Between Artistic Creativity and Documentation: An Experiment on Interaction with an Installation for Music-Making

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Abstract. This article presents the preliminary results of an exploratory experiment with BilliArT, an interactive installation for music-making. The aim is to extract useful information from the combination of different ways to approach to the art work, namely that of conservation, of the aesthetic experience, and of the artistic creativity. The long-term goal is to achieve a better understanding of how people engage with interactive installations, and ultimately derive an ontology for interactive art.

Keywords: Interactive art · Aesthetic experience · Conservation Documentation · Digital humanities

1 Introduction

Practices of documentation exists across a number of disciplines, and the definition of documentation can often differ subtly between the various approaches of those doing, using, or observing documentation. Whether written, visual, digital, or even embodied, documents (physical or otherwise) provide 'information' about a central object or phenomenon. Within the arts practice, and particularly within performance studies, documentation practices and products of documentation are problematic, due to the intrinsic impermanence of the phenomenon they try to capture. Beginning with the repeatedly cited claim by Peggy Phelan (Phelan 1993) that performance could not be recorded or saved in any way – the ultimate act of documentation – because of the intrinsic difference between the ephemerality of performance and the endurance of the document. Philip Auslander (Auslander 2008) later countered this by suggesting that it is only through the mediation of performance in another form that we become aware of 'liveness', and he also suggests that disappearance and loss are not exclusive to

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performance, but are also a part of the material existence of performance documentation. Christopher Bedford (Bedford 2012), considering performance art specifically, has also – like Auslander (Auslander 2006) – advocated for the continuing life of the performance-as-artwork through the performance document, and its journey through time and space. The creation of the documents, and their potential for organisation, retrieval, and use in the future (Briet 1951) constitute complementary problems in building a good body of documentation. The quality of the final *network*, which includes the art work or performance themselves, has to be predicated on a good conceptual model (high level), and has to make sure that the format of each document is easily accessible, interoperable, and implements safety measures against tampering.

In their contribution to this conference in 2013, the authors proposed an abstract model for the preservation of interactive multimedia installations (Bressan and Canazza 2014). In this work, they present the continuation of their work, which aims to explore the nature of *interaction* with an artistic installation. The long-term goal is to achieve a better understanding of how people engage with interactive installations, and ultimately derive an ontology for interactive art. In this article we present the preliminary results of an explorative experiment carried out with an interactive installation for music-making called BilliArT. The aim of the experiment is to extract useful information from the combination of different ways to approach to the art work, namely that of conservation, of the aesthetic experience, and of the artistic creativity.

We move from the assumption that, at this stage of the research, these approaches can inform each other and produce new knowledge. Conservators need to compose a thorough description of the art work, and in order to do so they need a model of the art work. A model for interactive art will have to include interaction, but interaction – especially in aesthetic contexts – is not yet well understood. So a better understanding of interactive processes is functional to the advancement of our preservation models. For their part, artists are interested – among other things – in verifying the “end-user acceptance” (how the audience received the work) and the “overall system usefulness” (effectiveness of the artistic concept), “to get feedback to inform future design” (Abowd and Mynatt 2000) – with a clear parallel with the evaluation of interactive systems (a well developed field in engineering, for example (Bellotti et al. 2013)). Mostly qualitative questions that nonetheless require systematic gathering of quantitative data. Documentation can, in some cases, come to be an artwork in itself, with photographic and film documents often being included in exhibitions, or in data visualisations that hold aesthetic value and can be further manipulated to become part of future works. The participation to the practice of documentation can be seen, in this sense, as part of an expanded artistic practice.

A note on gender: gender mainstreaming (European Commission 2008) is an intrinsic part of this project. One way of implementing gender mainstreaming in gender non-related studies is to monitor gender representation, and to detect eventual differences among gender groups (Balarajan et al. 2011). Within the limits of this article, a reference to gender appears in Subsect. 4.1. The authors are currently developing more sophisticated methods to carry out gender-related tasks across the project activities.

The article is structured as follows: Sect. 2 gives a concise description of the installation; Sect. 3 describes the experimental setup and the types of data; Sect. 4 discusses the preliminary results.

