ABSTRACT
This paper describes the development of movement-oriented personas and scenarios for representing multiple users of an interactive, immersive environment, designed as an artistic work for a public space. Personas and scenarios were integrated into a user interaction script and linked to a set of movement schemas using Labanotation for group choreography. Enactment of the script within a prototype environment enabled the designers to experience the aesthetic and kinaesthetic qualities of the work, as well as the social interactional aspects of the user experience. This ensured that the experience of those visiting the exhibition was always central to the design process.

Keywords
enactment, Labanotation, mobility, movement, persona, scenario, social interaction

INTRODUCTION
The development of novel technologies for public use in public spaces signals the shift from work-oriented technology to that where the user experience becomes primary to the design of such systems. This is of particular relevance to artistic works that are now utilising available technologies and expanding the aesthetics of user engagement to include aspects of interactivity and immersion involving the active and moving body. The design of interactive, immersive spaces intended for public consumption requires re-examination of the accepted user-and-use-oriented technology design practices. We undertook this investigation during our involvement with an established collaboration of artists in the design of a multi-user, immersive, interactive environment called “The Bystander Field”.

This paper describes the use of movement-oriented personas and scenarios for representing multiple users of an interactive, immersive environment. These new forms of interactive spaces, such as the Bystander Field, utilise the presence and motion of people as input for interaction. We extended the traditional user-centred design tools of personas and scenarios to explicitly address human movement characteristics that are embedded in social interaction. A major concern was to make visible the effects of multiple users on the behaviour of the room, and on each other’s experience of it. Personas and scenarios were one means of ensuring that this could be explicitly addressed and kept active during the Bystander Field’s design and development.

BACKGROUND
The Bystander Field is the latest work in a suite of multimedia artworks created since 1999 by Ross Gibson and Kate Richards, based on a collection of several thousand black and white photographs of crime scenes taken by forensic detectives. The Bystander Field is designed as a space for living, moving and active bodies to be in, that responds to their presence, movement and stillness, as they actively make sense of the different images and texts that are displayed to them.

The audience sees a flock of white particles that is present in the room with them. The activities of the flock are represented by changes in size, density, detail, position, sound and motion that respond to the presence and activity of the room’s current and shifting inhabitants, disturbed by intrusion and inappropriate, ‘disrespectful’ activities, calmed by stillness and solitude. As the flock moves around, it reveals sets of images and texts. The relationship between the revealed media is more coherent and more narrative when the flock is calm, less coherent and more associative when the flock is disturbed. This changing relationship has been modelled in the design by a series of states.

Understanding movement and social interaction
The Bystander Field does not use the gestural aspect of human movement as input because gestural interaction was ultimately seen as detracting from a satisfying user experience of the exhibited work. Our understanding of the relevant kinds of human movement was thus directed to patterns of mobility, general body movement and locomotion. Recent studies of human movement by anthropologists indicate a shift from "an observationist view of behaviour to a conception of body movement as dynamically embodied action" in semantically rich spaces [2]. Conceptions of movement range from movement as...
physical behaviour and motor activity to movement as situated, meaningful and embodied action. Even though we can more productively think of the moving body involved in acts such as walking, conversing and dancing in a particular place/space/time, when movement is input into technical systems, we still require descriptions of human movement at the physical and functional level. The important thing is to ensure that these descriptions are generated within the context in which they have meaning and can retain their links to real human behaviour throughout the design process.

An important source of understanding how people move and conduct themselves in museums and galleries comes from researchers in interaction and conversation analysis. They have shown that people’s experience and perception of an exhibit is fundamentally shaped by and through social interaction with others in the same space [3, 9]. Aspects of social interaction that were particularly salient to this work included: how visitors collaborate and coordinate activity; have sensitivity to others’ presence and orientation; encourage or discourage participation; continually monitor the environment; and maintain peripheral awareness of, and align their activities to, the conduct and performance of others, be they companions or strangers.

