Sound Design Ideation: Comparing Four Sound Designers' Approaches

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ABSTRACT

The craft of sonic interaction design (SID) for new digital objects is a non-trivial task. A deeper understanding of sound design practices employed by professional sound designers and Foley artists offers a rich source of knowledge which may inform future designs. Our research utilises a novel set of design briefs to examine and compare initial sound design ideas produced by four sound designers. Two participants are professional sound designers, while the other two are former professional sound designers who recently moved into academia. Results show a number commonality in ideas produced as well as uniqueness in approach and personal influences when completing the briefs.

1. INTRODUCTION

As new digital objects, with no inherent sound, are constantly being created the need for a deeper understanding of sound design practice and the role of the sound designer has increased. Often there are no inherent sounds associated with digital objects and multimedia product designers are often given the challenge of developing these, including bestowing some meaningful audio feedback. This is a non-trivial task and much can be learnt from practices established in media production. Sound designers and Foley artists have a history of creating sounds for everyday interactions and objects in creative industries including cinema, games, VR/AR, etc. Research into the design and production of these sounds is in its infancy, largely disconnected to its closest practice in media production. Recently, the creative contribution that sound professionals bring to multimedia production has started to be investigated (e.g., [1–3]) and results reveal the richness of sound designers' training processes, experiences and amassed knowledge.

This work contributes to this area of research by gathering new knowledge about the creative processes of professional sound designers with the view to strengthening connections between sonic interaction design and the existing practice of sound design. This research aims to inform the development of new techniques and tools for implementing sounds for new digital objects, following an approach inspired by Dourish and Button's concept of technomethodology [4] where ethnomethodology investigations form the basis of the design of new technology. New tools, informed by professional sound designers, will assist sonic interaction designers, reinforcing links between theory and what has already been developed and culturally established in creative practice. This paper presents the results of a study conducted with four sound designers, two participants off which are professional sound designers, while the other two are former professional sound designers who moved into academia. On the surface, each participant has a unique background and career path. Their ages cover different generations, there are three male and one female, each from different countries with different cultural backgrounds and work within different media (radio, film, games and sonic art). Results show, however, that common concerns, strategies and dimensions, which seem to bridge across these fundamental differences, exist along with unique approaches to identical tasks.

2. BACKGROUND

Sound design is a means to convey information relating to the function and the form [5] of an object or system. The function of a sound informs the listener of an event or an interaction that has caused the sound to be created. The form of a sound informs the listener about the characteristics of the object(s) themselves, e.g., the objects' size, whether the object is old or new, etc. For example, a knock on a door tells us that someone wants to come in (function), while the quality of the sound, form, indicates whether the door is made of wood or glass, or whether the knock is sad or happy [6]. Sonic Interaction Design (SID) focuses on the role of audio and sonic feedback in interactive devices [7].

Research on how design practitioners, in sound or other areas, think and use their creativity [8] is relatively recent [4,9–12]. Schön and Dourish have emphasised the dynamic nature of these processes [4,9]. They happen "in action", and therefore require to be examined "in action" too. Empirical design research can vary between "in the studio" ethnographic studies, which have the advantage of observing practitioners in situ, but are context dependent and difficult to generalise; and laboratory studies, where tasks and protocols might be more contrived in order to control variables, but comparisons and generalisations are potentially possible. Finally, intermediary studies, which aim to maximise the benefits of both approaches, are also possible, but difficult to design and carry out. Despite the differences, all these approaches have been found to be effective in extracting new knowledge about design processes [13]. Ethno-

graphic studies [14] employ a number of techniques [15], including observations of practice and semi-structured interviews, which help researchers identify key factors and methods undertaken by individuals within their everyday processes and practices. Pauletto [2] has used these techniques to investigate the creative processes of film audio post-production professionals.

