Designing from within: *humanaquarium*

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ABSTRACT
We present an experience-based approach to designing a collaborative interactive performance, *humanaquarium*. Our research explores public interaction with digital technology through the practice-based inquiry of an inter-disciplinary team of interaction designers and musicians. We present a method of designing experience from within, literally situating ourselves within the performance/use space and assuming the roles both of performers and of designers as we develop and refine the *humanaquarium* project over the course of a year's worth of public performances.

Author Keywords
Participatory performance, experience-centered design, practice-based research, interdisciplinary design, musicianship, busking, FTIR

ACM Classification Keywords
H.5.2 User Interfaces (D.2.2, H.1.2, I.3.6)

General Terms
Design

INTRODUCTION
The Baltic Centre for Contemporary Art is a large public gallery with a constantly changing programme of exhibitions. Before the opening of each new exhibition, the gallery assistants who discuss and present the work to visitors are given a brief overview of the work by a curator and are then left to live with the artworks, often spending up to eight hours a day in their company. This long-term relationship with the art leads to a gradual process of discovery over the life of the exhibition, which may last up to several months. Due to an urgent need to be able to respond to visitors' questions, assistants engage in an initial period of intensive study of the objects. Later, however, a deeper level of detail often emerges over time as conceptual and linguistic connections are untangled and made sense of. Sometimes, this occurs in solitude, but more often these leaps in understanding occur in the course of discussion, co-experiencing the works with visitors and other staff.

In this paper we present a method of research practice that leverages this long-term process of sense-making and applies it to the design cycle of the participatory performance piece, *humanaquarium* [19] (see Figure 1). Our use of performance as an investigation platform results in a design process which is literally hands-on, as the design and evaluation team also take on the roles of performers, placing themselves within the design space. This allows a co-temporal negotiation and renegotiation of the relationships between designers, participants, performers and audience. We engage in a design practice similar to that referred to by Wright and McCarthy as dialogical design [21]. Through our situatedness within the work the resultant dialogue plays out in real time.

The three researchers who comprise our production and performance team each bring to the project diverse backgrounds, with professional experience from the fields of fine art, music, computer science, interface design and curatorial practice.

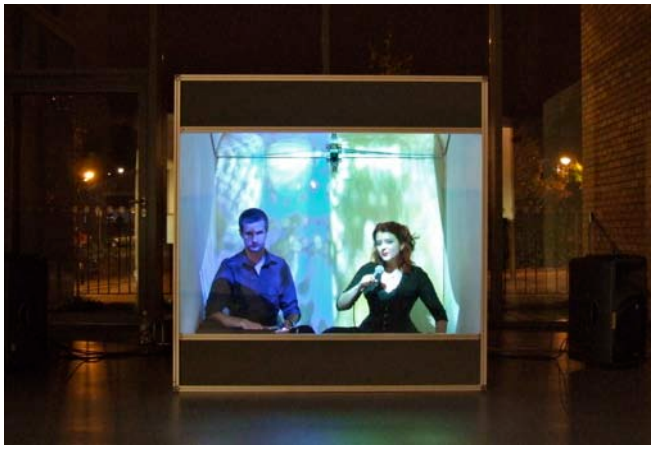

Figure 1. The *humanaquarium* performance

We reflect upon a year of performing *humanaquarium* as part of an ongoing program of inquiry into engagement

CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.

with digital technology in public spaces. Drawing upon the work of Benford *et al.* [1] and Sheridan *et al.* [15,16], we explore the interactive performance frame as an interplay between performers, participants and audience. Deliberately placing ourselves as performers within this frame over an extended period of time, we experience directly and immediately the results of our design interventions and their impact on the performance experience.

humanaquarium was intended to use existing creative practice to investigate specific design concerns regarding participant engagement with publically situated interactive technology. *humanaquarium* was structured from the outset to facilitate ongoing evaluation and revision over an extended period, allowing us to gradually re-imagine content and interaction strategies in response to a deepening understanding of the design space gained through performing the work in public.

The project has two interconnected elements: a physical interface comprising the hardware and software components of the performance space itself (hereafter referred to as 'the box'), and a performance practice designed to best exploit the affordances of the interface. We use the term '*humanaquarium*' to describe what is conventionally considered to be the performance – everything which occurs in the course of deploying the work in a public setting. The *humanaquarium* performance centers around interaction with a 1.5 metre cube, inside of which sit two live musicians (authors Taylor and Schofield). The structure is faced with a transparent acrylic frustrated total internal reflection (FTIR) screen [11]. The system translates the position of touches into audio visual effects that alter the musicians' performance as they play. In this way, participants can 'jam' with the performers in order to collaboratively control the audio-visual content of each *humanaquarium* performance.