Thus the kinds of movement that we wished to describe in our scenarios are the patterns and forms of movement and the spatial trajectories as people move through the space and interact or engage with the exhibited material. These patterns and trajectories include aspects of timing, position and orientation that are influenced by social interaction and social protocol, people’s aesthetic and emotional engagement with the exhibited work, as well as their response to physical properties of the space. Apart from textual descriptions of the patterns and forms of movement, we wanted a way of representing these visually to support the reflective design practices of the project team. We examined existing movement notations for this purpose.

**Labanotation for group choreography**

Various notations exist for documenting human movement. Most have arisen for use in documenting dance choreography and include Labanotation, Benesh and Eshkol-Wachmann [4]. Benesh was devised for recording ballet scores, and Eshkol-Wachmann is a system that is not specifically tailored to the human body, whereas Labanotation is suited to describing all forms of human movement. It is a system of analysing and recording movement, originally devised by Rudolf Laban in the 1920’s. There are three essential forms of description - Motif, Effort-Shape and Structural - which focus on the movement characteristics of an individual body. Earlier research by [6] investigated the suitability of the individual descriptive forms of Labanotation for analysing and describing movement when used as input for interaction with technology. Preliminary findings suggested that the power of Labanotation as a design tool in movement-based interaction lies in the provision of a system for recording and representing human movement that has the body as a central focus. The representation of movements used as input for interaction can be visually linked to the point of interaction with the interface, thus facilitating exploration of the possible input design options.

In this paper we describe how the symbolic notation intended for group choreography has proved to be extremely useful in the design of the Bystander Field for representing the social and contextual aspects of interaction that influence how and where people move and locate themselves in the space in relation to others. Spatial trajectories can be mapped onto floor plans indicating the position, orientation, direction and path taken through space and time of individual and multiple people.

**DEVELOPING MOVEMENT-ORIENTED PERSONAS AND SCENARIOS**

Very early in the project we developed a number of personas, related use scenarios and a preliminary script of scenarios over time to represent the expected museum audience and their activities in the room. At this stage no formal user studies had been done and these initial personas and scenarios were developed from interviews with the artists about their impressions of those who visited their own and similar exhibitions in the past. The intention was to provide some use-focused tools for the design team “to think with” [8] that would make the potential visitor’s possible experience of the room a driver of the design from the very beginning. These early personas and scenarios made a major contribution to the then newly formed project team in developing a shared understanding of the initial concepts of the project. They were then put aside until user research could ground and guide their redevelopment.

Two separate studies of audience behaviour in immersive spaces were done. The aim of the studies was to provide the design team with a working understanding of potential audience behaviours that could be mapped to whatever behaviour was to be available to the flock of images and texts within the room. There were two strands of investigation. The first was what actually happened in these spaces: who the audience were, how people were inhabiting the exhibition space and what kinds of activities they were doing. The second was the patterns of mobility and motor activity of the visitors to the exhibits. Six main audience behaviours were identified: 1. Poke head in and retreat; 2. Walk in, stand for a while and then go out; 3. Skimming; 4. Try and make something happen; 5. Serious, quiet and contemplative engagement; and 6. Kids (running round!). For more detail see [5].

**Evolving personas**

A series of personas was developed from the user studies and the early interviews with the artists to represent the
range of visitors to the spaces considered. Unlike Cooper’s recommendation of having 3 to 8 different personas for task-related scenarios of use in a work context, we found we needed to develop multiple examples of basic personas to allow us to populate the Bystander Field prototype over time so that different combinations and effects of public use could be investigated. A range of individual ‘characters’ was created for each persona. Note that these characters were not a return to individual users but were designed to carry the characteristics of the personas through multiple instances within the testing environment.

These persona descriptions evolved from traditional descriptions of user history, skills and goals to include two distinct characteristics specific to the kind of interactive, immersive environment under design: 1) a motivation for why that persona might be interested in the exhibit, either alone or with others; and 2) the movement characteristics that reflected the persona’s unique bodily expression and movement styles, and the kinds of movement that this person might perform in a specific situation encountered within this particular setting.

