USER-CENTERED DESIGN OF A TOOL FOR INTERACTIVE COMPUTER-GENERATED AUDIOVISUALS

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ABSTRACT

The present study aims to design a tool for interactive computer-generated audiovisuals. In this paper, we investigate if the tools for audiovisual performance and composition have caught up with the growing interest and the practices in the field. We have adopted a user-centered design approach for our study, based on interviews and a workshop with practitioners. The interviews identified key themes – expressivity, ease of use and connection with the audience – that were explored in the workshop. During the workshop, a novel methodology was adopted – *reboot* – which expands upon the *bootlegging* technique. Key ideas regarding audiovisual performance gathered from the interviews; sketches for novel audiovisual tools resulting from the workshop; and the reboot technique, are the main contributions of this study.

KEYWORDS

User-Centered Design, Interaction Design, Human-Computer Interaction, Audiovisual Performance, VJing, Computer-Generated Graphics, Computer-Generated Sound.

1. INTRODUCTION

The field of audiovisual (AV) performance and composition has been particularly active in recent years. New festivals (for example: LPM,[1] LEV,[2] Mapping[3]), publications (for example: *See This Sound* series and web archive,[4] *LEA Live Visuals* special issue[5]) and conferences/seminars (for example: Seeing Sound,[6] Real-Time Visuals[7]), have focused in this field in the last years. From our own experience as performers, we have realized that audiovisual performances often rely on custom software made by the artists, and not on ready-made tools available to other performers. We would like to understand if the tools for AV performance and composition have caught up with the growing interest and practices in the field. The practical aim of this study is to design a tool for computer-generated audiovisuals, taking into account expressiveness, ease of use, and audience involvement. In this context, we consider that expressiveness is "not a distinct action or task that can be isolated for study, but rather a phenomenon that arises as a consequence of how an action is completed" (Hook et al. 2011). In this paper, we present early results from research examining user interfaces for procedural audiovisual performance systems.

We adopted a User-Centered Design (UCD) approach consisting of two steps. We first conducted interviews with 12 audiovisual practitioners, to better understand their practice, in particular: the strengths and weaknesses of the tools that they use; and the role of the audience in their performances. We then conducted a 1-day workshop to brainstorm, create imaginary scenarios, and sketch possible future tools for audiovisual performance, taking into account themes identified in the previous interview stage. 19 participants attended the workshop. During the workshop, we implemented the *bootlegging* brainstorming methodology (Holmquist 2008) and introduced a novel twist on it, which we named *reboot*. This study gave rise to: key ideas on tools for audiovisual performance gathered in the interviews; the sketches for a novel tool for AV performance produced in the workshop (which used the key ideas as an input); and the reboot method (which was devised as a means to rapidly generate sketches based on an initial input).

1. LPM: *http://liveperformersmeeting.net*
2. LEV: *http://www.levfestival.com*
3. Mapping: *http://www.mappingfestival.com*
4. See This Sound: *http://see-this-sound.at*
5. LEA Live Visuals special issue: *http://www.leoalmanac.org/vol19-no3-live-visuals/*
6. Seeing Sound: *http://www.seeingsound.co.uk*
7. Real-Time Visuals: *http://www.realtimevisuals.org*

2. TOOLS FOR INTERACTIVE AUDIOVISUALS

Audiovisual performance has a long history, from color organs and the visual music cinema performances of early 20th century pioneers – artists such as Walther Ruttmann and Oskar Fischinger, who used "tinted animation to live musical accompaniment" (Moritz 1997) – to contemporary digital works. From the 1990s, there has been a strong interest in "screen-based performance", adopting "a long litany of names such as audiovisual performance, real-time video, live cinema, performance cinema, and VJ culture" (Salter 2010, 171). Chris Salter attributes this interest to two branches of techno-cultural development: on the one hand, "breakthroughs in digital computation, particularly the development of hardware and software components for the capture, processing, and manipulation of image and sound" and on the other hand, "the international rise of the techno/club scene, which rapidly exploited such technologies". From the terminology mentioned by Salter, we preferentially use *audiovisual* or *AV performance*, as it best encapsulates the two modalities of sound and graphics.