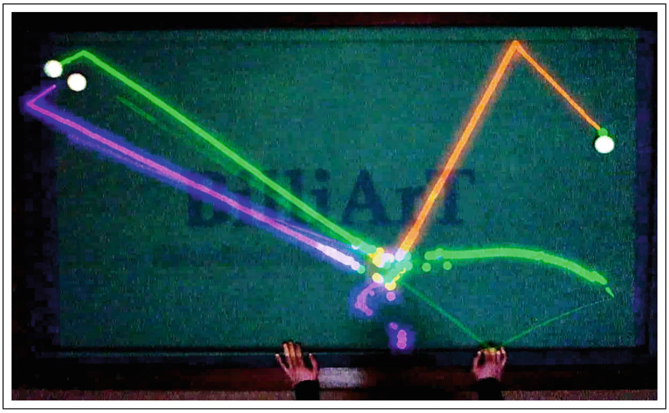


Fig. 1. Balls trajectories graphically reconstructed with the motion capture data log, and superimposed to the real-life video captured from the top of the table.

2 Description of the Installation

BilliArT is a dynamic system in which generative music emerges from the interaction of the participants with a standard carom billiard table. It was developed by Tim Vets at Ghent University, and first presented to the public in 2013 (Saenen et al. 2013). The installation features a jazz-inspired "algomorphic" approach to real-time music composition, combining sampled traditional jazz instruments (guitar, bass, drums) with their electronically manipulated counterparts. BilliArT presents the user with an interface familiar to most people, a standard billiard table: no musical training is required to compose with BilliArT, as the music unfolds as the game evolves. The balls rolling on the table, coated with a reflective material, are tracked by a motion capture system. The balls coordinates are passed to a Pure Data patch (using Open Sound Control) and drive the navigation through various dynamic melodic, harmonic, rhythmic and sonic structures. Standard billiard rules don't need to be respected, both to eliminate the requirement of having to know the rules, and to allow a greater degree of freedom in the exploration of sounds (for example the players can manipulate the balls with their hands, block their free roll or redirect them – but they cannot lift them from the table or remove them from the playing area). There is no standard playing duration and multiple players can interact at the same time. In this study, however, we experimented with a single-user interaction. For a detailed description of the system architecture, see (Vets et al. 2017).

3 Experimental

Setup. For this experiment, BilliArT was set up in a laboratory environment. A short verbal explanation about the installation was given to each participant before the game, then they were encouraged to familiarise themselves with the system by directly interacting with it (1 min training session). A researcher and a cameraman were the only spectators in the room. The playing time of the actual session was free (no time limit: participants were encouraged to follow the structure or the flow of their own musical inspiration).

Data collection. Qualitative as well as quantitative data were collected during the playing sessions:

- **Video recording:** each game was recorded with two fixed cameras: one on the side of the table, in the corner of the room, and one hanging from the ceiling, right on top of the billiard table, to capture the balls movements.
- **Audio recording:** the sonic output (the musical composition) was recorded directly from the line-out of the sound card mixing and redirecting the pre-recorded samples and the synthesised sounds to the speakers; the audio is also contained in the side video recording, providing an additional audio cue to align the video with the high-quality audio, besides the visual cue of the balls movement.
- **Motion capture data log:** the data log from the motion capture system was saved for each game, allowing for quantitative analyses on the games attributes such as exact duration and Quantity of Motion (see Subsect. 4.1);
- **Questionnaire:** a semi-structured anonymous questionnaire requiring the participants to fill in some questions right before and some questions right after the playing session;
- **Interview:** a semi-structured interview was carried out (and audio-recorded) right after the playing session.

There was some intentional redundancy in the data, aimed at integrating eventual missing data (which turned out not to be necessary) and at the verification of the consistency of the data. For example, the balls trajectories were graphically reconstructed starting from the motion capture data log and superimposed to the video recording captured from the top of the table (Fig. 1), to see how much noise was recorded by the motion capture system in the trajectories of the balls[1].

4 Analyses and Discussion

In the next paragraphs, we present the results of two analyses: the Quantity of Motion (Subsect. 4.1) and auto- and cross-correlations for the comparison of different playing sessions (Subsect. 4.2). In (Bressan et al. 2017), we reported

[1] A video is available at: http://federicabressan.com/daphnet/billiart/.

the effects of BilliArT on mood, and how previous experiences with installation art may influence the evaluation of BilliArT according to opposite pairs of adjectives (for example, "boring/exciting"). We plan to present the results of the questionnaires and the interviews in a separate article, oriented to qualitative analyses.

