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# Unlocking Social Innovation in XR for Healthcare in Coastal Communities


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## Abstract

This position paper reconsiders the "social" aspect of XR systems for healthcare, often developed following a "problem-solution" approach that neglects sociocultural factors affecting their codesign and successful adoption. Focusing on coastal and rural communities, we review and present key principles to consider when codesigning XR systems with marginalised groups. Our work stems from two projects funded by UK Research & Innovation that aim to promote healthy ageing in coastal communities.



**Index Terms:** Applied Computing—Life and Medical Sciences—Health informatics—; Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Virtual reality; Human-centered computing—Interaction design—Interaction design process and methods—Participatory design


Figure 1: Our research team 3D scanning the Stair Hall in Powderham Castle to produce XRH digital assets, Exeter, South West England. The image was captured by Reyes [45] and it is used with the owner's permission.

## 1 Introduction

Extended reality for health and care (XRH) products are often developed in isolation from end-users, without acknowledging factors likely to impact real-world implementation. Following initial development, systems commonly undergo feasibility studies to assess impact or benefits, however, rigorous and structured feasibility studies provide little insight into effectiveness of the XRH system [16], that is, the impact and adoption of the product in a real-world setting. This leads to products that poorly match evidential and implementation requirements for successful delivery to market. Barriers that can be underappreciated without engaging stakeholders include realistic perception of price, digital health literacy of those who facilitate device use, and technical aspects such as connectivity infrastructure [14]. Should follow-up trials occur, these generally note organisational and systemic barriers to technology adoption or success, such as restricted staff capacity in care settings or limited individual expertise and digital confidence, ultimately requiring XRH system design amendments [36]. The high rate of development and obsolescence in the immersive sector exacerbates this implementation challenge [29] with overworked healthcare staff unable to maintain pace with increasingly demanding digital skills, further emphasising digital health access inequalities [50].

This position paper emerges from two ongoing research projects funded by UK Research and Innovation involving rural and coastal communities on the cocreation of XRH: 'Generating older active lives digitally' (GOALD) and 'Intergenerational codesign of novel technologies in coastal communities' (ICONIC). We are working with ageing users in local care homes and intergenerational groups on the co-development of XRH systems stimulating new forms of access and engagement with local sites of natural and cultural significance. We do not present XRH as a 'means of engagement', but as a method to empower users and communities [4, 6] to deliver transformational change, broadening accessibility to sites and technologies otherwise out of reach of user groups disenfranchised from mainstream technological discourse. For example, our projects have enabled care home-bound older adults to engage with sites of local familiarity and sociocultural significance (see Fig. 1), aiming to improve their wellbeing while actively involving them in the codesign of new experiences that reminisce their former, active selves.

Addressing inequalities of access to sites of natural and cultural significance via XRH is a significant challenge, with documented health and wellbeing benefits such as improved quality of life, opportunity for reminiscence and connectedness to spaces and history [27]. Older adults in particular are invested in heritage, yet face exclusion both at the physical site and through digital access: in addition to lack of access to the cocreation of XRH, physical access to cultural or heritage sites is often limited due to site characteristics and conservation issues (e.g. uneven ground, or the inability to implement accessibility features) [18]. XRH can therefore aid in inclusivity for those with physical and sensory barriers [23], particularly prevalent for older adults in care homes. Furthermore, XRH codesign interventions in GOALD and ICONIC are expected to provide a meaningful activity for older adults, care home residents or patients, improving their quality of life and physical and mental health [35]. Steptoe et al. [38], reported on a bidirectional relationship between physical health and subjective wellbeing, suggesting psychological wellbeing can provide a protective role. As XRH innovations may have potential to enhance psychological wellbeing, physical health and social connectedness, exploring suitable codesign of XRH to meet the needs of health and care stakeholders and organisational implementation requirements could help provide a useful tool in supporting the health and social care system, and particularly for our ageing population (Fig. 2).

