Theatrical Co-Design with Families: Exploring Sustainability through the Creation of a Mixed-Reality Installation

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Co-designing with families for environmental sustainability relies on participatory imagination, yet habitual family roles and uneven voice, especially between adults and young children, often constrain it. A second challenge is translation across phases: workshop relationships and embodied ways of working do not easily survive into the final design, where artefacts travel more frequently than roles or interactional dynamics. We report on a nationally toured mixed-reality installation developed through applied-theatre-led co-design. Across three workshops, a professional theatre facilitator used applied theatre methods to support families to co-create narratives, artefacts, and interactional roles, and to re-stage workshop ecologies in the public encounter. We show how theatrical co-design fostered richer dialogue and collective creativity that persisted beyond workshops. We distil three design orientations for co-creating mixed-reality performances through applied theatre: rebalancing participation through status play, sustaining embodied practice across phases, and re-staging workshop ecologies within the installation.

CCS CONCEPTS • Human-centered computing ~Human computer interaction (HCI) ~HCI design and evaluation methods • Human-centered computing~ Interaction design ~Interaction design process and methods~ Participatory design • Human-centered computing ~Human computer interaction (HCI)~ HCI theory, concepts and models.

Additional Keywords and Phrases: co-design, applied theatre, families, art installation, sustainability

1. INTRODUCTION

Designing technologies to engage people with environmental sustainability is widely recognised as a wicked problem, requiring creative and multifaceted approaches (Kuznetsov and Tomitsch, 2018). Within HCI, ecologically engaged art has emerged as one response, using participatory artworks to prompt reflection on environmental issues (DiSalvo et al., 2009; Jacobs et al., 2013; Mendes et al., 2012). However, in family contexts, climate issues can be difficult for children to grasp, while adult dominance may restrict equitable participation. We report on HOME: Zero, a performance-led, tourable mixed-reality artwork co-designed with families and presented across national and community venues (256 performances across eight venues, 2022–2025, with over 1,300 visitors). This interactive performance invites families into a fantastical world in which time is running out, and uses historic paintings as prompts for imagining a more sustainable domestic life.

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Published by BCS Learning and Development Ltd.
Proceedings of BCS HCI 2026, UK



Figure 1: *HOME: Zero was co-created with families using theatrical methods to engage audiences in discussing and pledging to environmental interventions in their own family lives.*

Commissioned by Nesta and National Gallery X (NGX) and created by Makers of Imaginary Worlds, specialists in family interactive art, the project embedded applied-theatre practices within co-design workshops to support imaginative contributions from children and parents that were later translated into the final installation. We use this case to examine how applied-theatre co-design can structure more equitable intergenerational participation under real production constraints. In doing so, we identify two key tensions: entrenched adult–child hierarchies and the challenge of combining co-design with applied theatre—two participatory traditions with different lineages—within a professionally commissioned process. We propose three theatre-informed design orientations for family co-design: rebalancing child–adult power, sustaining theatrical embodiment, and re-staging workshop ecologies within the final installation through expert facilitation. We further identify mechanisms for carrying theatrical co-design into public-facing mixed-reality artworks, showing how performance-led methods can support creativity for environmental sustainability through embodied ideation and intergenerational collaboration.

2. RELATED WORK

In order to situate our study, we review three strands of related work. First, we consider research on co-designing for wicked societal challenges with families, which surfaces the opportunities and tensions of intergenerational participation. Second, we turn to applied theatre, a field with a long history of engaging communities in collective reflection and social change. Third, we examine how theatre-based methods have already been incorporated into co-design, highlighting both their affordances and their limitations.

2.1 Co-designing for Wicked Problems with Families

This subsection shows why co-design with families is appropriate for wicked challenges and surfaces tensions that our theatre-informed approach addresses. Co-design emerged within the participatory design (PD) tradition (Sanders and Stappers, 2008) and has become increasingly prominent in HCI, enabling designers and people from diverse backgrounds to collaborate throughout the design process and address complex challenges. PD itself arose in the 1970s to rebalance power between managers and workers in the development of information technology, and has since been applied to diverse societal challenges. Built on principles of collaboration, co-creation, and empowerment (Bødker and Kyng, 2018), co-design is well suited to developing installations that aim to engage families in conversations about sustainable behaviour.

Promoting sustainable behaviour in the home and achieving a net zero carbon future is a form of wicked problem, as there is not a definitive or optimal solution, the problem space is ambiguously defined, and there are multiple stakeholders (Churchman, 1967; Rittel and Webber, 1973). Studies of sustainability-related design have shown that co-design supports richer idea generation and broader perspectives than consultative approaches (Mitchell et al., 2016). Direct experience of the problem space also enhances creative contributions (Kristensson et al., 2002). In our project, families were engaged as experts on their own homes, with children and adults both bringing relevant perspectives on climate change and domestic practices.

However, involving families in co-design raises distinctive challenges. Early work demonstrated a range of methods—from cultural probes to low-tech prototyping—that helped families generate ideas (Milien et al., 2004; Westerlund et al., 2003; Xie et al., 2012). Yet these studies also highlighted tensions: the need to balance children's and adults' contributions, and to ensure that all participants felt their input was valued regardless of age or experience.

More recent research has focused on how intergenerational dynamics unfold over time. Yip et al. found that co-design with families is often slow and transitional, with parents shifting more gradually than children from facilitators to full design partners (Yip et al., 2016). They propose that achieving truly equal partnerships requires careful structuring of facilitation, relationship building, design-by-doing, and elaborating together (Yip et al., 2017). The most ambitious goal—families collectively imagining and committing to ecological change—demands conditions that support equitable collaboration between generations. In what follows, we turn to applied theatre as a distinctive set of practices that can address precisely these challenges.