4.1 Quantity of Motion (QoM)

As the game develops over time, it's hard to express its characteristics with fixed values. On the other hand, we are not so interested in a real-time reconstruction of the game progression, we don't want to "watch" it again. We want to know "how much" and "how" the players interacted with BilliArT (how long did they play? were they always using all three balls? did they leave a ball still for a long time? how much surface did the balls cover on the table? etc.). So we defined a derived quantity called Quantity of Motion (QoM), that is a useful way of looking into each games characteristics and be able to compare them with other games (see Subsect. 4.2).

For each game, the QoM is calculated first for each ball. The QoM is made of two values: speed and angularity. Speed is the linear distance traveled by the ball during the entire game duration. Angularity is a sudden change in the ball's direction. When it occurs, three cases are possible: the ball hit the rim of the table, or it collided with another ball, or it was redirected by the player's hand(s). Angularity is relevant in the game because – according to the mapping defined by the artist – it triggers a musical event.

Angularity detecting is performed by considering the position of the ball in three consecutive motion capture frames. The angle defined by the ball's position in the current frame (t) and the previous $(t-1)$ is subtracted from the angle defined by the previous frame $(t-1)$ and the one before $(t-2)$. Let x[t0] and y[t0] represent the coordinates of the position of the ball at a given frame, $x[t-1]$ and $y[t-1]$ the coordinates at the previous frame, and $x[t-2]$ and $y[t-2]$ the coordinates in the second-previous frame. Angularity is calculated subtracting $\arctan((y[t0]-y[t-1])\ /\ (x[t0]-x[t-1]))$ from $\arctan((y[t-1]-y[t-2])\ /\ (x[t-1]-x[t-2]))$. When $y[t0]-y[t-1]$ or $y[t-1]-y[t-2]$ (i.e. delta(Y)) is negative, 180° are added to the result in order to obtain that the correct quadrant. However, an accurate calculation of the angularity requires that speed is also taken into account due to the physiological noise of the motion capture system. When a ball is not moving, the motion capture will detect micro-changes in its position, like a slight oscillation of the centre of the ball. And even a micro-change in the position can result in a large angle change. Therefore, by considering speed, we are able to determine whether the ball is in motion or not, and to retain the angularity value or not. This is achieved by multiplying the angle by the speed of the ball (the distance between the positions in the current and the previous frame).

Speed and angularity are then divided by the duration of the game, as each playing session had a different duration. The resulting number is the QoM for each separate ball. The QoM of the entire game is the mean of the sum of each separate QoM value. Figure 2a shows the normalised QoM for male and female participants. The QoM median for female participants is higher, and female also show a greater variance in their game. For both male and female, the QoM of each ball is similar to the mean QoM, confirming that it is a fair representation of the overall game – and not, for example, that participants played with two balls a lot and left one still, yielding the same motion mean value. Defining a quantity to describe motion proves useful in two ways: it helps artists formally abstract some aspects of the playing mode and features, manipulate them intellectually and then decide to introduce (or not) modifications in future re-installations or novel works. In other words it provides a language to talk about one aspect of the interactive process – the definition of which may be adjusted to fit the type of interaction of this specific installation. At the same time, by calling for the formal definition of other aspects of the interaction process, the QoM contributes to the vocabulary that conservator uses to understand, describe and archive the work. In this context, QoM is not intended as the measurement of human gestures – the motion capture system, normally used to track human gestures in studies that involve QoM in this sense (e.g. (Burger et al. 2013; Visi et al. 2014a)), is used in BilliArT to track the balls movement. In human gestures, QoM "is proportional to the translational movement and it is extracted from a global set of features evaluated over time. It gives high values when the body is moving fast and low values when it is more stationary" (Visi et al. 2014b). In BilliArT, QoM combines both the speed and angularity of the balls, and the relation is not necessarily fast movement/high value and stationary/low value.

