent marketing: making olfactory advertising pervasive. In: Müller, J., Alt, F., Michelis, D. (eds.) Pervasive Advertising Human-Computer Interaction Series. Springer, London (2011)