2.2 Applied Theatre: Engaging with Audiences and Addressing Wicked Societal Challenges

Applied theatre offers both conceptual and practical resources for intergenerational participatory design. Its traditions often involve non-professional participants in collective, socially oriented processes, resonating with co-design's emphasis on agency and collaboration. Boal's Theatre of the Oppressed is central: by inviting "spect-actors" to intervene in staged dilemmas, it shifts audiences from passive witnesses to active participants (Boal, 1979). This parallels co-design, where users become collaborators in shaping outcomes, although theatre often works symbolically while co-design must also address tangible, material systems.

Applied theatre also includes less overtly political but still socially engaged practices that foster agency, identity, and solidarity. Vettraino et al., for example, argue that applied theatre can empower marginalised young people when treated as a philosophy of co-creation rather than an "add-on" (Vettraino et al., 2017). Its practical repertoire further supports imagination, embodiment, and collective play: Boal's games help participants interrogate social realities and propose alternatives (Boal, 2002), while related work shows how such methods cultivate embodied, emotional, and relational awareness (Boal, 1979; Ghoshal and Manna, 2020). Johnstone's Impro adds attention to spontaneity and status dynamics (Johnstone, 1987), and Johnston's House of Games emphasises facilitation, safety, group-building, and everyday experience as creative material (Johnston, 1998). Devising approaches likewise treat artworks, materials, and emergent interactions as generative sources that can migrate across contexts (Oddey, 2013), anticipating our concern with how workshop artefacts are transposed into an installation.

Together, these traditions position applied theatre not simply as a toolbox of games, but as a practice combining methods, facilitation, and social orientation. Transposed into co-design, they offer strategies for embodied, dialogic, and imaginative collaboration.

2.3 Applied Theatre in Participatory Design

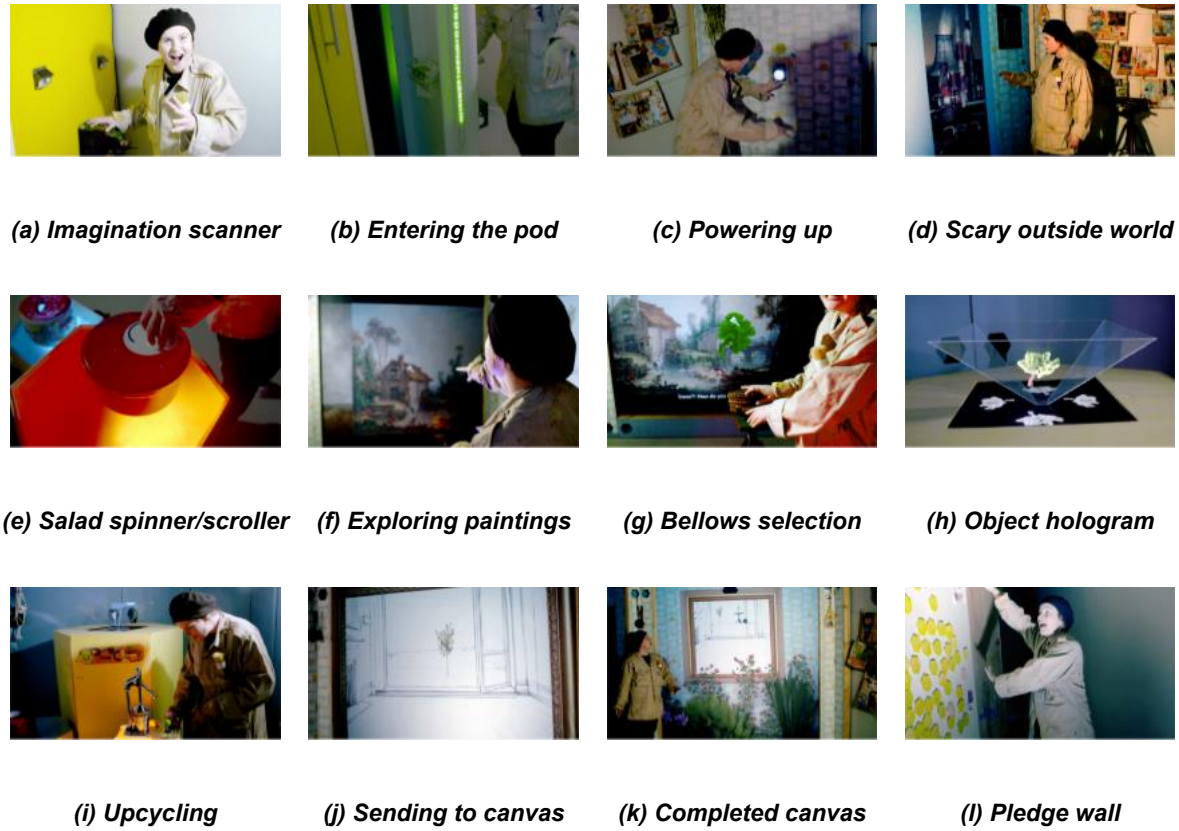
HCI has drawn on applied theatre in several co-design contexts. Mehto et al. (2006) used playback theatre, forum theatre, and improvisational workshops to elicit emotional and communal insights from professional groups such as teachers and nurses. Vines et al. (2014) developed Experience Design Theatre, where actors performed care scenarios to prompt stakeholder reflection, although participants often remained audiences rather than co-creators. Later work shows how theatre-based methods can support inclusion and reflexivity: Tzanidou et al. (2023) involved visually impaired artists in co-designing Touch Sensory Tours, while Polido et al.'s Theatre of the Innova(c)tors (2025) used Boal-inspired methods to challenge power relations and co-create alternative narratives.

With children, Schaper and Parés adapted physical theatre techniques to support embodied awareness, non-verbal expression, and playful collaboration, leading to a full-body interactive prototype inspired by A Midsummer Night's Dream (Schaper and Pares, 2021). Ventä-Olkkonen et al. (2022) combined Theatre of the Oppressed with participatory design to address bullying, involving pupils, teachers, and researchers in developing prototypes and a final spect-actor performance.