The think-aloud method [8, 16, 17], can elicit knowledge during practice, in which participants are encouraged to speak their thoughts out loud, with minimum interruption from researchers. Using think-aloud techniques, in conjunction with traditional interviews, can provide a better understanding of what participants do [18]. Previous research into SID where individuals and practices are observed have been carried out in [19]. A workshop involving postgraduate students was undertaken to analyse their sound design process, where bottlenecks occurred, and the cognitive behaviours involved in the creative process. Our research focuses on professional, rather than non-professional, sound designers currently or previously working across a range of media. We contend that the practice of professional sound designers might be richer in approach and originality than that of non-professionals, and therefore more fruitful when aiming to capture the sound designers' reflection-in-action [9] that could potentially be applied, in part or wholly, within sonic interaction design.

3. METHOD

A study procedure was developed for this project, which includes observation of practice in situ, an interview, and newly developed sound design briefs to be tackled by all our participants. A pilot study, reported in [20], confirmed that the sound design briefs we developed are successful in eliciting rich sound design creative processes.

3.1 Description of Study Procedure

A key element of our wider research is to understand how sound professionals conceive appropriate, original sound designs for a given task. To obtain research data in this area, we developed an intermediary study procedure that has both "in the studio" elements and laboratory aspects [13]. It is based on ethnographic techniques [15, 21], and think-aloud methods [16, 17, 22], which includes a set of specifically devised sound design briefs to be common across all participants so that different approaches to the same task can be compared. The overall study procedure spans a maximum of 4 days and includes the following phases:

- Day 1: Initial contact and establishment of rapport (prior to Day 2)
- Day 2: Observing moment-by-moment [4] practice (Duration: 4-8 hours)
- Day 3: Observing how sound designers approach given briefs (Duration: about 3-4 hours)
  - Brief 1: Abstract brief
  - Brief 2: Listener in focus
  - Brief 3: Case Study - The sound of air pollution
- Day 4: Final observations and follow-up conversation

The initial phase involves recruiting participants, engaging in dialogue about their role, outlining our research, and generally developing rapport. In the next phase, we observe the designers in their studio and learn about their moment-by-moment [4] responses to the daily environment and tasks, through tools and practices. The activities of Day 3 are designed to facilitate reflection-in-action [9] during the initial stages of the sound design process. Having a set of common briefs gives us an explicit way to identify common practices, as well as highlight unique approaches leading to novel solutions. The briefs also aim to challenge participants' habits, open their minds and provoke creative solutions. Sound designers are located in their normal working environment, usually a studio, and are free to use any of the tools they are familiar with to illustrate the type of sound designs they are thinking of while responding to the briefs. At the end of the briefs, researchers can seek clarifications, if necessary, without interrupting the thinking flow (a recognised technique within think-aloud methods [23]) and participants can offer feedback on the method. Finally, a semi-structured interview is conducted at the end of the process to gather more precise background information from the participant.

3.2 Description of Briefs

The briefs provide us with a tool to study sound designers, bringing to the fore their creative thoughts and processes. A previous study [20] using these briefs has shown that they are successful in eliciting a broad range of processes. This study focuses instead on the ideas produced within the briefs procedure. Non-standard tasks were deliberately chosen in order to shift the sound designers from their habits and comfort zones, pushing them to reflect on their sound design choices rather than rely on previous solutions. It also allowed us to present sound designers from different media fields (radio as opposed to film, for example) with the same brief. The Design Thinking framework [11, 24], partially influenced the way the briefs were constructed starting with a very open brief and concluding with a more focused one. Specifically, design thinking highlights the importance of exploring and empathising with the end-users and their needs, before reformulating the initial brief on the basis of this. Additionally, researchers have a list of what-if questions to be used at their discretion during the session to stimulate further design [24]. The aim of the initial brief, Abstract Brief, is twofold. Firstly, to present sound designers with an open task that challenges habits that they might have developed in their work, and secondly, it is an opportunity for participants to experience speaking out loud their thoughts in the presence of the researchers. The participant is presented with four coloured shapes and asked to choose one. This is the character they need to create sound for, which is described as walking happily down the road. On completion

of this, participants are informed that the character has arrived at the end of the road and that they are waiting for their friends, who are however not coming, so the character is now sad.