Performing from within the interface allows us a unique vantage point from which to explore participant experience with the *humanaquarium* project. We propose that this method of research provides a valuable complement to more traditional forms of experimental investigation, leveraging perspectives from the inside as well as the outside of the design space, and allowing design insights to emerge through the performance experiences we share with the audiences

We begin this paper with a discussion of situated, long-term research practice, and introduce the *humanaquarium* project. We present the methodology that we used to design *humanaquarium*, beginning with an investigation of a previous piece of participatory art that we used to define the design space and identify emergent concerns about participant engagement. We describe our initial concept for *humanaquarium* and how it was iteratively refined using practice-based research. We describe the insights into public behavior we gained from incorporating performance practice into our research process, and explore how designing the *humanaquarium* art piece from within yielded insight into overarching tendencies and trends including intuitive shifts in design focus occurring almost unconsciously at the time.

RESEARCH IN THE WILD

Goffman's use of theatrical analogy to describe human behaviour in social settings proposes that all social interaction bears similarity to dramatic performance – individuals choose to manipulate their *presentation of self* [10] in order to be esteemed by their peers. We suggest that exploring how people conduct themselves within a literally theatrical, improvisational context can afford us insight into how people experience technology in conspicuous public settings. *humanaquarium* was conceived as an application of performance practice to the exploration of public behaviour, intended to be developed and presented outside the laboratory. To date, *humanaquarium* has been performed in over forty performances at eight different venues. It has been sited in lobbies and exhibition halls, marine labs and museums, affording us extended immersion in the practice of developing an interface 'in the wild'.

Our research practice stems from our awareness that investigating human experience in the laboratory is necessarily exclusive of many of the contextual factors found in real world environments. Our approach builds upon an existing body of human-computer interaction research which prioritizes depth of insight by using long term studies of small participant groups in authentic settings. Approaches such as Gaver *et al.*'s long-term installations of unique technologies into people's homes [9], or Wallace's crafting of bespoke jewellery pieces for individual subjects [20] are situated outside the laboratory, allowing a genuine interrogation of the cultural context under investigation. The duration of these projects allows for rich insight to be evolved over time as the process of sense-making [14] allows elements of the investigation to be appropriated by the subjects. Intentionally developing and refining an investigation while situated within an authentic environment allows research interventions and inquiries to evolve in response to emergent ideas observed in practice [6]. We suggest that our investigatory approach bears similarity to Boehner *et al.*'s situated study of the *Affector* interface [3], allowing appropriation of the project to develop over time. While *humanaquarium*'s audience is necessarily new with each presentation of the work, the performance and design team remain constant, allowing our understanding of the experience to be enriched by its unfolding trajectory.

Creative practice has previously been used as an interrogative tool. For example, Gaver uses cultural commentators – professionals from the fields of cinema and documentary – to provide a polyphonic account of the design process "in which a multiplicity of perspectives encourages a multi-layered assessment" [7, p.292]. Hook *et al.* also use documentary specifically to provoke discussion

and elicit design response from participants [12]. These processes, however, still position the creative practitioner as an outside observer or commentator, and follow a classical design trajectory in which the designer and user take turns proposing and responding to artefacts in a strict temporal sequence. In *humanaquarium* we collapse this staggered proposition-response cycle to a real-time dialogue where the designer/performer and user propose solutions to each other, literally face to face. Taking active roles as performers during the investigatory process sites us inside the artefact that facilitates the dialogue. We leverage our own engagement in the process as a means of obtaining insight perceptible from within the experience itself.

Using performance as our investigatory tool allows us to draw upon art theoretical accounts providing perspective on the relationship between the viewer and the object. When planning a 2D image, a sculptural work or a performance, artists often take great care in considering the structure of the experience they are preparing for the viewer [2]. Krauss [13] describes tableau sculptures as existing in theatrical terms, with the viewer's movement around the work placing it in dramatic time. Suchman describes experiencing a creative work as determined not only by the content of the work, but by the relationship between the artefact and the viewer within a specific situation and context [17]. McCarthy and Wright's framework for describing experience [14] has previously been applied to the understanding of aesthetic content [22], examining not only the created artefact, but also its sociocultural context. We adopt their framework as part of our pragmatic approach using performance practice in the design process.

HUMANAQUARIUM: INTERFACE AND PERFORMANCE

The interface used in the *humanaquarium* performance is a large and virtually featureless aluminium and plywood box, painted a neutral grey. The front wall of the box is a transparent pane of acrylic allowing viewers to peer inside. Inside the box sit a soprano (Taylor) and mandolin/synth player (Schofield), whose musical performance is augmented by visuals projected onto the rear wall of the box. The *humanaquarium* is situated in an area where it can be encountered by passersby, with the third member of the team (Shearer) facilitating their interaction.