These studies show that theatre-based participatory design can support embodied co-creation, empathy, reflection, and the amplification of marginalised voices. However, work with children has mostly been pedagogical or researcher-led, often ending in classroom prototypes, with adults positioned as facilitators rather than co-participants. Less explored is the intergenerational case where families co-design together within a professional commission, requiring equitable participation despite adult–child hierarchies, compressed timelines, and the need for outcomes that resonate beyond the workshop. Our study addresses this gap by examining how applied theatre can structure participation across both co-design workshops and a public-facing artwork.

3. HOME: ZERO

Before turning to the co-design process, we outline HOME: Zero through the audience journey storyboard in Figure 2, with the accompanying video providing a walkthrough. The installation is a large wooden hexagonal space entered through a recycled 1950s-style fridge door, combining rear-projected walls, spatialised sound, central interactive plinths, and physical props. The twenty-five-minute experience hosts six to eight participants. Families are greeted outside by a performer, who uses an "imagination scanner" to playfully tell children their imagination levels exceed adults', before leading everyone inside. There, families meet Kitty, the disembodied voice of the homeowner, who guides them alongside the performer.



(a) Imagination scanner ***(b) Entering the pod*** ***(c) Powering up*** ***(d) Scary outside world***

(e) Salad spinner/scroller ***(f) Exploring paintings*** ***(g) Bellows selection*** ***(h) Object hologram***

(i) Upcycling ***(j) Sending to canvas*** ***(k) Completed canvas*** ***(l) Pledge wall***

Figure 2: *Overview of the installation: storyboard of the audience journey (performer image used with permission).*

A projected door opens to reveal a devastated world outside, and Kitty urges participants to pause time before inviting them to find solutions. The projected walls shift to reveal paintings from NGX's art collection, alongside a simple canvas sketch of a room and a sketchbook with notes and hints. Participants are then invited to help Kitty find solutions using the paintings by spinning a salad spinner to scroll through a series of ten paintings, pointing the bellows to highlight selectable objects, and pressing the bellows down to capture an object into the upcycler as a floating 3D hologram. Captured objects can then be upcycled with the wooden game controller and placed onto a blank canvas, with families repeating the process across different paintings. After a while, Kitty announces the task is complete and the family's canvas is revealed. Outside, each family receives a small hexagonal block to write an environmental pledge. These pledges are then added to the hexagon's exterior wall, forming a growing artwork of shared commitments for others to explore.

4. PROCESS OF CO-DESIGNING WITH FAMILIES

The team's approach was to put children at the heart of the experience and enable the family to work as a collective unit, which could support members in participating together and influencing each other. The team was also committed to the use of co-design methodology to develop the experience from the start and this was a key component of the pitch submitted to NGX's open call.

The key decision was to explore the integration of applied theatre and devising practices into the co-design sessions by engaging a professional performer/facilitator to lead these. The co-design process unfolded over seven months, from submission of the original pitch to the funders in November 2021 through to public exhibition in May 2022. While the original pitch sketched a vision of how the installation might potentially appear, specific choices of digital technologies, their integration into physical sets and props, and the narrative that held the experience together were reliant on the outcomes of the co-design workshops.

4.1 Method

We frame the project as Performance-led Research in the Wild (Benford et al., 2013): a production led by professional artists under real institutional constraints, analysed retrospectively as an HCI design case. We assembled a corpus spanning pitch-to-tour, including commissioning/pitch documents; workshop plans and session notes; family-generated outputs (drawings, prototypes,

annotations) and photographic documentation; user-testing materials and design-change records; documentation of the final installation (storyboard, key artefacts, audience journey); and a semi-structured interview with the performer–facilitator. We analysed the corpus through situated design reflection by (i) building a timeline linking workshop activities to subsequent design decisions and installation features, (ii) identifying critical episodes of participation and workshop-to-installation transfer, and (iii) synthesising episodes into the three design orientations reported. Interpretations were cross-referenced against documented outputs and project decisions. The lead practitioner/artist is a co-author; their account is treated as reflexive memoing and checked against project documents, artefacts, and the facilitator interview.

4.2 Co-design Participants

Local families with children aged 6-10 years were recruited to participate in the series of three workshops. Recruitment was through an online campaign and direct mailing to families delivered by Lakeside Arts which had a very good response with all places booked within one week. The decision was taken to 'overbook', which proved to be a good choice given the drop-off from 17 registered families to 11 attending the first workshop, with 9 families staying with the project from beginning to end (see Table 1).

Alongside the families, the workshops also involved the lead artist and the performer–facilitator. The lead artist set the aesthetic direction and curated ideas, while the facilitator led theatrical activities. Decisions were partly collective (e.g. families voted for the kitchen as the setting in Workshop 1) and partly curated, with recurring or feasible ideas taken forward. This ensured participants' contributions were visible in the final work, such as the bellows mechanism from a child's "sucking machine" and the "stop time" feature from family discussions.

Ethics approval for the research was obtained from the University of Nottingham ethics board. Consent was obtained at the beginning of the first co-design workshop. Consent forms and special information sheets were provided for the children; this practice was remarked on positively by the parents who carefully went through the details on the form with their children. Everyone in the groups consented to take part in the research project and for photographs to be made publicly available.

Table 1: *Workshop Participants*

Family	**Workshop Participants**		
	Number of Adults	*Number of Children*	*Children age(s)*
Family of 4	*2*	*2*	*7, 9*
Family of 3	*2*	*1*	*7*
Family of 4	*2*	*2*	*6, 10*
Family of 3	*1*	*2*	*9-Twins*
Family of 2	*1*	*1*	*10*
Family of 2	*1*	*1*	*6*
Family of 3	*1*	*2*	*6, 8*
Family of 3	*2*	*1*	*8*
Family of 2	*1*	*1*	*8*

4.3 The Pitch

The project began with an open R&D commission from NGX to reinterpret selected historic paintings from its collection in ways that could engage families with climate change and household emissions. The brief invited artists to draw lessons from how people lived in the past and imagine how these might inform more sustainable futures. In response, the artists proposed an immersive mixed-reality installation in which families would encounter altered digital paintings, guided by "The Old Keeper", and work together to discover what had gone wrong. Using projected controls and mixed-reality elements, they would "fix" the paintings and leave by adding a personal pledge on a hexagonal sticker to the installation wall. This early pitch established several elements that informed the later HOME: Zero: theatrical mystery, collaborative problem-solving, historical artworks as prompts, and a physical trace of family participation.