Two notable examples of contemporary audiovisual artists using computer-generated graphics and sound are Golan Levin and Toshio Iwai. They are relevant to this study because they are concerned with creating interfaces and instruments for audiovisual expression. Levin developed a suite of works under the name *Audiovisual Environment Suite* (*AVES*) and described his approach to audiovisual performance as being based on painterly interfaces (Levin 2000). Iwai creates playful pieces, crossing genres between game, installation, performance (with works such as *Elektroplankton*, *Composition on the Table*) and audiovisual instrument (with *Tenori-On*)(Wynne 2008).

There is a large choice of software tools for audiovisual performance. In this context, we use the term "tool" to define generic software systems that can be used by different artists to create their own performances (and not software created by an artist for a specific piece). These tools deal with audio, visuals or both. They can be ready-made commercial software such as Modul8,[8] Resolume,[9] VDMX[10] (with an emphasis on graphics) or Ableton Live[11] (with an emphasis on sound). There are also open-ended programming frameworks or environments – usually following either data-flow programming or textual programming paradigms. They usually carry with them steeper learning curves than turnkey software products. Examples of data-flow programming software used for audiovisual performance: VVVV,[12] Quartz Compos-

8. Modul8: *http://www.modul8.ch*
9. Resolume: *http://resolume.com*
10. VDMX: *http://vidvox.net*
11. Ableton Live: *https://www.ableton.com*
12. VVVV: *http://vvvv.org*

er[13] (with an emphasis on graphics), PureData[14] (emphasis on sound) and Max/MSP/Jitter.[15] Examples of textual programming frameworks or environments used for audiovisual performances: SuperCollider[16] (mainly for sound), openFrameworks[17] and Processing.[18]

Most ready-made commercial software tools for live visuals (such as Modul8, Resolume and VDMX) focus on video playback and manipulation. Therefore, artists interested in using video for their performances have a choice of using either ready-made (and easier to use) software, or programming languages / environments (with a steeper learning curve, but offering more flexibility). For artists dealing with computer-generated graphics, however, there is a scarcity of ready-made, easy to use software.

The design of tools for AV and VJ (Video Jockey) performances has been analyzed before from these perspectives: taking into account expressive interaction (Hook et al. 2011); ease of use (Correia and Kleimola 2014); and audience, specifically considering participation (Taylor et al. 2009) and awareness of performer's actions (Lew 2004). Our work is distinct because it takes into account all three aspects; it focuses on computer-generated audio and visuals; and because of the novel methodological approach regarding user-centered design.

3. METHODOLOGY

This study follows a UCD approach. UCD is "a broad term to describe design processes in which end-users influence how a design takes shape" (Abras, Maloney-krichmar, and Preece 2004). In this case, the end-users are audiovisual performers. We adopted a UCD approach to better understand current practices of audiovisual performers and to design a tool that addresses their needs. The interviews aimed to obtain insights into the practices of audiovisual performers, and the tools they use. The questions were grouped in six sections:

- Characterization of performer;
- Tools;
- User Interface (UI);
- Audience involvement;
- Artistic goals and technology; and
- Specific performance recollection.

The interviews were conducted prior to the workshop, so that the insights gathered during the interview stage could inform the scenarios for the workshop. Workshops are defined as "collaborative design

13. Quartz Composer: *http://quartzcomposer.com*
14. PureData: *http://puredata.info*
15. Max/MSP/Jitter: *http://cycling74.com*
16. SuperCollider: *http://supercollider.sourceforge.net*
17. openFrameworks: *http://www.openframeworks.cc*
18. Processing: *https://processing.org*

events providing a participatory and equal arena for sharing perspectives, forming visions and creating new solutions" (Soini and Pirinen 2005). Due to the collaborative and participatory nature of workshops, they were chosen as a key element of the adopted methodology. A one-day, 6-hour workshop was conducted, aiming to produce sketches of novel tools for audiovisual performance.