The second brief, Listener in Focus, is designed to encourage the designer to explicitly consider the listener of the sounds being created. Designers are asked to consider one specific group of listeners, and then, once finished, on a different group of listeners, who may (or may not) be judged to have different values from the first group. Participants are asked to consider how they would create the sound of a thinking, active brain that will be listened to by a group of engineers in order for them to understand it. On completion of this, designers are informed that the brain is now to be listened to by a group of people who are vegans. Obviously, engineers and people who are vegans are not mutually exclusive groups and indeed, sound designers can decide that their sound is appropriate for both groups. However, they could also decide to adapt their design for an audience depending on what characteristic of that audience has been highlighted to them. Brief three, Case study - The sound of air pollution, is based around a specific, more concrete, scenario of a coat with an embedded air pollution sensor. This brief purposely presents media production sound designers with what could be defined as a sonic interaction design task. In this brief, the air pollution sensor produces a sonic output which informs the wearer about the quality of air at their location. A route map of a journey in a city is given, and participants are invited to sketch the coat's sounds. On this occasion, researchers aim to observe how participants tackle a brief that is presented more concretely.

In the pilot study [20] thematic analysis was carried out where we identified a total of 8 themes and 3 sub-themes that successfully portray the main articulations of the creative process. Initially, themes were derived from the data itself rather [25]. We then compared our themes with those, for general design processes, devised by [26] adapted from [27] and validated in [13]. Our final themes adopt some themes from [26] as well as add some themes that emerged from the pilot and can be seen in [20]. The pilot study highlighted the processes, whereas in this paper we examine the ideas themselves, comparing and contrasting the four sound designers approaches.

3.3 Data Analysis

Audio recordings were transcribed. Otter.ai provided a first rough transcription, and then we refined this transcription by re-listening to the audio. The transcriptions were coded using NVivo using the concepts of Shaping Ideas and Incremental Ideas from [28]. Shaping ideas are defined as appearing usually early in the process and as being influential on subsequent ideation, while Incremental Ideas are defined as being single ideas that make small additions connecting one idea to the next, and are closely tied to the previous ideas. This allowed us to compare sound designers in terms of idea generation. After this, by analysing the sound design ideas' content, we highlighted the main directions along which sound designers seem to develop their initial sound design solutions. We organised and named overall 15 dimensions which are described in Section 4.

3.4 Participants

3.4.1 The Professionals

Participant 1 (hereafter P1) has over 35 years as a sound engineer working within radio drama for Swedish radio. When he took up this role, there were no educational programmes in the subject area and all knowledge had to be learned on the job. Although he has a wide experience in all aspects of sound (sound design, recording, editing, mixing, etc.), it is only until relatively recently (3 – 4 years) that he has taken over responsibility for performing Foley. Participant 2 (P2) is a sound designer who works mainly in independent, artistic and experimental films (feature and shorts), but she also develops sound design for other media such as VR, and theatre. She has been a successful freelance sound designer since graduating from a Master in sound design in 2012 in the UK and carries out the roles of sound designer, sound editor, mixer and Foley artist as required.

3.4.2 Former Professionals

Participant 3 (P3) has a professional background in sound for games where he had the role of Sound Designer and Sound Engineer for a start-up company. He is now a doctoral researcher whose interests include sound in interaction, interaction design, and human-robot interaction. Participant 4 (P4) is an artist whose work focuses on sound, music, physical interaction, games, and building new instruments. He has worked as a professional sound designer on an array of independent projects. He is now a doctoral researcher focusing on supporting sustainability through sonic interaction design.