4.4 Co-design Workshop 1

The objective of the first workshop was to understand how the families view the paintings and to choose a room in the house to set the experience. The workshop took place at the Performing Arts Studio, at Lakeside Arts. It was split into two sessions with five families attending in the morning and 6 in the afternoon. Each session lasted 2 hours and followed the same format.

4.4.1. Process

On arrival, participants received project information and consent forms, made name badges, and worked in family groups at tables with drawing materials and tablets showing nine paintings from NGX's collection. After a facilitator-led physical warm-up to relax participants and support ensemble-building, the team introduced the project. Families then completed three activities: responding to the paintings through writing or drawing; choosing a room in their home to make "perfect for the planet"; and performing their proposed solutions using only their bodies. This final task shifted ideation away from verbal reasoning, where parents often hold more authority, and drew on physical theatre methods that support children's expression through bodily action, gesture, and spatial interaction

(Schaper and Pares, 2021). The session ended with group reflection and discussion.

4.4.2. Outcomes for the Installation

Participant responses revealed that some of the original paintings provided by NGX were difficult to connect to sustainability, leading us to revise the collection around themes such as biodiversity, water conservation, renewable energy, recycling and repair, greener homes, heat conservation, rewilding, growing, and composting. The second activity identified the kitchen as the most popular domestic setting, which became the interior of the installation and the focus for exploring lower-impact household practices.

Families generated a wide range of ideas, including plant-filled living spaces, solar ovens, smoke-free heating, air-cleaning extractors, and green roofs supporting bees and honey production. Drawings from this activity were later incorporated into the installation's Sketchbook screen, where they provided clues about what to look for in the paintings and highlighted past "good ideas".

The final discussion showed considerable awareness among children of the need for environmental change. However, some families also felt there were too many ideas and too little time, suggesting a need for guidance, skills, and knowledge to support action. This shaped the installation's use of projected to-do lists to represent the difficulty of having "too many ideas." At the same time, the discussion was dominated by adult voices, despite some children contributing suggestions. In response, the second workshop was designed to more actively empower children to take the lead.

4.5 Co-design Workshop 2

The main aim of the second co-design workshop was to explore how audiences might interact with the installation. The groups were again split into two sessions, which took place at Lakeside Arts and lasted 2 hours each.

4.5.1. Process

As participants entered the workshop space, the facilitator scanned them with an "imagination scanner", a simple animated light that playfully measured imagination levels. Children were deliberately given the highest scores and special badges, positioning them as imaginative leaders and encouraging parents to adopt more playful, supportive roles. The facilitator then led a Cops and Robbers icebreaker, in which families chased each other while miming film-like actions, such as climbing through windows, to emphasise imagination, physical action, and collective play (see Figure 3).

The first design activity asked families to examine a painting of a stove, a chimney and a pot, and imagine how it might change in response to sustainability concerns. The second activity focused on prototyping an interactive control panel. To help participants visualise the installation, the team mapped the hexagonal space on the floor and explained that animated projections could make "anything possible" inside it. Families then imagined a central table with controls for stopping the deterioration of the paintings, drew and built prototypes from craft materials and found objects, and presented them through bodily performance in the marked-out space. The session ended with a group discussion comparing the designs and considering how to support equal voices between children and adults.



Figure 3: *Cops and Robbers ice breaker game*

4.5.2. Outcomes for the Installation
The first task generated imaginative transformations of the painting, including solar-powered stoves, smoke extraction, natural light and energy capture, and more playful ideas such as the stove turning into a rock or giraffe. These suggestions were later used as hints and thoughts in the installation's Sketchbook.

The second task substantially shifted the interaction design away from the original idea of a projected tabletop control panel. Families proposed more physical, distributed forms of interaction, including turning wheels, powering up the installation, and using multiple objects rather than a single interface. This led to the "upcycler" being designed around separate physical controls: the bespoke wooden videogame-like controller, hacked salad spinner, and Victorian bellows. It also established key interactions, including selecting objects from paintings and upcycling them into environmental solutions. The emphasis on working together in different parts of the room further supported teamwork and more equal participation.

Families also expressed a desire for help during the experience, and voice control was received positively. This contributed to the development of Kitty, the disembodied voice of the homeowner, who gives instructions. Finally, adults responded strongly to the imagination scanner, noting that it reminded them not to constrain the children and helped everyone enter a playful creative mode. The scanner was therefore incorporated into the final installation as the first interaction visitors encounter before entering the hexagonal room.

4.6 Co-design Workshop 3

The third co-design workshop focused on deepening the collective storytelling practice and exploring the potential use of "Pledges" in the final installation, a mechanism intended to empower participants to conceive actionable commitments and cultivate a personal sense of responsibility.

4.6.1. Process
The performer began with Irish Duels, a playful physical icebreaker involving three short competitive games. As before, the activity warmed up participants, encouraged playful interaction, and re-established a tone of open participation.

The first design activity focused on narrative exploration. Families tested versions of an interactive story using Twine ("Twine. Interactive fiction tool," n.d.), collectively making decisions about how the plot unfolded. The story placed them in an imaginary situation where paintings in NGX's gallery were changing rapidly and unpredictably, requiring them to act to stop the disruption. The task encouraged improvised narrative responses and ended with reflections on the emotional, narrative, and challenging aspects of the experience.

The second activity asked families to craft pledges for positive change at home. These were intended to emerge collectively from each family's shared experience. Participants used prompts to develop their pledges, considered possible barriers, discussed ways to overcome them, and then shared the pledges publicly.