For the first part of the workshop, we conducted a *bootlegging* session. Bootlegging is a "structured brainstorming technique particularly suited to multidisciplinary settings" (Holmquist 2008, 158). Bootlegging applies the notion of cut-up – a form of literary collage popularized by William Burroughs – to brainstorming sessions, mixing familiar concepts in a way that stimulates creativity. A bootlegging session requires a theme. It also requires the definition of four categories for idea generation, two relative to the user side and two related to the theme and technology. A presentation format should also be chosen. The participants, divided into groups, should then generate several ideas (as post-its) for each category, mix those ideas and create 4-5 random combinations of each category per group. Those combinations then become the trigger of a brainstorming session, attempting to imagine different potential applications for each combination. Afterwards, the groups are asked to pick one of the ideas and prepare a presentation in the chosen format (Holmquist 2008, 159).

For the second half of the workshop, we devised and ran a variation of the bootlegging technique, which we entitled *reboot*. Reboot is a brainstorming technique that builds upon bootlegging, and is intended as a follow-up to a bootlegging session. Similarly to bootlegging, it also requires a theme and four categories (the same ones as in the preceding bootlegging session) for idea generation. For more focused results, additional requirements are introduced to the initial theme, taking into account the results of the bootlegging session. Instead of relying on generating multiple variables for each category and random mixing, the variables for the four categories are deliberately chosen by the participants (one variable per category). Some or all of these variables may also be defined by the session facilitators. The same steps as in bootlegging are taken, with the exception of the mixing and combining steps. The aim of reboot is to give direction and focus after the open-ended and aleatoric nature of the first exercise. After having stimulated the creation of new application ideas with the bootlegging session, reboot allows the participants to concentrate on more specific solutions.

4. INTERVIEWS

4.1. PARTICIPANTS

We conducted 12 face-to-face interviews lasting between 25 and 56 minutes. 11 of the interviewees were male, 1 was female. The interviewees had between 4 and 18 years of performance experience.

4.2. RESULTS

When asked what is the most important feature of the tools they use, two interviewees mentioned modularity and flexibility of the software ("easily adaptable to different performance situations and its flexibility"; "the fact that it can be configured in so many different ways"). Two artists mentioned ease of integration with hardware and other software ("the way that Modul8 is built, with the options that you have, basically controlling those options with knobs and faders" and "Resolume was always working well alongside Ableton"). Two others mentioned expressivity and fluidity ("it creates images a bit more like you were creating music"; "you want to be like a musician, you want to play an instrument, you want to respond in real-time"). Other interviewees mentioned integration of environmental elements ("construction with the elements that are around"), generative capabilities and diversity ("the fact that it's generative (…) each performance becomes different"), communication of live creative process to the audience ("projecting agency to the audience"), reliability ("software can be glitchy, slow, crash") and speed ("I want to be able to do multiple processes very quickly").

When asked what features they would like to add to their performance tools, interviewees repeated qualities mentioned earlier, such as stability, modularity and diversity. Additionally, two artists mentioned that they would like to have a flexible timeline view in their software (because "the time of the performance is of a different time from the reality" and "for running more generative kind of installation type stuff"). Ease of mapping audio reactivity to graphics was also mentioned ("the ability to make a video file or a layer audio reactive with a single button").

Regarding ease of use, the interviewees who use commercial software agreed that these tools are easy to use. The others consider that the custom systems they have built are personal and not designed for others to use ("we always get it quite personal"; "I don't care about ease of use I care about expressiveness"; "I don't think that the system itself is complicated but the way it's controlled might be complicated"; "it's more the realization that it is your own tool and that you're showing your composition through that tool where the value lies"). Two of the artists make a distinction between systems created for their own performances, focusing on expressiveness and individuality, and systems that they have created for others, which are easier to use.