4. RESULTS

The coding of Shaping and Incremental ideas for the four sound designers shows some large differences between participants. P2 produced about 3 times more ideas than P1, for example (see Fig: 1). The ratio between number of Shaping ideas and number of Incremental ideas is about 1 to 2 for all sound designers. P1 and P4 have produced a similar amount of ideas across briefs. P3 has produced more ideas for Brief 2 than the other two, P2 has produced the least number of ideas for Brief 2 than the other two.

An analysis by the two authors of the sound design ideas' content highlighted 15 *Dimensions* along which sound designers articulated their thoughts (see Table 1). These are grouped into 3 categories: Overarching strategies sound designers seem to adopt irrespective of the nature of the brief; Design Strategies adopted when tackling a specific brief; Approaches to the creation of sound. Here follows some examples from the transcripts of the articulation of each dimension.

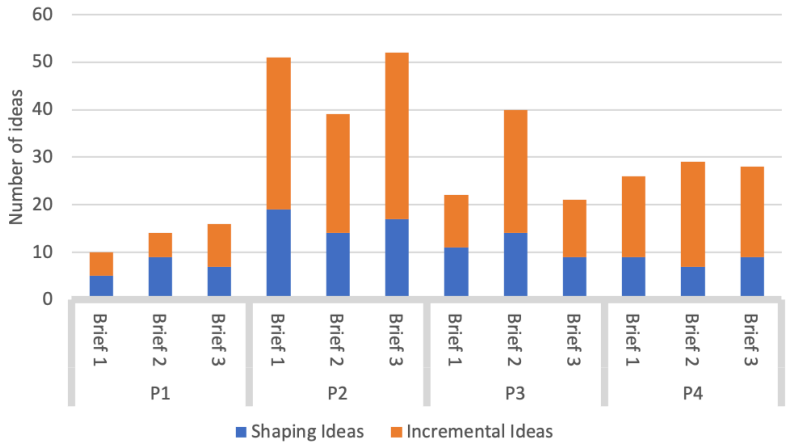

Figure 1. Graph illustrating the number of different ideas from the participants, separated into shaping and incremental ideas [28].

Table 1. Emerging Dimensions

Dimension	
Overarching Strategies	
Audiovisual Construct	Visualisation vs. Audio Only
Knowledge	Research vs. Culture
Anthropomorphism	Human vs. Non-human
Future	Speculation vs. Not Considered
Guidance	Directed vs. Autonomy
Design Strategies	
Initial Focus	Scene vs. Object
Mapping	Literal vs. Association
Characteristics	Static vs. Dynamic
Adaptation	Objective vs. Subjective
Design Approach	The Sound vs. The System
Context	Dependent vs. Independent
User Control	Provided vs. Absent
Approach to Sound	
Sound Provenance	Synthetic vs. Real
Audio Effects	Processed vs. Unprocessed
Communication	Existing vs. Novel
Perceptual Issues	Considered vs. Disregarded

4.1 Overarching Strategies

4.1.1 Audiovisual Construct - Visualisation vs. Audio Only

This refers to whether sound designers tend to visualise what they are trying to design sound for, or whether they tend to remain in an audio domain while ideating. Throughout the sound design briefs, P2 seems to conceptualise sound only as audio. For example, she does not speculate of potential visual characteristics of the object producing the sound, or picture a scene or context in which she sound might be occurring. One example of this is the sounds of the shape happily walking down the road. P2 does not discuss the scene or context at all, instead ideates purely about the sound of the shape and designing audio for it. Similarly, P1 describes a scene as in terms of a soundscape rather than anything visual. On the other hand, P3 describes the brief as an audiovisual scene, and P4 examines visually the context in which the shape is meant to sound, *"... how are we seeing this happen? ... is it like a two-dimensional road?"*.