FTIR [11] is used to monitor participants' touches via infrared LEDs in the edges of the acrylic window and a camera mounted in the ceiling of the box. Max/MSP/Jitter translates this data into MIDI messages which are then sent to Ableton Live to control audio processing and synthesis, in some instances controlling the orchestration of the piece by cross-fading between different instruments, and in others adjusting audio properties of the instruments and voice. Jitter is used to combine visualizations derived from the singer's vocal performance with visual effects (created from multiple video layers) controlled by the position of participant touches. A video layer consisting of a distinct animated element which directly mirrors the position of touches is used to reinforce the legibility of the connection between the interaction and the performance. Further detail explaining the implementation of *humanaquarium* can be found in a previous publication [19]. Videos are available online at http://www.humanaquarium.org

humanaquarium performances range from ten to thirty minutes, the length being largely determined by the siting of the interface and presence of passersby. During each performance, members of the audience may at any time take an active part in the performance by moving their hands across the window (see Figure 2) as the musicians play. The performance trajectory varies according to the interactions of passersby, with the musicians controlling the instruments available to participants and, in effect, 'jamming' with them. Performances end either when participants lose interest and move away or, more frequently, when the musicians decide that the piece has reached a natural end because the emergent structure of the performance suggests a finale.

Figure 2. Participants interact with *humanaquarium*

INITIALLY DEFINING THE DESIGN SPACE

The *humanaquarium* project is the second in our series of performances designed to explore audience engagement with creative experiences. We began the design process for *humanaquarium* by examining our experiences with a previous work created by members of our design team, a stage-based participatory performance, *dream.Medusa* [18].

In *dream.Medusa*, four selected audience members joined a live singer (Taylor) on the stage. Taylor's singing controlled a responsive visualization which could be influenced and adapted by the four participants who used hand-held devices to control features of the visualizations and collaborate with Taylor to create the visual component of the piece. The participants were not instructed in how to operate the deliberately ambiguous interface (a featureless metallic tube containing accelerometers which transmitted participant gestures to the visualization engine) but were encouraged to improvise and explore the gestural space during the development of the performance. The participants were located centre-stage with Taylor, so they

were visible to the audience who could watch how their gestures influenced the performance and could see the resulting visualizations projected on the backdrop of the stage.

dream.Medusa had originally been commissioned by the Nuit Blanche festival in Toronto, and was subsequently performed in a variety of international festival contexts over the course of a year. During that year, we were able to observe and interact with numerous participants in a variety of cultural contexts as they experienced the work. Often we were able to engage participants in discussion after the conclusion of the performances. Participants were consistently enthusiastic to discuss what they deemed to be a novel and stimulating experience (taking part in an improvisational multimedia performance in a public setting). They were often surprisingly forthcoming and frank in their feedback, describing how the risk-taking aspect of performing an improvisational and unknown piece of work in a public setting made them acutely aware of their relationship to the audience. Participants reported a heightened sense of vulnerability, knowing they were being watched and possibly judged by their peers, but also described feeling creatively empowered knowing that they were contributing to the execution of the performance that was being experienced by the group.

Our experiences with *dream.Medusa* highlighted a number of factors influencing participant engagement in interactive performance scenarios. Identifying these factors provided the starting point for the design of *humanaquarium*:

• Stage fright: the stage-based nature of the traditional performance medium increased participants' concerns about being observed, making mistakes and appearing foolish in front of the audience

• Collaboration: participants wanted an understanding of how they were permitted to interact with one another, what the boundaries of shared interaction were, and how they could create shared effects

• Legibility: participants wanted to know how their actions affected the performance development, and to understand the domain space of what actions they could take.

Although the process of designing, performing and then evaluating *dream.Medusa* had produced interesting feedback about user engagement, we realized that this did not fully leverage the dialogical potential offered by the designer taking the role of performer during the performance. *dream.Medusa* was in most respects composed traditionally, with a fixed temporal structure. Although it allowed improvisation and participation it was presented from the outset as a finished piece and was performed with minimal variation between repetitions. When designing *humanaquarium*, we decided to leave the structure of the performance open, allowing the possibility of ongoing refinement. The presence of the designers allowed immediate adaptation of the work in response to the shared performance experience.

Four threads of experience

We saw a need to adopt a theoretical framework with which to focus our understanding of the performance experience and the interplay of the various roles involved. We used McCarthy and Wright's pragmatic approach to structure an investigation of participant experience in *dream.Medusa* [18]. Using their practice of addressing technology within its sociocultural context, we examined participatory performance in terms of its *threads of experience* [14].