Literature indicates that higher proportions of older people are located in coastal regions in the United Kingdom [41]. Asthana & Gibson [1] reported on the limited public health literature focused on coastal areas, despite a reported public health crisis for those communities. Sources suggest a high burden of ill health, poor outcomes for young people, low educational levels and high rates


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Figure 2: XRH codesign and feedback activity in a local care home in Cornwall, England. The image was captured by Wilmot [49] and it is used with the owner's permission.

of self-harm, suicide and substance misuse, potentially linked to economic decline and socioeconomic deprivation in coastal areas [7]. Coastal areas can also face challenges of rurality that impact digital equality. Socio-economic and geographic marginalisation can impact prevalence of digital infrastructure within rural communities [4].

Our research context is then delineated by the health and wellbeing implications of XHR for older adults, combined with issues faced in the typical development of XRH in excluding end-users at design stage (and involving them mainly for testing stages), and the lack of engagement with real-world implementation settings to ensure suitability for adoption. Specifically, the GOALD project focuses on XHR for physical activity and reminiscence, while the ICONIC project focuses on intergenerational cocreation of XHR in coastal communities with older adults and young people, alongside additional work packages on telepresence, social games and AI for communication.

Prior work has demonstrated the importance of engaging end-users in design for other technologies aimed at health and care [3], and noted the importance of effectiveness (testing within real-world settings and contexts) rather than highly controlled trials demonstrating efficacy [2]. We focus particularly on the context of rural and ageing communities, due to the specific impact of digital inequalities on these areas. In this position paper we identify 3 core tenets (methodological, theoretical, and technological) for XRH codesign with rural and coastal communities. First, we discuss methodological issues arising from transdisciplinarity in the context of XRH codesign activity. Then, we describe our position regarding the theoretical contextualisation of place-based XRH codesign interventions, and last we identify key technological approaches for XRH codesign which facilitate embeddedness, participation, and access.

## 2 Codesign and transdisciplinary boundaries

In our research, XRH development involves end users as well as specialists from healthcare, technology, and design fields. Here we recognise an initial point of contention - that of implementing codesign methods from diverging disciplinary views, epistemologies, and value systems. In an attempt to facilitate a rich transdisciplinary dialogue, we see XRH as an 'information ecology' [47], a broader and inclusive space for exchange and cocreation not necessarily restricted by disciplinary boundaries and conventions. We present the collaborative design of XRH as a 'complexified' [42] synthesis across design, history and health disciplines and their corresponding analytical strengths [25], mobilising them into innovation which would not be otherwise available to any particular field of specialisation [15]. This is further emphasised by our methodological approach 'on-site', embedding researchers in residence [19] in different participating communities, negotiating the hybridisation of both technical and creative directions [26] for XRH codesign.

Secondly, we recognise a temporal boundary on the way we engage with end users, audiences and disciplines. In 1969, Herbert Simon [31] framed design research within a natural sciences paradigm. The work of Simon was foundational on developing scientific approaches to design research such as the problem-solution co-evolution model [8] and protocol analyses [12], and additionally addresses the notion of 'cognitive comparative advantage', in which early ideas of machine and artificial intelligence are set on imagining human-computer collaborative futures [17]. Here, we see XRH design as an instrumental space for future-making in transdisciplinary collaboration [21], continuously negotiating both reflective (focused on past and lived experiences) and projective (focused on speculative future visions and imaginaries) actions. Although this temporal distinction has been hardly explored within healthcare and design literature (see for instance the work of Burke and Veliz Reyes on the codesign of care home facilities for dementia patients [5]), it gains relevance in the development of XRH in the context of communities often deprived of the means of envisioning futures amid pressing socioeconomic and accessibility challenges. We propose an assertive methodological approach based on the creative future-making contributions of rural and coastal communities, addressing the needs of users with significant hardships through visibilising their future aspirations and creative drive rich in lived experiences and unexplored socio-cultural legacies [9].