4.1.2 Knowledge - Research vs. Culture

This refers to the tendency to research the objective characteristics of an object (its physical characteristics, how it works, etc.) in order to inform the sound design, versus getting inspired by what the object might be culturally associated with. When designing the sound for a brain belonging to a snake, P2 states that she would carry out research to gain an understanding of the functions of a snakes' brain. She envisaged the sounds created would be designed from this knowledge, hypothesising that the functions of a snakes' brain will be different in size and scale from those of a human brain. This is in contrast to P3's approach, which tends to make use of sounds already culturally associated to a snake to create a new sound design. His comments include, *"there will be lots of..., more like hissing sound, of a snake, because that's definitely associated with snakes"* and *"Rattle snakes, they have, the tail have this kind of rattling sounds. That, that could be there ..."*. Another example of this is can be found when P1 is describing the worst sound design that could be employed for the sound of a brain. He states, *"boiling pottage (porridge) ... but maybe that's not totally wrong, I don't know."*. Porridge Brain Syndrome is a anecdotal condition where the person suffering complains of excessive forgetfulness, tantrums and poor memory. It is often described on pregnancy forums [1] .

4.1.3 Anthropomorphism - Human vs. Non-Human

This is the tendency for some sound designers to give human characteristics such as emotions and behaviours, to

[1] https://4mom4ever.blogspot.com/2015/10/porridge-brain-syndrome.html

the object for which they are asked to design a sound for even when the object is not human. In our study, this strategy appears on a number of occasions, more for some sound designers than others. This is evident in P3's approach to the first brief where he imagines a red square as a woman, red being the colour of her dress and square being her movements. This is also seen in P1's approach to the same task, where he adds footsteps and foot shuffling to express the shape's movement and feeling. In contrast, when ideating about sounds of the shape in brief 1, P4 keeps the character as a shape but he gives it some humanoid characteristics when the shape is meant to be unhappy, by vocalising a sigh-type sound accompanied by hunching shoulders (in an imagined animation). Finally, P2 does not humanise any of the sounds she designs throughout the briefs.

4.1.4 Guidance - Directed vs. Autonomy

This refers to whether a sound designer searches for additional guidance from others in the project (director, producer) or from other documents (script), or they are comfortable to define all aspects of the project themselves if given the freedom to do that. In our study, the sound designers varied in how much autonomy in sound ideation they felt comfortable with, and when they would seek further direction from other sources. P1, P3 and P4 all looked, at least initially, for additional information regarding the context and the object of brief 1. P1 indicated, after a few sentences, that he would be looking for a script to gauge the pace, the mood and how the object is supposed to be moving in order to develop his idea of footsteps any further. P3 initially thought of the sounds of footsteps, along with birds, people chattering and music before stopping. After eliciting details on the footsteps he stated, *"if I only got that sentence to begin with, I would stop there because usually I would ask whoever person designing the scenes for more details"*. P4 looked for clarification early on while ideating about his sound design for brief 1 stating, *"Am I in charge of the animation as well? Or can I just be in charge of the sound? Okay, I'm in charge of everything. Yes, I'm a vengeful and terrible God."*. P2 did not seek the same guidance and focused straight away on realising the sound she had initially described.

4.1.5 Future - Speculation vs. Not Considered

This refers to the tendency to speculate about what the future would look like and base ideas for sound design on that speculation, when a brief is set in the future. During brief 3, the sound designers were asked to ideate a sound for a coat that can detect air pollution if the year was 2200. Both P1 and P2 considered that the coat would convey extra information to the user. Similarly to P1, P2 includes in the design a voice like Siri as well as beeps or Morse code. P2 then moves on to the idea of a musical output. Overall, P1 and P2 do not speculate greatly about the future. On the other hand, P4 reflected that the harmonic and rhythmic preferences of the future might be different. Since his design relied on environmental sounds as input, the overall sonic result would be different because including futuristic sounds from the environment.