McCarthy and Wright frame experience in terms of its *sensual, emotional, spatio-temporal,* and *compositional* elements. Rather than partitioning experience in a reductionist manner, they suggest using each of these elements to filter the examination of experiential phenomena. Being mindful of the interplay and overlap between each of these threads can provide new insight into complex scenarios in which addressing the social and cultural context is fundamental to understanding what is taking place.

When one considers multimedia art, the **sensual** characteristics of the media content figure prominently in the discussion. The artist's crafted audio-visual content provides sensory stimulation both to the audience and to the participants, shaping their instinctive and visceral response to the work. Additional sensory information is provided from the environment (the sounds of other activities in the background, the scent of the space in which the performance takes place, etc.) also influencing the way in which the experience is perceived by those involved.

The experience of the participatory performance is **emotionally** shaped by the ongoing casting of each individual's role – at different times during the performance, each individual may consider him/herself to be fulfilling the role of 'performer', 'participant' or 'observer'[16]. Each of those roles carries with it social context and expectation, while framing the individual's emotions as well as the emotions they ascribe to the other people sharing the performance frame.

Spatio-temporal factors describe the influence of the setting and context in which the performance is enacted. Venues and events have perceived cultural contexts that imbue weight and meaning to the actions taking place within. It is therefore important to consider how the understood prestige of the performance setting, the degree of public exposure, and the perceived openness and accessibility of the environment influences the experience of each participant. Also relevant to a discussion of spatio-temporal issues are the concepts of ephemerality and non-repeatability. Collaborative performance is strongly affected by the unpredictable contributions of the individuals gathered together at a specific point in time.

The **compositional** narrative experienced by those taking part in a participatory performance consists not only of the artistic or aesthetic 'story arc' of the performance itself, but also of the processes of discovering the art piece, choosing to pay attention to it, possibly choosing to interact, and formulating an impression of the ongoing experience. This narrative arc experienced by participants, audience and performers as well as the creative and development teams is integral to the sense-making process of understanding the experience.

Addressing the participants' observations and our own insights within the context of McCarthy and Wright's four threads of experience, we conducted a simple theoretical thematic analysis of participant interviews and observations we had made about the *dream.Medusa* experience. We codified observations in terms of how they related to the various threads of experience. Temporarily narrowing our focus to sequentially explore each thread in turn helped us to unpick the insights contained within the body of complexly interrelated sociotechnical observations. It enabled us to scrutinize elements participants had found enjoyable about the performance experience, and also recognize the source of issues participants had raised regarding barriers to their enjoyment and engagement with the performance interface.

THE *HUMANAQUARIUM* DESIGN

The next stage in our process required to use what we had learned from *dream.Medusa* to inspire initial design decisions for *humanaquarium* which could later be refined as we experienced and re-evaluated the piece in public settings. We began the creative process by considering each thread of experience in isolation. We considered how manipulating each thread in turn could allow us to address our previously identfied concerns of stage fright, collaboration and legibility in interactive performance. This strategy generated the key ideas used to inform the design of *humanaquarium*.

One of *dream.Medusa*'s major creative goals was to immerse audience and participants in the performance, hoping that they would feel enchanted and engaged with the collaborative experience. Many of the decisions we made when considering the sensual and compositional aspects of the performance were done in the hopes of promoting engagement and immersion. The performance was characterized by an ethereal soundtrack with sweeping strings and a pulsing bass rhythm. Visually, *dream.Medusa* was equally hypnotic, with vividly-coloured images of jellyfish slowly drifting across the screen. Participants described how the audio-visual content focused their senses and helped them immerse themselves in the performance, losing track of time as they focused on the sensual aspects of the experience. We were encouraged by these reports, as a diminished awareness of the passage of time is a signifier of immersion or flow, as reported by Csikszentmihalyi [5], indicating to us that our crafting of the performance's sensual and compositional elements had been successful in promoting participant engagement. We decided to include similarly styled audio-visual content in *humanaquarium*.

Participants had reported that although they did not always understand the functionality of the ambiguous gestural interface of *dream.Medusa*, they felt increasingly engaged with the work simply because they believed that their actions impacted its execution. We decided that the ludic ambiguity [8] and playfulness of the interface was an interesting avenue of exploration, and that we could use *humanaquarium* to investigate further how legibility of interaction affected participant engagement and satisfaction.