Scenarios and the user interaction script
Scenarios of each character’s movement and activity inside the Bystander Field were developed and then joined together to form a user interaction script that could structure the exploration and evaluations of various models and prototypes over time. The basic script was produced during a design session that involved developing and simulating various scenarios of audience activity and behaviour that were grounded by the observations made during the user studies. A scaled-down model of the room was constructed out of foamboard and cardboard cutouts were made of different characters to make multiple instances of each of the personas. Care was taken to ensure that the full range of audience behaviours we had observed was captured in the script, as well as different configurations of people in the room so that full functional testing of the system could be done with particular regard to state definitions, boundary cases and transitions between states.

The script was structured so that the audience activity was listed on one side of a table along with what was available to them to sense in the room at the time. On the other side, we defined whatever was actually available for the room to sense and its corresponding behaviour. This approach was directly inspired by the analytic framework Suchman used to identify available conversational resources in her classic study of photocopy use [7]. The matching of audience and system behaviour and perception allowed for the mapping of action and response, where appropriate, from both the user and the system perspectives, as well as making the perceptual asymmetry between the two available. Audience activity was described in terms of position, orientation, direction of movement, degree of movement, spatial paths and configurations within specific scenarios of use.

A 3 minute excerpt (see Table 1 and Table 2) from the 40 minute user interaction script illustrates two scenarios. We have presented it here in two separate tables purely for formatting reasons. In practice it is a single table in landscape format, with the User Perception and Machine Perception columns side-by-side. The Time column connects the two tables. Table 1 contains the audience or user perspective and Table 2 contains the room or machine perspective.

The first scenario involves Betty and her friend, Val, entering the space. They represent visitors who are slow-moving and contemplative. When they first enter, they stand just inside the entrance, looking around to watch the flock revealing images and text on the wall opposite. At this point in time, the system should detect two figures and transition to state one, where the flock changes in some way but still coherently presents images and text. The second scenario involves a young teenager attempting to enter the room.

### Table 1. Audience Perspective - User Interaction Script

<table>
<thead>
<tr>
<th>Schema</th>
<th>Time (M:S)</th>
<th>Scenario</th>
<th>Activity</th>
<th>Movement/Stillness</th>
<th>User Perception</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>01:00</td>
<td>Slow-moving, contemplative visitors. Betty and Val about to enter.</td>
<td>Betty and Val enter room together and stand fairly still looking around with heads turning.</td>
<td>See flock revealing on wall, w2.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>01:30</td>
<td>Head-poker. Young teenager enters, blocked by Betty and Val, so leaves. (see Figure 1)</td>
<td>Young teenager enters room, then exits.</td>
<td>What they see depends on whether or not the room perceives the head poker</td>
<td></td>
</tr>
<tr>
<td></td>
<td>02:00</td>
<td>Betty and Val decide to stay and watch more.</td>
<td>Betty and Val walk towards centre.</td>
<td>See flock moving, some images and text unfold.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>02:30 - 04:00</td>
<td>They watch the flock.</td>
<td>Slowly turning to watch flock, taking 1 or 2 steps each way.</td>
<td>See flock moving, more images and text unfold.</td>
<td></td>
</tr>
</tbody>
</table>
But the entrance is blocked by Betty and Val, so the teenager leaves. The question arises, for the designers, as to whether the young teenager (persona - a "head-poker") is detected and registered by the system as a presence that will affect the subsequent behaviour of the system. Then Betty and Val walk towards the centre of the room and remain there for a couple of minutes, slowly surveying the exhibited material, turning and moving around occasionally. The system remains in state one, with the flock moving dynamically around the five walls of the space and coherently revealing images and text. The description of the characters’ movement in space and time is represented visually in movement schema 2 (see Figure 1).