Regarding preference for type of UI, nine of the 12 interviewees use hardware controllers (with two expressing a preference for motorized controllers), and five of these complement the hardware controller with an Apple iPad running a controller software application (app). Hardware controllers and iPad (running Touch OSC or Lemur apps) are used to control the audio and/or visual software running on the laptop. Hardware controllers are favored because of the eyes-off tactile feedback they provide. The following quote reflects a general view for

a majority of the interviewees: “the physical feeling for me is essential for performance: buttons, rotaries whatever; because I’m more precise – they never let me down and I feel the performance better”. For some, motorized controllers are preferred: “a motorized physical controller with real sliders makes it easier to be able to look at the screen without the need of looking at the controller”. iPads are used because of the identification and visual information they provide: “it’s really an easy way of labeling up all your effects and be able to see all that stuff without having to stick all bits of plastic to MIDI controllers or to keys in your keyboard”, although that comes with a cost: “but of course the problem is that you need to be looking at the iPad because you don’t feel with the finger”.

One of the artists uses live coding as a performance technique, because in his opinion “graphical interfaces are frustrating” and slow. He considers live coding natural for him, as he uses SuperCollider. He has some doubts regarding the impact of live coding on the audience: “I have a bit of a problem with live coding and people showing the screen, you know – I always just stand there and wonder how it’s like for most people”. The solution he has found is to integrate the code with the visuals: “I’m trying to find creative ways to display the code and also make it part of the graphics”. Another interviewee explores showing the Graphical User Interface (GUI) as a means of projecting the performance process to the audience: “there’s two visuals going on, there’s the visual object that is showing, which is somehow the thing to be manipulated, and then there’s the act of manipulation itself, which is some kind of GUI that sits on top of that”. He tries to find a balance between having more GUI and more ease of use for him, or less GUI and therefore less visual interference for the audience: “I could put loads of GUI and make things maybe clearer for the audience and they could see more of my actions, but then it starts to crowd over the graphics that are underneath”. The remaining controls are executed with key presses. Two other artists use only the computer keyboard and keyboard shortcuts as their interface.

4.3. AUDIENCE REACTION AND PERCEPTION OF LIVENESS

Audience reaction to the performance, as perceived during the performance or communicated afterwards, is important for eight of the 12 interviewees. When questioned if their audiences understand the interactive and real-time element of the performances, five replied that it depends on the audience and the setting. According to these artists, some audiences might be more knowledgeable in computer-based performance than others, whereas in some venues the visual element might not be as valued as in others. Four of the artists state that it is indifferent for them if the audience understands that the visuals are interactive or not. For these artists, the importance of the performance lies in the quality of the experience, not in the perception that it is live. For two of the interviewees, audience perception of liveness derives

from the assumption that it is live if there is someone on stage ("if you see ... another people doing other things") or to post-performance feedback ("they'll actively tell me why they've enjoyed it ... I'm pretty confident that it's communicating what it's trying to"). One interviewee considers that the audience generally does not understand that the performance is being done live – "people can't see much what we're doing" and "people think once you have a laptop on stage that laptop is doing everything for you", therefore: "we are considering: should we actually make that clearer".

Interviewees were asked to suggest ways to improve audience understanding of liveness. Two of the interviewees did not have interest in improving communication with the audience, with an additional one stating that it would make sense only in specific performances. Live coding, or further displaying aspects of the code, is a possible path for four of the artists. The live coding interviewee suggests further integration between displaying code and additional visuals ("make the codes animated somehow" and "add some comedy to it"). Two artists who are not currently using live coding contemplate using that performance technique in future work. Another interviewee mentioned the notion of "debug interface" to showcase parameters to the audience, in the same way that an artists uses debug windows to check for values ("almost like another layer of visual information that's purely only really for the developer but that is displayed for the audience"). Two of the artists suggest adding live camera feeds to convey a sense of liveness, either pointed to the audience ("more cameras where the space of the audience is") or to their stage setup ("a camera over my head on my set up showing what I'm doing"). Additional suggestions are: using custom apps that the audience could download and interact using their mobile devices during a performance ("custom apps or information that's being kind of gathered or created by the audience); and tracking audience movement as an interaction mechanism ("body positioning, and somehow one of the persons in the audience can affect the music somehow, or the visuals").