4.6.2. Outcomes for the installation
The first task led to the narrative developing in a way that better represented the co-design team's ideas. It changed from paintings transforming to participants selecting objects from them using a machine that sucks them, while the content projected on the walls showed impending environmental destruction. This new narrative consolidated ideas about selecting objects from paintings and upcycling that had already appeared in workshop 2. The second task helped to develop further the idea of installation visitors making pledges. To reinforce the pledges' lasting impact, it was suggested that these commitments be creatively represented in a tangible form, like seed paper, promoting a continued engagement through a living testament of the pledge at home.

4.7 Role of the performer/facilitator in the co-design process

The professional facilitator's role in the co-design process, and his later presence as actor-facilitator in the final installation, became a notable and unanticipated development. Given his central role, we conducted a final interview with him about how this role developed. Drawing on acting, writing, and workshop facilitation, he described his main aim as to "draw out responses, provoke thought, and empower behaviour change." He explained that "the writer in me relied on the facilitator-me to draw out the imaginations and desires of the participants so that the piece could be as much them as it was me."

A key part of this work was modelling safe engagement. Rather than instructing participants how to play, the facilitator used performance to make playfulness feel permissible: "there were rare moments of clear role play (as the imagination assessor, for example) but primarily the actor-me existed as a role model, not to show how to do something ever, but to show that it's safe to." He linked this to family settings, where "being given permission to play through example by either a peer (another adult) or someone with more authority (someone from the adult sphere), can reset the dynamics of propriety and allow the most rigid of expectations and boundaries to soften." Even his workshop clothing was used as a small performative cue, intended "to gently signal playfulness and risk-

taking," so that participants could feel "their quirk is welcome by virtue of mine being on display."

The facilitator also deliberately challenged family hierarchies by creating situations where children could become experts. He described this as placing "the mantle of the expert" with the child rather than the adult, where "play rather than attainment is praised and there is a healthy inter-dependency to achieve the task." Adults were sometimes asked to listen and build from children's ideas, akin to a "yes... and" approach (Johnstone, 1987), so that "the adult's task is to listen and find something to use as a springboard to their imagination."

Embodied and playful activities supported this shift. Participants were often asked to present ideas "using only their bodies… like the image-based work of Jacques Lecoq" (Lecoq, 2006). The facilitator also used "Light and Lively" games from Theatre of Empowerment (Boon and Plastow, 2004) to reduce judgement and unsettle age-based hierarchies, creating conditions where "there is no advantage in age or experience, where winning is a very weak motivator… where assumed social structures and hierarchies don't function anymore." Cops and Robbers, for example, helped "reset the definitions of space and behaviour" by placing families in a shared imaginative frame built on "existing in each other's shared imagination without judgment, invention from nothing, and imagination being the only limit."

For the facilitator, the co-design process was therefore not only a way to generate material for the installation, but part of the project's outcome. He described it as "more than material and idea generation for the installation and narrative," arguing that "the co-design process itself delivered core aspects and objectives of the project." The final piece became "a mouthpiece for their attitudes and beliefs and a microcosm of the process we had all gone on together." As he put it: "It was mostly a product of our collaboration; my role was to stitch it all together with some script and story writing experience into an experience that the audience families could appreciate and end in place together whereby they themselves felt empowered to make a change at home. In a way, the process was the outcome. They are inseparable."

Finally, he reflected that earlier and more continuous family involvement would have allowed participants' contributions to shape the concept from the outset: "I would like to have had the families in co-design sessions before the formal pitching sessions so that we were hitting the ground running once the project began in earnest. This would also have enabled the families' DNA to have been inside the early concept and navigated more easily around any potential feeling that the families were there to 'help us create our idea.'" The main limitation was therefore time, which reduced the scope for deeper collaboration and responsiveness to participants' input.

5. DISCUSSION

We turned to theatrical participatory design to create a collaborative space where families could reflect on climate change through playful, embodied exploration. The workshops surfaced familiar frictions: adults often dominated discussion and resisted imaginative play, while children's contributions risked being sidelined. These asymmetries are well documented in participatory design (Lindqvist et al., 2007; Westerlund et al., 2003), and are especially acute in family contexts (Yip et al., 2017, 2016). A second challenge was to carry co-design beyond the workshop, so that audience families could co-shape interventions in the finished installation and continue the process at home. We therefore used the installation as a probe to examine how applied theatre could restructure participation across both workshops and the final experience.

Unlike projects where theatre is ancillary, theatre professionals here led the creative process, using dramaturgical judgement to pace, adapt, and shape participation. We argue that applied theatre functioned not only as a source of tools and activities, but as a mode of participatory design: orchestrating group work, generating candidate solutions, and scaffolding reflection across cycles of ideation and enactment. From this practice, we distil three design orientations for theatrical participatory design with families: (1) rebalancing child–adult power, (2) sustaining theatrical embodiment, and (3) re-staging workshop ecologies within the final installation, supported by expert theatrical facilitation. Together, these orientations show how theatrical principles can reposition participatory design as a dramaturgical practice that engages playfully with power, embodiment, and the extension of co-design into public-facing mixed-reality artworks.

5.1 Rebalancing Child-Adult Power Relationships

Even when initial ideation is balanced, adults often dominate elaboration and evaluation unless specific interventions are made (Yip et al., 2017). Unlike much design literature where asymmetries reflect formal researcher–participant roles, here they stemmed from everyday family dynamics, with parents positioned as experts and children as guided actors. Because collaborative tasks could easily revert to adult-led guidance, we employed status-rebalancing mechanisms to create space for greater child initiative, a dynamic that can unsettle power relations (Volkmann et al., 2023).