The format of the script clearly allowed the designers to recognise the extent of the perceptual asymmetry between the audience or users and the room or ‘machine’ [7]. The users act in the space within a social, situated and interactive context and hence their perception is shaped by and through their action and interaction with others, and the nature of the interactive work. In contrast, the machine’s perception of the action is limited to detecting what the designers chose to make available to it. Presenting the design questions regarding the mapping of audience input to system response within the analytic framework of the user interaction script meant that they could be continually addressed and evaluated as the design evolved.

Movement schemas

At the same time as the script was developed, an augmented set of Labanotation designed for group choreography was used to describe a set of movement schemas. Figure 1 and Figure 2 are examples of such a schema. These were developed to illustrate the changing spatial configurations and trajectories of the users during the scenarios. They provided an easily learnt, at-a-glance view of the overall activity in the room in terms of the path, position, orientation and movement of multiple users in space and time. By matching these schemas to the script it was possible to map the movements of individual characters both within the Bystander Field and in relation to other characters participating in the experience with them. This enabled us to ensure that the interaction with others that has been identified as defining of user experience of interactive art works, e.g., [3,9], was represented within this design tool. Most importantly it provided us with a way to represent findings from the user studies so these could be used to drive the enactment and evaluation of the developing Bystander Field.

Figure 1. Movement schema 2

We needed to augment the standard Labanotation symbols with a few of our own to enable us to represent, for example, undifferentiated body movement or ‘motion’ within a bounded area (see the dashed circle in Figure 1). This was important because the authors of the Bystander Field wanted audience presence and stillness to encourage revelation of the content, whereas activity and motion would result in less coherent and more turbulent presentation of the content. Body movements (be they gestures, postural shifts or locomotion, etc.) were treated as motion in the room: a source of disturbance. This raised the question of what constitutes ‘stillness’ in interactive spaces as people are rarely ever completely still in these
environments. User studies also found that stillness can sometimes be associated with a lack of engagement, when for example, people are ignoring the exhibited work to talk together about something else. We needed an understanding of stillness that was defined in relation to people's experience of the content and behaviour of the room.

**DISCUSSION**

The interaction script and its accompanying movement schemas were intended to enable the design team to experience aspects of the work that had not been possible until team members could immerse themselves in the piece. Prior to enactment of the script, much of the design conversation about the nature of the interaction between different members of the audience and between the audience and the room had been speculative and ungrounded. The first scenario enactment provided the design team with an extraordinarily strong sense of the physical and social aspects of the audience experience. The influence of other people's presence and activity in the room on an individual audience member's experience and perception of the work was made evident [9]. It was clear that for an individual to experience all aspects of the work, it might not be possible without the presence of several other people [3]. For example, it may only be possible for a quiet and attentive couple to witness the full extent of the work when a group of hyperactive children enter. This meant that audience understandings about how the interactivity of the room 'worked' could be only loosely tied to the experience of participating in whatever the current behaviour of the room actually was. It also meant that we needed to think about a range of 'satisfying' experiences for various configurations of people in the room.

During the script enactment, different people had quite different experiences regarding how and where they wanted to move or position themselves in the space. There was a tension between moving into the centre and moving to the periphery or corners. This pattern of movement was influenced by several factors such as moving to a position to gain a wider field of view; moving backwards to keep the visuals in front; following the flock by moving or watching; the sense of scale and physical shape of the room; the presence, position and behaviour of other people in the space and corresponding accommodation or sensitivity; the social interaction between companions and strangers; and actively engaging with the images and text. Later versions of the user interaction script were developed to support the design team's understandings of other aspects of the design such as movements in response to different experiences of the aesthetic content of the room.

**CONCLUSION**

The use of scenarios, personas, immersion and enactment revealed crucial aspects of the emerging design in ways that enabled them to be reflected on and used to build robust shared understandings among the designers. They functioned as "tools to think with" [8] to enable the design team to test, reflect and refocus their decisions throughout the design process. Most importantly, the use of personas and scenarios as design tools ensured that the experience of those visiting the exhibition was always central to the design process and that design decisions were always accountable, in a range of ways, to user experience of still emerging and novel technologies.

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**REFERENCES**