5. WORKSHOP

5.1. PARTICIPANT CHARACTERIZATION

The one-day workshop took place in October 2014, at Goldsmiths, University of London. The call for participation was circulated among mailing lists within the Goldsmiths and London Video Hackspace[19] communities. 19 participants (12 male and 7 female) took part in the workshop. Ten described themselves as VJs and/or AV performers, three as programmers, one as video artist, and four as musicians - all practitioners in the field of audiovisual performance or related fields (music, video, media arts). One anthropologist studying audiovisual performance also participated in the workshop. Four of the partici-

19. London Video Hackspace: *http://www.videohackspace.com*

pants develop work with video footage, another four with computer-generated graphics and six with both. Nine of the participants stated that they build their own tools for performance, with Max/MSP (five), openFrameworks (three) and with Processing (one). Three of the workshop participants had been interviewed in the previous stage of the study.

5.2. BOOTLEGGING

In our bootlegging session, the theme was: "Software for interactive computer-generated audiovisuals, using a single screen". The constraint of the single screen aimed to stimulate creativity in terms of user interface, avoiding a performer-specific screen populated with GUI, common in commercial software. The participants were divided into five groups. During the generation stage, each group produced post-its with dozens of variables for each of the chosen categories – user, situation, interface and device. In the mixing stage, these were randomly mixed within each group, and each group was asked to produce four random combinations with one item per category. Each of these combinations was pasted to an A3 paper. The groups were then asked to think of different applications per combination. Finally, they were asked to pick one of the applications and develop it conceptually, preparing a presentation based on a storyboard and wireframes (figure 1).

The bootlegging session achieved the aim of stimulating creativity in participants and opening up the range of possibilities for audiovisual performance outside of the usual scenarios. Many of the concepts were humorous, ironic and playful. The five concepts were:

- *Botanical garden motion sensors*, a garden transformed into a performance space, augmented with surround sound and visuals projection-mapped on trees;
- *Fish food - an audio-fishual dance ensemble*, a reactive aquatic audiovisual environment for public spaces;
- *Interactive surgery blanket*, a special fabric for health purposes, incorporating a flexible screen, which reveals physiologic aspects of the patient it is covering, with bodily functions being sonified and visualized;
- *EAVI sleeper*, a system incorporating a blanket with different biological sensors, which generates an audiovisual performance based on the biological data of a sleeping "performer"; and
- *Blind date sensory experience*, a system for two artists who meet on an online "blind date" for a networked audiovisual performance.

Figure 1 Bootlegging presentation

5.3. REBOOT

After the serendipity, humor and technological speculation generated by the bootlegging stage, the reboot stage aimed to bring more focused results. The participants were regrouped into different combinations. The groups were asked to brainstorm on the same theme as the bootlegging session, but adding a few more constraints:

- to focus on a performance scenario, and
- to take into account key qualities in tools for audiovisual performance detected during the interviews – expressivity; ease of use; and connection with the audience.

After the brainstorming session, the groups were asked to prepare a presentation, also based on a storyboard and wireframes.[20] Two of the concepts (*Gestural Touchscreen* and *Meta/Vis*) aimed to reach a balance between expressivity and ease of use. The additional three concepts focused on audience participation. Two of these (*Sensor Disco* and *Fields of Interference*) consist of performance spaces without a single main performer – the audience becomes the performer:

- *Gestural Touchscreen* is a touch-screen based application, controlled entirely by gestures. There is no GUI. Users can only load SVG files as visual content and there is a built-in physics engine (figure 2).
- *Meta/Vis* also relies on multitouch, but adds a "pre-performance" configuration stage. This stage adopts a data-flow paradigm, although substantially simplified. Objects such as sound, visuals, control, generative and physics can be linked with arrows in different configurations, and contain drop-down menus for additional options. The group described it as "a simplified Jitter-style patching system".