Johnstone shows that status in theatrical improvisation is continually renegotiated (Johnstone, 1987), and such shifts can reconfigure relationships and create alternative roles (Volkmann et al., 2023). Viewing power relations as enacted and relational (Foucault, 1977), we found that theatre offered "as-if" spaces where authority could be redistributed by rehearsing alternative roles and establishing new habits of participation through playful practice. The imagination scanner exemplified this: a device that "measured" imagination and always ranked children above adults. Its humour enabled children to act as "imagination leaders," while adults adopted more receptive roles. In workshop 2 where it was introduced, facilitators noticed children taking more initiative, such as selecting materials from the table and deciding what to present. Over successive workshops this shift became more visible, from adult-dominated discussion in the first session to greater child leadership in the second and more balanced decision-making in the third. Adults themselves later reflected that the scanner reminded them not to constrain the children and helped everyone enter a more creative play mode. For practitioners, a key takeaway is that playful status reversals, such as casting children as "imagination leaders," can redistribute authority and invite fuller contributions from less dominant voices.

5.2 Sustaining Theatrical Embodiment

HCI has long explored embodied methods for ideation, including bodystorming, soma design, tangible interaction, and physical play, showing how sensorimotor engagement can surface design possibilities (Höök, 2018; Segura et al., 2016a, 2016b). Our contribution builds on this work through a specifically theatrical grounding, where physical presence becomes a medium for shared fantasy and for enacting ideas, roles, and relationships. Related HCI work has used physical theatre to heighten children's awareness and stimulate design ideation (Schaper and Pares, 2021), while theatricality has also been explored in professionally produced mixed-reality performance (Benford and Giannachi, 2011). Less attention, however, has been paid to how theatrical embodiment can be sustained across participatory design workshops and public-facing encounters, especially when co-designers and audiences are the same demographic.

In HOME: Zero, theatrical qualities rehearsed in workshops carried across the co-design process and into the final installation. Warm-up activities prepared participants physically, socially, and imaginatively before design work. Games such as Cops and Robbers, decoupled from the design brief, helped align group energy (Johnston, 1998), gave children confidence, and nudged adults beyond default authoritative roles. This momentum continued into ideation through the "hot seat" exercise, a theatrical technique for deepening character understanding adapted here to explore children's perspectives (Ventä-Olkkonen et al., 2022). In the installation, theatricality persisted through stop-time interactions, small choreographies such as crouching under thresholds, playful engagement with imaginative props, and the pledge wall, which turned private resolutions into a public ritual of shared responsibility.

These examples show how theatrical embodiment can move beyond isolated workshop exercises. It can form a dramaturgical arc across workshops, design activities, and public performance, shifting attention from artefacts alone to the embodied practices that sustain collaboration. We now turn to one concrete mechanism of this continuity: the re-staging of workshop ecologies in the public installation.

5.3 Re-staging Workshop Ecologies

This principle concerns how artefacts, roles, dynamics, and interactional qualities from co-design are carried forward and re-enacted in the installation, so that dramaturgical logics of the workshops shape the public encounter. The imagination scanner, first used as a playful status-balancing device, was carried into the installation almost intact once its value in amplifying children's voices was recognised by the team. The facilitator's live presence was also retained, echoing prior HCI research on performers shaping interactive experiences (Benford et al., 2006; Koleva et al., 2001) as it was reported and observed to help sustain active and inclusive engagement. Drawing on theatre-devising practices that treat existing artworks as creative seeds (Bogart and Landau, 2005), workshops also introduced historical paintings from NGX's collection to prompt embodied reflection on lower-carbon domestic futures. These generated interactions such as the "sucking objects" mechanism, which was later incorporated into the installation to enable visitors to playfully imagine alternative futures.

In practice, re-staging workshop ecologies operates as a rehearsal-to-performance process. First, workshops are composed to mirror the social make-up of eventual visitor groups. Second, activities are designed to cultivate the same rhythms and roles that the installation will later demand. Third, facilitation supports the trial of activation mechanisms, allowing the design team to identify which can be carried forward intact or with light adaptation. Finally, the key criterion is not simple transferability but preservation of intent: in our case, mechanisms that redistributed authority or amplified marginal voices beyond the sheltered conditions of the workshop were prioritised.

5.4 Expert Theatrical Facilitation

Although the value of theatrical activities in participatory design has been recognised, the craft of theatrical facilitation has received far less attention. It is not another design principle, but a practice that holds the process through embodied timing, aesthetic instinct, and social sensitivity (Preston, 2016). We raise it here because applied theatrical facilitation intersects with participatory design facilitation and can generate hybrid forms, if treated as craft rather than as a set of borrowed methods.

A precedent for facilitating from inside the experience is *designing from within* (Taylor et al., 2011), where a design team situated itself inside the performance space as both performers and designers, affording access to subtle participant exchanges invisible from outside and the capacity to intervene mid-performance to repair faltering engagement. Here, however, that position is held not by the designers but by a performance practitioner, who facilitated both the families' co-designing and, later, audiences' participation in the final event.

The applied theatre facilitator occupies a paradoxical position: structurally high status because they set the frame of activities, yet operationally low status because they avoid determining content or outcomes (Nicholson, 2015). Boal's Joker captures this stance: someone who can shift the rules without playing the game. Participatory design scholarship echoes this, presenting facilitation as the cultivation of conditions where participants feel safe to take risks and speak with authenticity (Light and Akama, 2012). In our workshops, this stance was enacted through playful theatrical self-presentation, for example bright clothing and moments of clowning that modelled vulnerability and invited risk taking.

A central question is which aspects of this approach require expert theatrical facilitation. Techniques such as warm-ups, simple status shifts, and embodied ensemble tasks could be responsibly adapted by experienced co-design facilitators with light applied theatre training. By contrast, higher-order capacities such as dramaturgical reframing, theatrical calibration of status across sessions, and holding uncertainty while composing actions for public performance usually depend on skills honed through years of practice. We do not present this as a definitive claim but as professional judgment informed by working across both fields. The implication for HCI is practical: projects that seek power-aware, intergenerational co-design with public-facing outcomes should either scope ambitions accordingly or plan from the outset for collaboration with theatre professionals. Rather than setting firm boundaries, we propose that hybrid models of facilitation, drawing from both participatory design and applied theatre, hold considerable promise for future research.