Negative issues that were brought up in discussion with participants often focused on issues triggered by aspects of the emotional and spatio-temporal elements of the participatory performance experience. People reported fears of appearing foolish in public, of overstepping personal boundaries in terms of personal space on the stage, or of failing to operate the technology properly during the performance and upsetting the artist responsible for the conception of the work. This feedback suggested to us that the stage-based nature along with the pressure and formality of the *dream.Medusa* performance was increasing participants' feelings of stage fright. The visibility and conspicuousness of participants' interactions exacerbated their occasional frustration with the ambiguity of the interface due to their natural social desire to appear competent in public. We were eager to investigate how participants would interact with a participatory creative environment if the stressors triggered by the theatrical context of *dream.Medusa* were reduced.

We decided that exploring a less intimidating manner of performance would be beneficial. Drawing upon the improvisational tradition of busking (a casual, street-based form of performance) we designed *humanaquarium* to be experienced in a less formal context, hoping that novice, untrained participants would find this platform more comfortable and accessible. Eliminating the need for participants to take part in a traditionally staged performance also reduced the level of commitment required. Interacting with two street performers residing in a glass fronted box is an inherently transient act. When participants no longer wished to interact they could move away from the interface, leaving the performance frame.

The very site of interaction (the transparent FTIR surface of the box) was also a response to the emotional and interpersonal issues raised during the *dream.Medusa* experiences. Participants had reported feeling uneasy being in close proximity to Taylor as she sang. Most audiences would naturally have no experience of the sheer volume and dynamic energy projected by a classical singer who is engaging in the physically demanding act of producing supported sound. Participants described it as fascinating yet somewhat uncomfortable, as they wanted to observe but felt that they weren't sure if it was appropriate to stare. The

transparent front of the aquarium provided a physical and metaphorical boundary between participant and performer, increasing the socially appropriate space between them, while maintaining the performer's ability to make eye contact and indicate approval and encouragement of the participatory actions.

INVESTIGATION AND REFINEMENT METHODOLOGY

Once the *humanaquarium* was built, the third phase of our design process involved launching the performance into the public sphere, continually refining the design based on our ongoing understanding of the performance experience.

Earlier we discussed the process of gradual sense-making experienced by art gallery assistants over the course of an exhibition and how this led us to a novel investigative methodology in which we situated ourselves within the design. Living with *humanaquarium* over a period of time allowed us to make sense of it in new ways as it became integrated into our existing creative practices. We suggest that investigating public interaction with technology through the medium of performance demands a long-term approach, as changes in context across performance repetitions affected not only the participants who encountered *humanaquarium,* but also our own engagement and perception of the interactive experience. By deciding to place ourselves within the work as performers as well as designers, we gained the advantage not only of a co-temporal and co-spatial proximity to both the users and the artefact – in this case the *humanaquarium* performance – but also of offering it up to the filter of our own creative practice over an extended period of time.

Performance Practice

A crucial factor in designing for *humanaquarium* was planning for live shows. By conceiving of *humanaquarium* as a 'show' – a performance in the theatrical sense with a beginning, an end and a musical trajectory between the two – we committed to a form of practice where the creators of the piece would necessarily be occupied and immersed in the work during performances. During a performance of *humanaquarium*, Taylor and Schofield (within the box) had to consciously engage the audience, play and sing around each other, monitor the changing state of the interface for faults in the computer vision system or audio/visual processing software and react to both the participants' physical actions outside the box and the consequent effect on their own musical output. Shearer (outside the box) watched for faults and performed the duty of sound engineer by listening and watching the musicians intently and gesturing for changes in volume etc. As well as these tasks, in some cases Shearer acted as a 'ringer' by demonstrating the interaction potential to particularly shy audiences.

In addition to performing these tasks it was crucial to the development of the research trajectory for us to consciously observe and reflect upon the unfolding performance. Performances were videotaped, and immediately after each show, all three members of the team individually took written notes, anecdotally recording their impressions of the performance. Critical incidents such as unusual audience actions were recorded.

It became rapidly apparent that the design of *humanaquarium* enabled the research team to observe the experience from perspectives that were both literally and figuratively diverse. The performers inside the box had a very different visual perspective on the performance than did the external observers. They could see the faces of the participants through the acrylic window and were able to recount experiences and communications that were shared between themselves and the participants as they watched one another through the glass. The performers were also uniquely positioned to observe smaller, more subtle communications and interactions between participants who had a perception of relative privacy when standing in front of the box with their backs to the observing audience.

In addition to the observations afforded to them due to their physical vantage point inside the installation, the performers' roles as creative practitioners immersed in the execution of the piece allowed them to reflect upon the experience from a perspective of enriched investment. Their observations of the experience were fundamentally filtered by the instinctive audience evaluation and self-monitoring practiced by seasoned performers when engaged in their craft. Taylor and Schofield documented their self-evaluation of their own musical performances and described their tacit perception of how well the show had been received from their perspective as the performers of the work. The team was, however, aware that these observations would inevitably be influenced and coloured by their inherently self-conscious nature.