20. The five sketches can be downloaded from: *http://nunocorreia.com/files/IG-AV-sketches.zip*

- *Sensor Disco* consists of an environment containing multiple sensors. By moving in the space, audience members trigger and modulate sounds, which are visualized on the walls and on the floor.
- In *Fields of Interference* users creates sound and visuals by moving with their mobile devices in a room. The system is composed of an array of sensors, which sonifies and visualizes Wi-Fi interference from mobile devices – using surround sound and an immersive dome-like projection screen.
- In *Beat the DJ*, there is a main performer role (in this case, a DJ/VJ), and the club environment becomes a game where audience activity "unlocks" audiovisual content. In the beginning, the audio and visuals are simple (for example, a drum loop and a few melody lines) but audience reaction can give the DJ/VJ more elements to play with. These elements can potentially trigger further reactions from the audience.

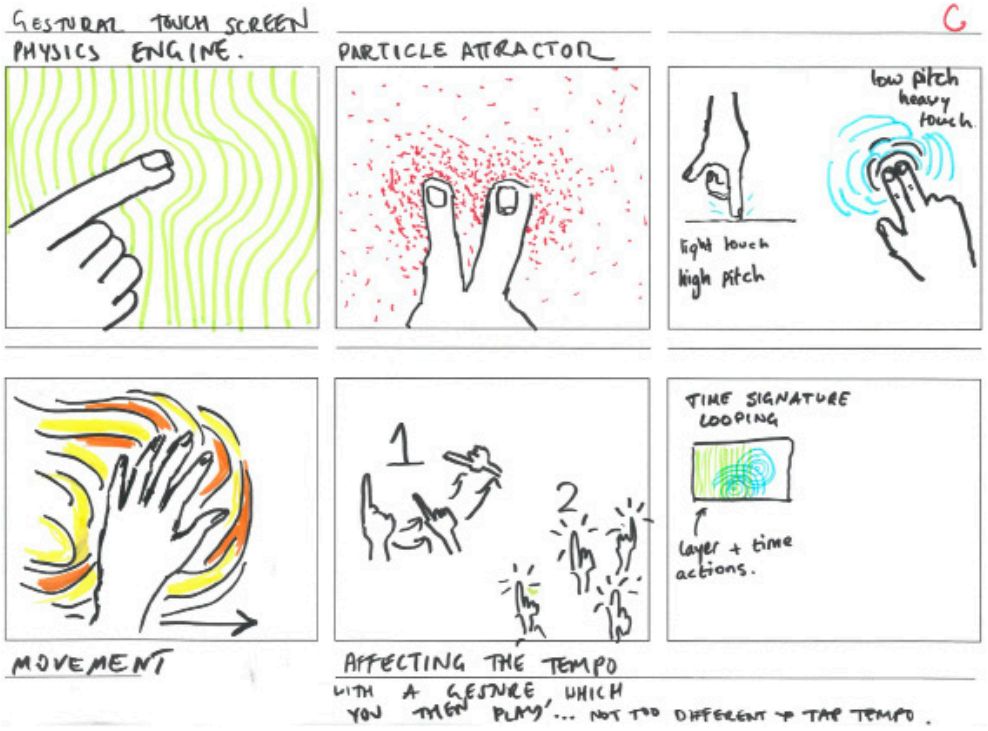

Figure 2 Storyboard from reboot session (*Gestural Touchscreen*)

6. DISCUSSION

The adoption of a UCD approach generated surprising results, which would not have been achieved from a top-down design process. In the beginning of the reboot session, we asked participants to reflect upon themes identified in the interview stage – expressivity, ease of use and connection with the audience. The resulting sketches successfully incorporated those reflections. The unconventional approaches of several of the sketches would not have been possible without the earlier bootlegging session, which stimulated out of the box thinking amongst the participants, enabling them to envision possibilities that go beyond

traditional solutions. We were thus satisfied with the method taken, from interview and identification of themes to bootlegging and reboot. We believe that reboot is an important methodological contribution of the study.