5.5 Limitations and Future Work

This study is grounded in practice-based reflection, drawing on workshop plans, artefacts, facilitator accounts, and researcher positionality. This limits the extent to which claims about equitable participation, including shifts in child–adult balance, can be supported with systematic behavioural measures. A further limitation is the compressed commission timescale, which constrained trust-building and iterative development typical of applied theatre and family co-design. Future work should address these limitations through mixed-method evaluations of participation (e.g., interaction coding and analysis of material engagement) and longitudinal designs that allow theatrical processes to unfold over time, across varied cultural and institutional settings.

6. CONCLUSION

This study positions applied theatre not as a toolkit of engagement exercises, but as a way of organising participatory design from workshop practice into public mixed-reality experience. In HOME: Zero, family co-design for environmental sustainability involved not only generating ideas, but also negotiating who could lead, who could play, and how families could act together in imagining domestic change. The orientations discussed above show how theatrical co-design can rebalance child–adult participation through playful status shifts, sustain embodied practice across phases and re-stage selected workshop roles and ways of working within the final public event. These methods are not easily detachable techniques: they require contextual sensitivity, time, and skilled facilitation. For HCI, this points toward closer collaboration between design researchers and theatre practitioners in participatory projects involving families, embodiment, environmental imagination, and social change.

Acknowledgments

This work was supported by the Engineering and Physical Sciences Research Council [grant number EP/T022493/1] and the Horizon Centre for Doctoral Training at the University of Nottingham. HOME: Zero was created by Makers of Imaginary Worlds in partnership with Lakeside Arts, Sam Redway, and the Mixed Reality Lab, University of Nottingham. The project was commissioned by Nesta and National Gallery X, a partnership between the National Gallery and King's College London, supported by LEADD:NG, and co-designed with Nottingham

families. The 2024–2025 UK national tour was supported by Arts Council England.

7. REFERENCES

Benford, S., Crabtree, A., Flintham, M., Drozd, A., Anastasi, R., Paxton, M., Tandavanitj, N., Adams, M., Row-Farr, J., 2006. Can you see me now? ACM Transactions on Computer-Human Interaction (TOCHI) 13, 100–133.

Benford, S., Giannachi, G., 2011. Performing mixed reality. MIT Press, Cambridge, MA.

Benford, S., Greenhalgh, C., Crabtree, A., Flintham, M., Walker, B., Marshall, J., Koleva, B., Rennick Egglestone, S., Giannachi, G., Adams, M., 2013. Performance-led research in the wild. ACM Transactions on Computer-Human Interaction (TOCHI) 20, 1–22.

Boal, A., 2002. Games for actors and non-actors. Routledge.

Boal, A., 1979. Theatre of the Oppressed. Pluto Press, London.

Bødker, S., Kyng, M., 2018. Participatory Design that Matters—Facing the Big Issues. ACM Transactions on Computer-Human Interaction 25. https://doi.org/10.1145/3152421.

Bogart, A., Landau, T., 2005. The Viewpoints Book: A Practical Guide to Viewpoints and Composition. Theatre Communications Group, New York.

Boon, R., Plastow, J., 2004. Theatre and empowerment: Community drama on the world stage. Cambridge University Press.

Churchman, C.W., 1967. Wicked problems. Manage. Sci. 14, B141–B142. https://doi.org/10.1287/mnsc.14.4.B141

DiSalvo, C., Boehner, K., Knouf, N.A., Sengers, P., 2009. Nourishing the ground for sustainable HCI: considerations from ecologically engaged art, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '09. Association for Computing Machinery, New York, NY, USA, pp. 385–394. https://doi.org/10.1145/1518701.1518763

Foucault, M., 1977. Discipline and Punish: The Birth of the Prison. Vintage Books, New York.

Ghoshal, S., Manna, N., 2020. Dialogue for Empowerment: Jana Sanskriti's Experiment with the Method of the Theatre of the Oppressed in Rural Bengal. New theatre quarterly 36, 117–130. https://doi.org/10.1017/S0266464X20000226

Höök, K., 2018. Designing with the Body: Somaesthetic Interaction Design. MIT Press, Cambridge, MA.

Jacobs, R., Benford, S., Selby, M., Golembewski, M., Price, D., Giannachi, G., 2013. A conversation between trees: what data feels like in the forest, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '13. Association for Computing Machinery, New York, NY, USA, pp. 129–138. https://doi.org/10.1145/2470654.2470673

Johnston, C., 1998. House of games: making theatre from everyday life. Routledge, London. https://doi.org/10.4324/9780203824535

Johnstone, K., 1987. Impro: Improvisation and the Theatre. Routledge, New York.

Koleva, B., Taylor, I., Benford, S., Fraser, M., Greenhalgh, C., Schnädelbach, H., Vom Lehn, D., 2001. Orchestrating a mixed reality performance, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA, pp. 38–45. https://doi.org/10.1145/365024.365033.

Kristensson, P., Magnusson, P.R., Matthing, J., 2002. Users as a hidden resource for creativity: Findings from an experimental study on user involvement. Creativity and innovation management 11, 55–61.

Kuznetsov, S., Tomitsch, M., 2018. A Study of Urban Heat: Understanding the Challenges and Opportunities for Addressing Wicked Problems in HCI, in: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, CHI '18. Association for Computing Machinery, New York, NY, USA, pp. 1–13. https://doi.org/10.1145/3173574.3174137

Lecoq, J., 2006. Theatre of movement and gesture. Routledge, Abingdon.

Light, A., Akama, Y., 2012. The Human Touch: Participatory Practice and the Role of Facilitation in Designing with Communities, in: Proceedings of the 12th Participatory Design Conference. ACM. Association for Computing Machinery, New York, NY, USA, pp. 61–70.