4.2 Design Strategies

4.2.1 Initial Focus - Scene vs. Object

This refers to the tendency, when approaching a brief, to imagine and describe an overall scene, rather than concentrating on the sounds of the object within the scene. Typically, P1 and P3 would first ideate a scene and its soundscape thinking about footsteps, traffic, etc. Additionally, both indicated that they would be looking for further information regarding the scene. P1 states: *"it's very depending on the dialogue"*. P4, on the other hand, initially reflects on different potential scenes, *"Am I like a first-person hexagon walking through, walking down a road? Or is it like a third person hexagon? Or, like, how far would the camera.... is this on a screen?"*. After establishing the scene, his focus is on the sounds for the objects rather than the scene. For all the briefs, P2 focuses on the object from the outset, stating at the beginning of brief 1, *"I'm thinking about the shape in isolation, so not thinking about the task, per se, like 'The walking down the road' "*.

4.2.2 Mapping - Literal vs. Association

There are clearly different approaches when ideating about sounds relating to specific objects and the paths that our participants chose to explore. Some looked for literal interpretations of the objects while others looked for an association to the object. An example of this can be found when participants were asked to design the sound of the brain of a superhero. P1 thought that the sound of a superhero's brain should have an association with the specific superhero's powers, or their signature theme tune. P3 has very similar ideas, using the character's voices (*...in a low deep voice saying, "I'm Batman"*), or including the superhero's powers into the sound design, e.g. Superman hearing all the sounds throughout a city. In contrast, P2's approach is to start from a data set of brain waves and shift the frequency content to higher frequencies so that it is audible, and then introduce additional frequencies that brains of ordinary people don't have to signify that the brain is that of a superhero. Different approaches can be found also for brief 3. For P1, more pollution required an alarm sound, so he considers different kinds of beeping sounds, or a Geiger counter sound: the rate of beeping would increase as the air pollution increases. This was then complemented by the use of a synthesised voice like *"Siri"* that informs the coat wearer of the air pollution level. P3 associates poor air quality to the sound of breathing while blocked up with a cold. In contrast to this, P2 associates poor air quality with a more noisy sonic output, describing a sound design based on filtered noise where the narrower the filters the cleaner the air. P4 had a similar approach where he associated poor air quality with a *"dirty (sonic) aesthetic"*.

4.2.3 Characteristics - Static vs. Dynamic

This refers to focusing more on the dynamic characteristics of a brief, rather than the static characteristics. In brief 1, P2 and P4 developed the sound of the shape on the basis of how they imagined the object rolling down a hill, or imag-

ining how they would move over obstacles or how they would bow their head when sad. In contrast, P3 designed the sound on the basis of associations he made with the objects static characteristics. He chose a square, and then associates its lines to straight and assertive movements.

4.2.4 Adaptation - Objective vs. Subjective

This refers to the tendency to consider a sound design, when finished, as something objective, that cannot be altered on the basis of a different listener, or a different context, or a different highlighted quality of the object producing the sound. An example of this can be found in the ideations of brief 2. P4 described a sound design for a brain to be listened by engineers. When asked what the worst sound for a brain would be, he stated that he would make the initial sound design "less accurate". He did not attempt to vary the main concept of the sound design he ideated, but considered what the word "worst" meant within that concept. On the other hand, P3 did not think that once created a sound design could not completely diverge from the original concept. When asked the same question, to ideate the worst sound for a brain, he completely changed to a new type of sound based on words associated with brains (*"Brain-fart"* and *"Brain-freeze"*), and continued by describing how to make the sound of freezing.

4.2.5 Design Approach - The Sound vs. The System

This refers to the tendency to approach a sound design by ideating a sound producing system first, rather than directly ideating the sound. On a number of occasions, a sound designer would describe a system which would generate sounds based on mappings from input to output, rather than a sound to represent the object in the brief. An example of this is appears when the designers were invited to describe the sound of a brain to be listened to by vegans. P4 discusses a system for generating the sounds of a brain based on amplifying and shifting the waves of the brain. Therefore, when the additional *what-if* question was asked to describe the sound of the brain on drugs, for example, P4 replied *"I don't know ... I wouldn't want to know ahead of time"*, meaning that he would input the waves of a brain on drugs and accept whatever result the system would produce. This is in contrast to the other sound designers who designed the sounds for a brain and then adapt the sounds based on their impression on how the brain would sound under the influence of drugs (e.g. the sounds would become more confused, erratic, etc.).