## 3 Framing a 'conceptual' home and a 'societal' place

As mentioned above, a consequence of a transdisciplinary approach is the diverging epistemologies around XRH, in particular regarding codesign and social innovation. There is, however, a body of research that stresses the place-based nature of social innovation, and the need to contextualise social innovation within specific societal groups and geographies. Slee et al [34] detail how there is no 'theoretical home' for social innovation, with multiple interpretations and definitions across a range of disciplines [34]. Yet, social innovation has thrown 'light on complex processes of socioeconomic and spatial restructuring that have emerged at multiple levels in developed Western economies, especially as responses to the challenges confronting marginalised rural areas' [11]. The proposals by Pel et al. [24] identify, among others, the relevance of socio-material contexts on shaping social innovation initiatives, and nationally, all UK Research & Innovation Strategic Delivery Plans have set an objective to develop 'world-class places' through agile and responsive innovation ecosystems [44]. Locally in South West England, Willis [48] stresses the need to make a 'place' for ICT in rural communities, 'both metaphorically in terms of the sense of community, and literally as a particular space' in which ICT is developed, shared and taken care of.

While our work does not attempt to define social innovation more broadly, it does align with the need to acknowledge the socio-material contexts and places in which XRH is codesigned, developed and implemented. Our focus on rural and coastal communities considers conditions of 'place' on the codesign of XRH both metaphorically but also logistically; we need to address challenges such as limited connectivity infrastructure, lack of existing digital infrastructures, or limited access to local follow-on funding. On the other hand, we expect XRH codesign to unwrap and sustain local and social infrastructures (such as the development of local skills addressing digital inequalities) that stimulate place-based collective change [46]. To achieve this we work with a broad ecosystem of partners that do not only engage as end users (e.g. Cornwall Care, iSight Cornwall), but also manage local sites of cultural and natural significance for XRH case study development ( e.g. Cornwall Area of Outstanding Natural Beauty, Dartmoor National Park Authority), local skills delivery partners (e.g. Cornwall & Isles of Scilly Digital Skills Network, City College Plymouth) and technological business partnerships (e.g. Hi9, Plymouth Digital Inclusion Network, Made Open, Wildanet).

## 4 On the 'extended' in XRH

The study of local sites' interpretation plans use as a basis for XRH experiences has revealed the need to rethink the 'extended' in 'extended reality'. Codesign with end users can result in more experiential, compelling and engaging systems 'beyond the visual' dimension, with complex multimodal and sensorial layers of interaction, physical activity and perception modalities. [22]. User perception of realism in an immersive environment plays a pivotal role in the creation of a convincing immersive virtual environment [33] with the main contributing factors being the place illusion and the plausibility illusion [32]. The place illusion is the sense of presence or the sensation of "being there", and it is mainly dependent on the multisensory perception such as vision, hearing, olfactory, gustatory and tactile with the addition to proprioception [43] (the sense of force and position). The plausibility illusion refers to the degree of belief the participant experiences in a particular immersive scenario and interaction with elements inside the virtual environment which adds to the credibility of the experience (see Fig. 3).

A multimodal approach [20] impacts the perceived quality of the experience in areas such as realism, presence and immersion [13]. Furthermore, the interaction between various sensory modalities, crossmodality [37], can affect the perceived experience and can be exploited to create and deliver virtual experiences that engage the user into experiencing non-geometric assets such as the perception of weight of a virtual object [28]. All these factors require careful consideration in the design process of an immersive experience, as individuals have different tolerances and sensitivities in the use of their senses and even more so for older age users which can present an additional challenge from a sensory decline due to ageing [39,40]. This makes their involvement in the codesign process crucial to the development of XRH that survives beyond the trial stage of a research prototype. In order to gauge this valuable feedback, our technological codesign process employs an iterative approach [30] with methods such as brainstorming and problem framing, storyboarding, physical prototyping using photography and film, and digital immersive prototypes with multimodal interaction.

## 5 Conclusion

This position paper asserts that compelling, engaging and useful XRH experiences cannot be developed in isolation from the communities of users and broader technological ecosystems they intend to support. Beyond a purely methodological approach, we pose the challenge of revisiting disciplinary, methodological, and technological conventions applicable to XRH development in order to increase XRH systems' effectiveness, and support developers on meeting evidential implementation requirements for successful delivery to market in the health sector. We hope that this position paper draws the attention of the XRH community toward the relevance and timeliness of broader, place-based and inclusive directions for XRH development.


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Figure 3: Lighting and textural design in an interactive XR environment of Powderham Castle. The image was captured by Garghouti [10] and it is used with the owner's permission.

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