Lindqvist, S., Westerlund, B., Sundblad, Y., Tobiasson, H., Beaudouin-Lafon, M., Mackay, W., 2007. Co-designing communication technology with and for families–Methods, experience, results and impact. The Disappearing Computer: Interaction Design, System Infrastructures and Applications for Smart Environments 99–119.

Mehto, K., Kantola, V., Tiitta, S., Kankainen, T., 2006. Interacting with user data – Theory and examples of drama and dramaturgy as methods of exploration and evaluation in user-centered design. Interact. Comput. 18, 5, 977–995. https://doi.org/10.1016/j.intcom.2006.05.006.

Mendes, M., Ângelo, P., Nisi, V., Correia, N., 2012. Digital art, HCI and environmental awareness: Evaluating play with fire, in: Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design, in NordiCHI '12. Association for

Computing Machinery, New York, NY, USA, pp. 408–417. https://doi.org/10.1145/2399016.2399079.

Milien, E., Roux, C., Golanski, C., 2004. Involving families in a design process, in: ACM Participatory Design Conference (PDC). pp. 187–190.

Mitchell, V., Ross, T., May, A., Sims, R., Parker, C., 2016. Empirical investigation of the impact of using co-design methods when generating proposals for sustainable travel solutions. CoDesign 12, 205–220.

Nicholson, H., 2015. Applied Drama: The Gift of Theatre, 2nd ed. Bloomsbury Publishing.

Oddey, A., 2013. Devising theatre: A practical and theoretical handbook. Routledge.

Polido, A., Ehnert, F., Jossin, J., Mascarenhas, A., 2025. Theatre of the Innova(c)tors: An Interactive Theatre Tool to Create Transformative Spaces. Sustain. Sci. 20, 659–664.

Preston, S., 2016. Applied Theatre: Facilitation – Pedagogies, Practices, Resilience. Bloomsbury Publishing, London. https://doi.org/10.5040/9781472576965.

Rittel, H.W.J., Webber, M.M., 1973. Dilemmas in a general theory of planning. Policy Sci. 4, 155–169.

Sanders, E.B.-N., Stappers, P.J., 2008. Co-creation and the new landscapes of design. CoDesign 4, 5–18. https://doi.org/10.1080/15710880701875068

Schaper, M.-M., Pares, N., 2021. Co-design Techniques for and with Children based on Physical Theatre Practice to promote Embodied Awareness. ACM Trans. Comput.-Hum. Interact. 28. https://doi.org/10.1145/3450446

Segura, E., Turmo Vidal, L., Rostami, A., Waern, A., 2016a. Embodied sketching, in: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems. pp. 6014–6027. https://doi.org/10.1145/2858036.2858486

Segura, E., Vidal, L., Rostami, A., 2016b. Bodystorming for movement-based interaction design. Human Technology 12, 193–251.

Taylor, R., Schofield, G., Shearer, J., Wallace, J., Wright, P., Boulanger, P., Olivier, P., 2011. Designing from within: humanaquarium, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11). Association for Computing Machinery, New York, NY, USA, pp. 1855–1864. https://doi.org/10.1145/1978942.1979211

Twine. Interactive fiction tool [WWW Document], n.d. URL https://twinery.org/ (accessed 9.2.25).

Tzanidou, A., Abosaleh, A.H.S., Lindsay, S., Durrant, A.C., Vlachokyriakos, V., 2023. From Inclusive Theatre to inclusive technologies: Lessons learnt from co-designing Touch Tours with an Inclusive Theatre group, in: Proceedings of the 2023 ACM Designing Interactive Systems Conference, DIS '23. Association for Computing Machinery, New York, NY, USA, pp. 1367–1382. https://doi.org/10.1145/3563657.3596094

Ventä-Olkkonen, L., Iivari, N., Sharma, S., Juustila-Cevirel, N., Molin-Juustila, T., Kinnunen, E., Holappa, J., Hartikainen, H., 2022. All the World is our Stage: Empowering Children to Tackle Bullying through Theatre of the Oppressed in Critical Design and Making, in: Nordic Human-Computer Interaction Conference, NordiCHI '22. Association for Computing Machinery, New York, NY, USA. https://doi.org/10.1145/3546155.3546705

Vettraino, E., Linds, W., Jindal-Snape, D., 2017. Embodied voices: using applied theatre for co-creation with marginalised youth. Emotional and Behavioural Difficulties 22, 79–95.

Vines, J., Denman-Cleaver, T., Dunphy, P., Wright, P., Olivier, P., 2014. Experience Design Theatre: Exploring the Role of Live Theatre in Scaffolding Design Dialogues, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI 2014). ACM. pp. 683–692. https://doi.org/10.1145/2556288.2556960

Volkmann, T., Dresel, M., Jochems, N., 2023. Balancing Power Relations in Participatory Design: The Importance of Initiative and External Factors, in: Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems, CHI EA '23. Association for Computing Machinery, New York, NY, USA. https://doi.org/10.1145/3544549.3585864

Westerlund, B., Lindquist, S., Sundblad, Y., Mackay, W., 2003. Co-designing methods for designing with and for families, in: The 5th European Academy Of Design Conference, Barcelona, 28–30 April 2003.

Xie, B., Druin, A., Fails, J., Massey, S., Golub, E., Franckel, S., Schneider, K., 2012. Connecting generations: developing co-design methods for older adults and children. Behaviour & information technology 31, 413–423. https://doi.org/10.1080/01449291003793793

Yip, J.C., Clegg, T., Ahn, J., Uchidiuno, J.O., Bonsignore, E., Beck, A., Pauw, D., Mills, K., 2016. The Evolution of Engagements and Social Bonds During Child-Parent Co-design, in: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems. ACM, pp. 3607–3619. https://doi.org/10.1145/2858036.2858380

Yip, J.C., Sobel, K., Pitt, C., Lee, K.J., Chen, S., Nasu, K., Pina, L.R., 2017. Examining Adult-Child Interactions in Intergenerational

Participatory Design, in: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17). pp. 5742–5754. https://doi.org/10.1145/3025453.3025787