4.2.6 Context - Dependent vs. Independent

Some of our participants strongly linked the ideated sound designs with the context they imagined for the brief. For example, P4 created a sound for a coat that communicated air pollution using sounds of the environment where the coats would be worn in as input. The sounds produced were therefore highly dependent on the current location of the wearer. On the other hand, for the same brief, P1 used beeping sounds meant to be completely independent of the wearer's environment.

4.2.7 User Control - Provided vs. Absent

This refers to whether sound designers envisage that the user or listeners can have some control over the design of the sound in question. Brief 2 explicitly asked the participants whether they would change a sound design depending on who was listening to it. P1 and P4 were quite reluctant to change design, while P2 and P3 made modifications. Even more explicitly, the provision of controls for the users were discussed by some of the sound designers when asked to creating a luxury version of the coat with the air sensor. Both P2 and P4 decided that the wearer would be able to change the sounds that the coat produced to the wearer's preference. Both would allow the user to select their own input sounds with P4 stating, *"completely different sound library"* and P2 stating *"they can somehow programme their own sounds into it"*.

4.3 Approach to Sound

4.3.1 Sound Provenance - Synthetic vs. Real

Throughout the study, the sound designers described on a number of occasions how they would produce the sounds they were ideating. P2 often started from synthetic tones, sometimes dissonant and a-rhythmical. She often started from the idea of a pure sine tone, for example using oscillators and LFOs to produce the sound of the shape in brief 1. This is in contrast to her approach when designing the sound of a brain to be listened to by people who are vegan. On this occasion, she wanted to work with very organic sounds, specifically using a contact mic in trees and bushes to get lots of natural sounds to use. P4 used a similar approach when ideating the "sigh" of a unhappy shape by describing how he wanted to use a squeak from a door hinge and decrease it in pitch.

4.3.2 Audio Effects - Processed vs. Unprocessed

When describing the sound of a brain for engineers, both P1 and P3 described using human voices as part of their sound design, P1 to give the impression of activity and P3 as a means of representing different brain functions. P1 stated they would employ EQ and consider reversing the audio so that the words were not fully comprehensible. P3 imagined more a conversation between the different functions and a central controller. The idea of processing audio was also present when P4 was considering a sound design for the air pollution sensor, using a bit-crusher to process the wearer's own music, so that the worse the air quality the more processed the listener's music would be. P2 also considers audio processing for this task, with the use of filtering a number broadband noise sources, and with the filter bandwidth mapped to the air quality.

4.3.3 Communication - Existing vs. Novel

This refers to whether sound designers decide to employ and harness the power of existing and established audio communication systems in their design, such as beeps, alarms and the voice of Siri, or they attempt to create completely novel ways of communicating with sound. As mentioned before, both P1 and P2 introduce existing auditory

displays in some of their designs, especially in Brief 3. P2, however, also ideates a novel system to communicate the air pollution quality based on noise filtering. P3 and P4 tend to create novel sound design rather than rely on existing paradigms.

4.3.4 Perceptual Issues - Considered vs. Disregarded

This refers to the degree with which sound designers consider perceptual issues already at the ideation stage. On occasion, our sound designers where concerned with how the sound they were ideating would be perceived within the environment, for example, if it could be masked of misinterpreted, or if it would be distracting. For example, this was a concern for P2 when asked if she would change her sound design for the air pollution coat in a stormy day. Her original idea was around filtered noise signals but during this task she stated, *"If you think about wind, and about broadband noise, there's not that much difference. So, you know, the sound would need to be distinguishable through that (wind)"*. This is also highlighted when she discusses the sound design being in a frequency range close to that of traffic, with the concern that traffic is something that is often *tuned out* by those who hear it. The other sound designers do not express a consideration for sounds being masked or misinterpreted by the listener.