Shearer, observing from the outside of the performance space, was able to provide a different accounting of the work. Observing from an external vantage point, he could see a much larger area of the room. He could observe how audience members approached *humanaquarium* and how they behaved before, during, and after interacting with the performance. Shearer could also evaluate the aesthetics of the performance from a removed, arguably more objective standpoint, as he was monitoring the action remotely rather than as an immersed participant.

During the course of the year we had occasion to augment our usual documentation practice with more formalized investigatory studies, where the reports of the core team members were augmented by the annotations of a newly introduced observer previously unfamiliar with the performance, and where participants were interviewed for feedback after the performance event had concluded.

After each performance, we reviewed our notes and videos, discussed what was successful about the performance, and addressed what we felt could be changed in order to

improve subsequent presentations. We then filed the notes and videotapes so that we could revisit them at a later date in order to explore how our design decisions and perceptions evolved over time.

Iterative Revision Process

A fundamental component of the *humanaquarium* design process was our awareness of how growing familiar with our own performance platform over a period of time increased our ability to use the art piece as an opportunity for exploration. In contrast to *dream.Medusa* where the performance content was fixed and remained relatively constant over the year in which it was performed, we specifically designed *humanaquarium* to be easily adaptable and changeable. We theorized that over the course of numerous performances (at the time of writing we have performed *humanaquarium* over forty times) we would want to adjust the audio-visual content and the interaction strategies in order to respond to participant feedback and our own experiences and perceptions of *humanaquarium*'s strengths and weaknesses.

We deliberately made technical decisions which would allow us to rapidly reconfigure *humanaquarium*'s creative content and interaction mappings. By defining the relationships between participant touches and system reactions in the visual programming environment of Max/MSP, we were able to make changes to the way participants' actions affected system output without recompiling code – enabling us to make minor revisions on-site during the intervals between performances.

We very consciously decided to present *humanaquarium* in a form which was simultaneously finished and unfinished. In our earliest performances, we were acutely aware that our performance was essentially being tested `in-the-wild', and we accepted that we were going to be unable to truly predict how our audience would choose to interact with the performance. From an artistic standpoint, this presented the performers with an opportunity that was at once both exhilarating and anxiety-provoking – they were aware that they would have to experience the resulting performance in a public context (for better or for worse!) and use their artistry and professional skill to react to participant behaviour truly on-the-fly.

We deliberately scheduled an initial run of small-scale performances scheduled two weeks apart, in order to maximize the opportunity to review, revise, and remount different versions of the performance. The rapid turnaround time between iterations allowed us to immerse and focus ourselves in a very immediate and intense process of creative design development. Many of these revisions centered upon improving system legibility by adjusting the mapping between participant touch and audio-visual response.

As the design stabilized and we began presenting the piece in more prestigious contexts (international festivals and exhibitions) we were able to take more time between revisions, permitting more labor-intensive changes such as the addition of an entirely new selection of new audio-visual content and motifs.

After-the-fact reflection

At the end of the year, our core production team scheduled a dedicated review session in order to discuss the project in terms of the progressions and insights we felt had been achieved over the course of the year.

Initially we assembled a recollected narrative of the project's trajectory constructed out of the notes associated with each performance. We discussed the key issues which had emerged during each performance repetition, and identified how these issues had inspired us to modify or adapt *humanaquarium*'s design in response. With this retrospective created, we then reviewed the video documentation, exploring from this more temporally removed perspective how our intended modifications had actually impacted subsequent iterations of the performance.

This after-the-fact exercise afforded us the opportunity to make a holistic assessment of how *humanaquarium*'s evolving design trajectory addressed the issues and challenges originally targeted in the project brief. We also found that a retrospective look at the year's progression raised some previously undiscovered discussion points about the emerging tensions evident in this experience-centered design approach. Reviewing the entirety of the video documentation made it evident to us that our motivations were simultaneously being influenced by concerns regarding aesthetics and usability, and that these concerns occasionally were in conflict, as we discuss later in this paper.

IMPACT OF OUR DESIGN DECISIONS

By conducting ongoing evaluation and monitoring over the course of the year as well as retrospectively assessing the progression of *humanaquarium*'s design, we were able to examine how we had addressed the design concerns we had originally intended to explore.