6.1. EXPRESSIVITY, FLEXIBILITY AND EASE OF USE

One of the key themes detected in the interviews was expressivity, to be able to make visuals "like a musician" and the desire to play an audio-visual tool with the same expressivity and fluency as a traditional musical instrument. Another was flexibility and the possibility of reconfiguring the software in many ways. Yet another was ease of use – existing ready-made tools are easy to use, but they focus mostly on video manipulation, and there are few targeting computer-generated graphics. Combining these elements can be challenging, and often there are trade-offs between expressivity, flexibility and ease of use. Two of the sketches that came out of the workshop, *Meta/Vis* and *Gestural Touchscreen*, address these issues. Both rely on multitouch interaction so as to convey a sense of immediate control of sound and visuals. In *Gestural Touchscreen*, the expressivity comes from the rich variety of gestures that can be used to control sound and visuals and from the pressure sensitivity capabilities. The flexibility arises from the possibility of loading SVG (Scalable Vector Graphics) files as visual patterns to be animated and manipulated, making the graphical possibilities virtually endless. *Meta/Vis* also relies on multitouch gestures for expressivity (although less than *Gestural Touchscreen*). The focus of *Meta/Vis* is on flexibility and reconfiguration. To solve this, while maintaining ease of use, it incorporates a simplified data-flow programming component – basic blocs such as sound, visuals and control that can be re-routed and that contain simple drop-down menus with options. Both *Meta/Vis* and *Gestural Touchscreen* address ease of use by: implementing multitouch gestures that are easy to understand, while allowing for a great variety of control (particularly in *Gestural Touchscreen*); and adopting ingenuously easy solutions for reconfiguration (with the SVG approach in *Gestural Touchscreen*, and the simple data-flow modules of *Meta/Vis*).

6.2. AUDIENCE INVOLVEMENT

Another key theme detected in the interviews was audience involvement: the importance for some artists of conveying the liveness of the performance to audiences; and how to have audiences participate in the performance. Three of the sketches from the workshop address the issue of audience participation. In *Sensor Disco*, audience positioning in the space affects sound and visuals; in *Beat the DJ* the amount of physical activity of audience participation enriches the sound and visuals with a game-like "levels" logic; and in *Fields of Interference* the Wi-Fi signal from mobile phones of audience members is sonified and visualized.

7. CONCLUSIONS

Although the field of audiovisual performance has a long history, it has not been thoroughly documented, and it has not been the subject of design research. Technological developments present numerous opportunities – in interaction with the tools; creation of sound and graphics; visual and auditory diffusion; use of networks; ubiquitous computing; and audience participation. This study focused on one aspect of content generation – computer-generated audiovisuals – and arrives to concepts that explore some of these opportunities for performance, using a UCD approach. The study is an early stage part of our research. With this study, we were able to identify key ideas on audiovisual performance in the interviews; participants produced sketches for novel tools in the workshop; and we conceived and tested the reboot brainstorming technique. The sketches produced in the workshop show great promise in addressing key themes and concerns identified during interviews to practitioners – such as expressivity, flexibility, ease of use and audience involvement. These concepts can be useful for audiovisual performers, or designers of tools for audiovisual performance. The study also proposes an extension to the bootlegging methodology, which we entitled reboot. Reboot extends open-ended brainstorming to bring additional focus to brainstorm sessions through focused iteration. In this case, the focus was defined based on key themes identified during the earlier interviews stage. The interviews set themes. Bootlegging facilitates serendipity and out of the box thinking. Reboot brings themes from interviews into an iteration of bootlegging to provide focus and structure to the brainstorming process without constraining it to a task-based exercise.

In a future stage of the research, we will conduct another workshop with performers and programmers, in order to develop these sketches into functioning prototypes. Some features from the different concepts might be merged into one or more prototypes. Afterwards, we will conduct tests with these prototypes in a performance setting. The prototypes will be made available as open-source code. With this study, we hope to contribute to the audiovisual performance community, and the expansion of the range of creative possibilities at their disposal.

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