Finally, QoM was mapped against the participants answers to the question "how much did you feel in control [during the playing session]" (for a description of the questionnaire see Sect. 3). The Likert-scale was grouped in three bins: "not in control", "somewhat in control", "very much in control" (Fig. 2b). Participants who felt less in control have the highest QoM value, while participants who felt 'somewhat in control" or "very much in control" have a similar median, although participants who felt "very much in control" also show a greater variability. The oral interviews reveal that participants who didn't feel in control were more relentless in trying to figure out the relation between balls movement and sound, resulting in a greater activity – as well as in a feeling of frustration, as revealed by the interviews. Conversely, participants who felt in control show a lower QoM because they were not trying so hard to "make" the installation sound, but let the balls roll longer, manipulated them less with their hands, and "listened" more to the co-created composition.

4.2 Comparing Games

We now take a closer look at some features of the playing sessions and compare them. We derive some observations on the participants' perceived sense of control, and on the tension between the concepts of "searching" and "finding" during the game progression. Cross- and autocorrelation matrices were made for the game data recorded by the motion capture system. A set of 12 variables was considered separately, among which the movement of each ball along the x and

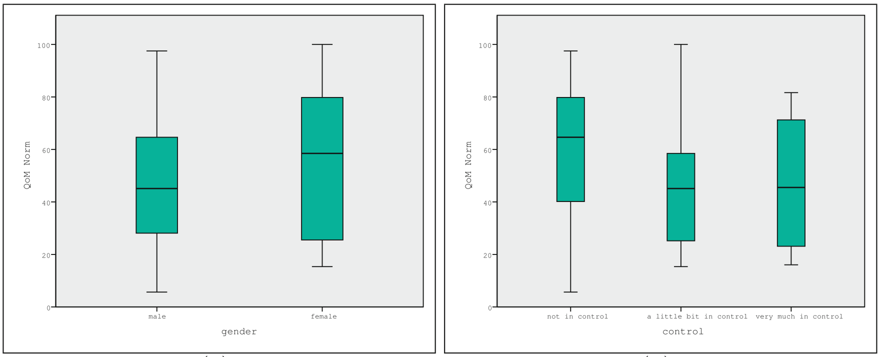


Fig. 2. Left: box plots of the Quantity of Motion (QoM) for two gender groups. Right: box plot of the QoM for groups of participants that evaluated how much they felt "in control" during their interaction with BilliArT.

y axis and the QoM. The raw motion capture data consist of time series that correspond to the three spatial coordinates (x, y, z) for each of the three balls (total of 9 values per sample), with a sampling frequency of 100 Hz. The matrices were generated discarding the value for the z axis (balls roll on the flat table, elevation is not relevant), and calculating the speed and angularity for each ball (totalling a number of 12 variables). Angularity is detected when a ball suddenly changes direction (see Subsect. 4.1).

Each of the 12 values were compared with themselves and the remaining 11, yielding 144 correlation matrices. Figure 3 combines the correlation matrices of two different games, laid out in a 12 by 12 *fingerprint*. The visual impact of the *fingerprints* expresses the overall similarity of the games.

Zooming in on each square gives us more information about the game progress. For example, Fig. 4 shows the auto-correlation of the movements of ball number 2 with respect to the x axis in two different games (a and b) and the correlation of both (c). Time runs on the diagonal line from the bottom left to the top right of the square. As can be readily seen in the auto-correlations, in the first game most activity is concentrated in the middle of the session, whereas in the second it is more spread out over the entire duration. Colour channels in subfigure (c) have been assigned so that green indicates changes taking place predominantly in one of the two games, blue indicates changes taking place in both games simultaneously, and plateaus without change in either game are depicted in pink/purple. Therefore, the green lines in Fig. 4c summarise the difference in activity between the two games where activity refers to every time ball number 2 has crossed the x axis on the billiard table. These data visualisations are a special example of documentation with aesthetic value, in that they were produced by the same artist who authored the installation; they can simply be seen as images, without a reference to their source (data) or meaning (data interpretation); they keep informing the artist's creative process, to feed or inspire future data-driven projects.