Stage Fright

The setup of *humanaquarium* was intended, as much as possible to overcome the intimidating nature of traditional stage performances. As previously discussed, the spatio-temporal and emotional aspects of the performance were calculated to minimize stage fright and facilitate fearless engagement with the work. Seating the musicians at ground level, physically separating the performers from the participants, and enclosing the performance environment within a small space were all expected to reduce the sense of invasion of personal space and ease the emotional aspects of transition [15] between the roles of passive audience member and active participant in the performance. By placing the performance space in non-theatrical venues, we hoped to dispel the sense that *humanaquarium* was a

traditional theatrical experience which required the audience to arrange themselves in a particular way as passive observers of the performance. We hoped that this would minimize the anxiety inherent in audience members consciously identifying themselves as part of a formal performance, with all of the concomitant social factors associated with such a high stress situation. Certain factors were retained in order to facilitate the audience's understanding of the situation – the window could still be read as a proscenium, encouraging viewing from the front, and the musicians were costumed and played conventional instruments. However, casting the scenario as a busking performance meant that participants were free to join or leave at any point, reducing the level of commitment required to take part.

The chief source of discomfort for participants, unsurprisingly, still seemed to be the presence of other audience members. While many audience members came forward to explore and interact with the box, some were still reluctant to relinquish the anonymity of the crowd and would form a horseshoe (see Figure 3), observing the action from several metres away.

Figure 3. Observers, participants

Collaboration

When designing *humanaquarium* we were interested in developing a set of affordances that would facilitate collaboration between performers/designers and audience/participants. The FTIR technology which formed the basis of *humanaquarium*'s interactive screen allows for multiple touches to be tracked and used in the performance. In designing compositions for *humanaquarium*, we attempted to build in responses which took into account multiple participants interacting with the entire area of the screen. In one particular paradigm, we divided the screen horizontally into three areas, allowing separate control of three separate instruments. In practice, however, we very quickly found that in nearly every case, adult participants were very reluctant to use the central portion of the screen.

In every performance, audience members approached the glass and seemed able to cope with their extreme proximity to the performers, suggesting that the ameliorating effect of the transparent barrier had been successful in reducing social anxiety in that regard. However, we noticed that many audience members chose to hover at the edges of the frame rather than placing themselves directly in front of the screen, enabling themselves to stay out of the performers' field of vision. Nearly everyone was extremely careful about blocking the view from audience members behind them. Participants would usually restrict themselves to one side of the screen, and stake out an area of the glass with which to play. The exception to this otherwise consistent phenomenon was small children (see Figure 2), who rarely seemed to have any anxieties about either their extreme closeness to the performers or the effect of their presence on other audience members, often standing directly in the middle of the screen.

As previously discussed, the audience was provided with few cues as to how to interact with *humanaquarium*. The screen was apparently an ordinary piece of acrylic and bore little resemblance to any kind of traditional musical instrument or electronic interface. In order to explore whether audience members would be able to determine its functionality from each other's efforts or whether approaching the glass would be a natural response to the performance we avoided using explicit graphical instructions of any kind. We occasionally met with a certain amount of trepidation concerning the interface: on several occasions audience members caused an abrupt effect on the audio when they touched the screen, and instantly gestured an apology for their perceived 'mistake'.

Due to the types of events at which *humanaquarium* has been shown, most audiences were aware that the performance involved some kind of interaction on their part. However, we occasionally encountered situations where audience members would initially install themselves in front of the box and wait to be entertained. We decided to intervene with gestures from inside the box if necessary to begin the collaboration and surmised that one of the musicians placing an outstretched hand on the glass would elicit a mirrored gesture from participants. This was borne out consistently. Participants were in general very willing to interact directly with the performers, making eye contact and watching their actions closely. We noticed a willingness to take cues in the form of gestures which helped us clarify some of the interactions in otherwise complex parts of performances.

Legibility

In *humanaquarium*, legibility was from the beginning an important factor. As we found in *dream.Medusa* that participants wanted to know how their actions affected the performance development, and to understand the domain space of what actions they could take, we consciously strove to make *humanaquarium* as legible as possible in

terms of the connection between the actions of the performers, the participants and the system itself, without resorting to actual graphical instructions.

After the initial hurdle of beginning to engage participants, we quickly found that there was some variation in how well different audiences were reading the interaction. By scheduling multiple performances of *humanaquarium* at each venue, we were able to experiment with strategies to engage audience members at different levels, structuring the same shows slightly differently across repetitions. One particular approach which we adopted from very early on was a gradual increase in musical complexity - using 'tutorial' passages in the composition so that solo instruments or voices could be clearly heard and the control paradigm discovered. As discussed, if necessary, we would intervene with gestures, if for instance, participants were attempting actions that the system did not support well, such as very rapid or light touches.