5. DISCUSSION

As seen from the results in section 4, we have identified three main themes which include a number of dimensions. These highlight the different strategies and axes along which sound designers developed ideas to complete the briefs. They do not apply to every idea, brief or participant rather provide an initial framework that designers working in SID could explore when seeking a solution to their specific problem. When looking at Overarching Strategy, we found that there was great diversity among the participants in relation to whether they would develop an audio-visual construct or an audio-only construct to facilitate ideation. A link between visuals and audio was expected for the first brief, where a visual object is given to the designers to sound design, but P2, for example, did not construct any visual representation of a triangle and her design focused purely on the sound. There was also variety among participants in relation to whether they were comfortable having full creative autonomy. P1 referenced seeking guidance more than other participants, and also struggled to ideate as much as others solely on the basis of the given briefs. P3 and P4 appeared more comfortable with complete autonomy after initial guidance from the authors, whereas P2 was happy to take the direction given from the briefs and interpret in her own fashion without questioning her own autonomy. Under the heading of Design Strategies, the Mapping dimension showed a wide variety of approaches. P4 tended towards using very literal connections between objects and sound design. While P1 and P3 often used cultural associations as a source of inspiration for their sound designs. P2 oscillated between these two approaches throughout the task. We did not anticipate that some participants would focus on imagining a sound producing system, rather than the sound itself. This approach was used by P4 in both Brief 2 and 3 so that at times he was unable to describe how the final audio output would sound, but stated that he could not know beforehand, confident that if the imaginary system would incorporate all the data, it would produce the desired sonic output. P3 described a system for the air pollution coat which would link the air pollution sensor data to the breathing of the wearer. The system was triggered with each breath and a beads moving in a tube sound generated, the air pollution data linked to the number of beads and tube material. As we would expect, participants had a wide approach to sounds in relation to the dimension labelled Sound Provenance. At the opposite ends are P1 who, similarly to P3, tended to refer to existing natural sounds, and P2 who seem to use as as starting point always a synthesised sine wave. P4 made use of synthesised and natural recorded sounds, including Foley. It was common for our participants to initiate their designs by imagining a scene in which their sound design belonged to. Both Brief 1 and 3 give a basic outline of a scene - *walking happily along the road* and a journey map given which one would think naturally draws the participant along this dimensions. P2 only occasionally discusses aspects associate with a scene, however she is the only designer who expresses concern that their designs might be perceived incorrectly or masked by other sounds in context. The number of ideas identified as shown in Fig. 1 shows that P2 overall had the highest number while P1 had the lowest. When comparing the dimensions, it could be hypothesised there may be a link between the dimension of Guidance and the number of ideas generated. As P2 embraced creative freedom, she was able to ideate more, while P1 found difficult to ideate without external directions. We also observe that the greatest number of ideas were generate by P3 for Brief 2. P3 often focused on setting a scene before developing his sound design ideas. As no scene was hinted at in the second brief, we hypothesise that P3 had to ideate more to be able to come up with a final sound design idea. The study seems to confirm that sound designers are highly influenced by their most recent area of work. P1, a sound designer for radio, often felt the need to be guided by a script or a voice something he explicitly stated *"I mostly try to give a body to a voice, a spoken voice"*. P2, a sound designer who works across a wide range of media, was the most comfortable with receiving little direction and with experimenting with synthesised sound. P3, who now works in research within sonic interaction design for robots, linked his final sound design to a piston sound. Finally, P4, who now works as a researcher focusing on the sonification of data, focused, in Brief 2 and 3, on describing a sonification system rather than the sonic output.

6. CONCLUSIONS

We have presented the results of a study into the process of sound design ideation involving professional and former professional sound designers. We have found a number of common dimensions used within their strategies for ideat-

ing and producing solutions. We have highlighted how different sound designers move within these dimensions to progress with their design ideas. We have shown that the designers vary in number of ideas generated and hypothesise some reasons for these differences. We plan further studies with professional sound designers with the aim to enhance and expand our findings.

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