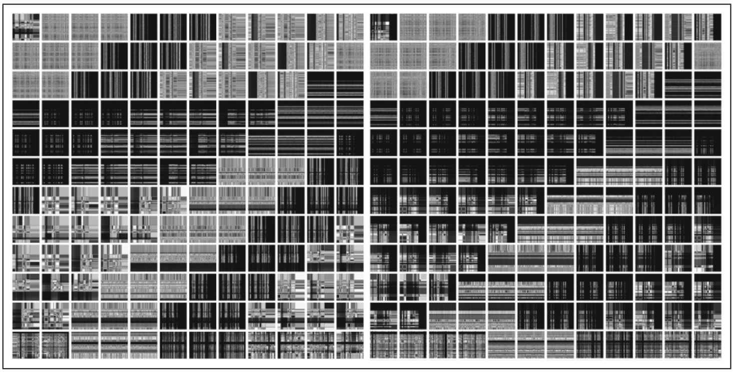
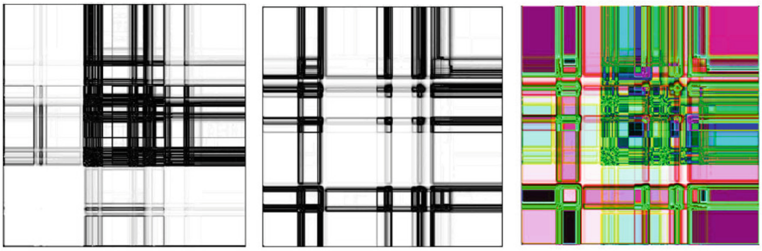


Fig. 3. Fingerprints of games 4 and 9, showing the correlation matrices of 12 parameters.



(a) (b) (c)

Fig. 4. Auto-correlation matrices (a and b) for the values of the movements of ball number 2 across the x axis in two different games, with angularity transitions emphasised in black; and coloured overlay of both (c). (Color figure online)

Billiard tables have a standard size of $2M \times M$, i.e. their length (x axis) is twice their width (y axis). Moving the balls along the x axis is allows for a greater span than moving them across the y axis. In relation to the musical mapping of BilliArT, it can be said that when the player has the ball cross the y axis, (s)he's trying to "find a new musical idea", while crossing the y axis (s)he's trying to "develop the current musical idea". This allows us to formulate some hypotheses on the musical intention or direction of the player at a given time in the game. Higher activity along the x axis reveal how often the player tried to change the overall musical idea; higher activity along the y axis reveal the desire to explore that idea, to elaborate on it.

5 Conclusions and Future Work

This article presented the preliminary results of an exploratory experiment with BilliArT, an interactive installation for music-making. The aim is to extract useful information from the combination of different ways to approach to the art work, namely that of conservation, of the aesthetic experience, and of the artistic creativity. The long-term goal is to achieve a better understanding of how people engage with interactive installations, and ultimately derive an ontology for interactive art. Future work include the selection of the most suitable indicators about the interactive aesthetic experience, and the design of experiments that refine the emerging concepts and test them on installations other than BilliArT. In a specific example, when we can distinguish the cause of direction change in a ball (hitting an obstacle while rolling, versus manual redirection), we can gain a better understanding on the experience of the player by combining this information with the perceived sense of control reported in the interview, the physical engagement and finding the game "clear" vs. "confusing". Letting the balls freely roll across the table (they only change direction when they hit a rim or another ball) may indicate that the player is more in an "observing" mode of the system, listening to the sounds of the installation without interfering much, trying to understand the mapping behind the movement and the sound; while intense hand manipulation reveals a will to "do", to control, to maximize the amount of sound "extracted" from the system. It may also indicate an inclination to stick to the original game of billiards, where balls are supposed to roll freely, or to engage in the interaction exploiting all the possibilities of the installation, where the rules of the original game don't have to be necessarily respected – actually not respecting them allows for more interesting sounds sequences and combinations.

Of course, regardless of the player's observing or active mode, the questions whether interactive systems such as BilliArT actually allow for *control* are open for debate, just like the question of the *authorship* of the musical output (who is the composer? the artist who designed the installation, the player, or the installation? or all three?). It depends how we define "control" and "authorship", and this is why definitions are not secondary not only in art history and critic for the sake of classification, but in preservation insofar preservation (of interactive art) requires a clear understanding of the phenomenon we're trying to describe, trans-code, and ultimately transmit over space and time.

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