We came to realize that certain controls were easy to discern, for example, the vertical axis of the screen mapped easily to balance between high and low synth lines. Other, more subtle controls were sometimes missed, such as variations in the tempo of arpeggiators or vocal panning effects. We realized quite quickly, to our surprise, that although legibility was important to some participants, it was quite possible to engage many audiences with the most basic forms of participation. Some audience members were apparently content to experiment with the first controls they discovered. Children in particular, would often watch the performers enthralled, while keeping one hand motionless on the glass for the duration of the performance. They appeared aware that their participation was required but otherwise had no desire to collaborate actively with the performers, choosing simply to register their presence and participation in the experience. For participants, knowing that their actions were in some way necessary to the outcome of the performance seemed to increase their investment in the experience, whether or not they chose to experiment with the full range of controls.

REFLECTIONS ON A YEAR OF PRACTICE

We began this discussion considering the experiences of gallery staff living with artworks over extended periods of time. Their unpicking of the artworks through conversations with each other and visitors would over time form a polyphonic account of the work, incorporating perspectives that had evolved from the shared experience. The voice that was always missing from this conversation was that of the creator him/herself. The gallery staff effectively took on the role of interpreter, conveying their own understanding of the artist's intentions at one remove, necessarily filtering the work through their own experience of it.

Approaches such as Gaver's [7] cultural commentators or Hook *et al*'s [12] use of documentary as an investigatory tool similarly use an outsider's account of a design and then communicate it back to the designer. Due to their external vantage point they offer an intriguing set of perspectives from outside the design space. In the design of *humanaquarium* we deliberately decided to attempt the inverse of this approach, seeking a more central perspective by designing from within, engaging in a direct dialogue with the user. Situating ourselves within the design and taking the role of performer during the *humanaquarium* performance we were able to add the voice of the designer directly to a phase of the design process from which it would normally be absent. While this manner of investigation is necessarily self-reflective in nature, placing ourselves inside the design provided us with a combination of first-hand experience and simultaneous dialogical exchange with users, leading us to a number of insights that may have been overlooked in a traditional design process.

Crucially, while Gaver's and Hook's approaches involve the creation of what could be termed secondary artefacts to explore the design space (e.g. documentaries and cultural commentaries), our practice-based investigation allowed our design process to focus entirely on the artefact under consideration: the *humanaquarium* performance. This approach was advantageous in that it allowed super-rapid prototyping of new design revisions and periods of simultaneous design proposition and response. A particular challenge of this approach, however, was that we had to adapt the complexity of our design interventions to account for the real-world time frame of the performance schedule.

Living with the piece for a year and integrating it fully with our creative practice led to a gradual reframing of the design space. Simultaneous with the evolution of *humanaquarium*'s design, we experienced a deepening understanding of our instincts as performers. In reviewing a year of performing and developing for *humanaquarium*, we realized certain factors were being constantly re-negotiated, sometimes unconsciously shifting the priority focus during the design process.

Each musician came to the project with nearly 20 years of experience in traditional stage performance and playing with other performers, either in jazz/improvisational contexts or in the performance of rehearsed pieces. However, the unique setup of *humanaquarium* necessitated careful consideration of our roles as performers. We had begun preparing performances for *humanaquarium* with the initial hypothesis that allowing users the creative agency to structure and control the sensual components of the experience would increase user engagement. As time progressed, however, and we gained in confidence as performers, we began to introduce more complex structures, musical motifs and visual narratives and began to interact more with each other musically. A tension emerged between our instincts and desires as musicians to make more complex and (to us) more satisfying musical pieces, and the necessity to retain a simplicity and transparency in our compositions which would allow

passing viewers to instantly collaborate with us. Upon reviewing footage of early performances, we realized that in creating more intricate, polished shows, we had inadvertently sacrificed some of the unpredictability of the medium: something which we had always thought important. The combination of being able to look back on a large number of design iterations coupled with a deeply personal experience of each performance allowed us to identify and learn from embedded trends such as these.

In *humanaquarium*, we drew upon experience gained from working both in the arts and in HCI. When asked whether we had considered particular elements of the design 'as artists' or 'as HCI designers' we realized that in most cases the answer was both – the concerns of the one inextricably intertwined with the other. This meant that when tensions arose between the goals of one discipline or the other there was no linguistic barrier to overcome. Moreover, as we experienced each performance first hand, we were able to learn not only from participants' accounts of the experience but multiple readings of our own, informed by the differing perspectives of our dual practice.

ACKNOWLEDGMENTS

This work has been part-funded by the Research Councils UK Digital Economy Research Hub SiDE: Social Inclusion through the Digital Economy.

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