To embody or not to embody: A sound design dilemma

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ABSTRACT

Designing with sound is about constructing appropriate sound representations of a concept, from the early ideas to the final product. A survey research on embodied sound sketching is presented, and the problems of early representation in sound design are discussed by analysing the questionnaire results of three workshops on vocal sketching.

1. INTRODUCTION

Is there a difference between sketching sound and sketching with sound? What is a sound designer expected to do when approaching from scratch a creative project involving sound? It has been argued that sound design is a funnel-shaped iterative process of analysis, creation and evaluation [1], and that the sound designer operates at the intersection of several disciplines (acoustics, psychoacoustics, music studies, psychology and computer science). This professional is an artist/composer who has the *tacit knowledge* to mediate the early industrial, perceptual and physical constraints into aesthetic sound specifications [2]. On the contrary, according to [3], the sound designer is essentially an engineer provided with a strong and interdisciplinary skillset, able to carry out the product sound development task, autonomously. Somewhat in the middle, Erkut and colleagues situate sound design in the wider context of multisensory product appraisal, and look at interaction design and product orientation as reference domains [4]. As such, sound represents one opportunity to alter the perceived product attributes, through design choices. Along the same line, Hug and colleague advocate a sound-driven interaction design approach by means of performance-led, increasingly complex and refined representations [5].

However, at the beginning of any project, the designer has to confront with a given brief, analyse and set the problems, conceptualise abstract (i.e., values, beliefs, principles) and concrete (i.e., sensory, physical, spatial, temporal) attributes, and progressively embody them into representations, from early ideas and mock-ups, to prototypes up to the final product [6]. Would it be more appropriate to talk about designing (also) with sound, then? We believe that there is a substantial shift of perspective, not only because the aural dimension is taken into account from scratch, together with the other aspects (visual, tactual, formal, etc.), but also because audition emerges as one of the channels through which materialising conceptual associations throughout the design process. The consequent question is which kind of representation is more effective, at which stage of the process, to embody concepts in and through sound.

Designing *with* sound puts *design thinking* at the center of the sound creation activity, whereas designing sound seems to suggest rather a focus on sound production of quality factors in the refinement and optimisation of a product. In other words, designing sounds rather reflects the sonic representation *per se* in its formal elements, assimilable to a *reduced listening* approach. According to Visser's proposition, we see design thinking in the aural domain as a peculiar implementation of a generic cognitive activity (i.e., design as construction of representations), and yet clearly distinct from other cognitive activities (e.g., economics) [7].

In this paper, we problematise and reflect on this apparently controversial aspect, by reporting the qualitative assessment of three workshops on sonic sketching. Therefore, we consider only the early stage of the creative process, wherein ideas generation and conceptualisation take a fundamental and considerable part. What we strive to understand is the focus of sound design as a reflective practice, from an embodied cognition perspective, that is considering the body as the natural mediator between internal, mental representations of concepts and external representations in sounds [8]. As such, carving the auditory information and sensation (i.e., designing sound) is only one type or step of product embodiment, among e.g., in a non-exhaustive list, anthropomorphism, symbolic meaning attribution, familiarity, agency and action-sound coupling [9, 3, 10].

We contend that the problem of sound design is essentially a problem of construction of representations, "in an area where best practice is virtually inexistent" [5]. We mean, for instance, that types of visual representations are existing and taxonomically classified, depending on the design stages, the design or technical information, the function and the detailing of the representation (e.g., a study sketch, a 3D model, or a prototype), and are widespread in the professional practice [11]. The same depth of knowl-

edge and expertise is not available yet in the realm of sonic representations of designs [6].

Section 2 summarises the basic characteristics of conceptual sound design within the framework of embodied cognition, with a special focus on sketching through vocalisations; Section 3 introduces the workshop format on vocal sketching, and the evaluation questionnaire; comparative analysis and results of three workshops are reported and discussed in Section 4.

2. EMBODIED SOUND SKETCHING

Sketching as a product and a process is that peculiar design activity through which designers externalise their ideas into representations. Typically, the word sketch is associated to drawing, which is the first and most immediate spatial way to embody concepts held in mind, into a visual artefact. This is only the first leg of a journey in the design funnel, which leads the initial concept(s), existing in one's own body and mind only, to being distilled and embodied into structural properties and configurations of the design entity under scrutiny.

Drawing is an effective means because it exploits a tool, the pencil, and a spatial support, the paper, that allow a speed of production coherent with the immediacy and flow of thought. It is a form of expression tolerant to incompletion and inaccuracy, it is reversible, and yet capable to provide evocative, economical and disposable impressions. The body, by means of the hand, is actively engaged in sketch-thinking by encoding and exploring the information [12]. The body at large, through talk, action, and gesturing, is all the more so involved in catching and expressing the dynamics of situations, processes, systems, and behaviours, that do not exist in space only, but especially in time [13, 14, 15].

Hence, sketching does not equal to drawing, it is rather a peculiar way of thinking and searching which is independent from the medium, e.g., a drawing, a photograph, a pantomime, physical props, and sound. What matters is the appropriateness of the chosen medium in representing, evoking and possibly sharing a specific concept. Figure 1 represents sonic representation techniques and methods in the designing-with-sound funnel, according to their degree of embodiment and detailing [17].

A primary viable way to sketch concepts is to browse and wander through collected representations of direct percepts. Designers are prone to collect, annotate, and archive external images in sketchbooks, for a variety of purposes. Archives are usually organised according to subjective categorisations, which take in account distal (source-related), proximal (sensory-related) or semantic representation strategies. In the early stage of the project, sound designers largely resort to "external" images and visual analogies to illustrate the overall concept of their idea [18, p.35]. Sounds collections are mostly kept in the form of sound banks and libraries, which respond to the rationale of an efficient selection task in the workflow of Digital Audio Workstations (DAW), rather than a serendipitous encounter and exploration of others' works.

In our research through design workshop activities, we have been striving to subvert the prevalent disembodied sound design practice and recover the original rationale of personal collections, namely having thoughtful materials that facilitate ideas generation and reflection, rather than sound materials to be readily edited and processed [19]. As an example, two introductory "sound hunting" exercises may play as follows:

Exercise 1: Go out and hunt sounding objects in the wild. Collect them (physically!) and write down the reasons why sound captures your attention. Revise the text and try to label the reasons according to sound categories and conceptual associations. Skim the most meaningful label(s) representing the sounding object and start populating the corresponding boxes.

Exercise 2: Go hunting a sound event and make the audio-visual recording. Try to understand the reason(s) why that particular sound idea interests you. Go out in the wild again, and look for 20 different samples that follow your idea.
Now, work by contradiction, and look for sound events that evoke the opposite of your idea, e.g., dynamic - static, hot - cold, happy - sad, energised - exhausted, textural - gestural, informative - confusing, etc.

Here, Foley-oriented practices [5, 20] are aimed at fostering the construction of personal thoughtful collections. A second way to sketch concepts is to actually externalise ideas and "images" held in the mind, and thus producing self-generated representations. These include *performed* sounds, that is made with an *intention*, whether through vocalisations or physical manipulation of objects. In embodied sound design, access to imagery is rooted in the sensory-motor nature of auditory experiences. Through his body, the sound designer accesses such internal representations, previously stored as perception - action ensembles [8, 10, 21].

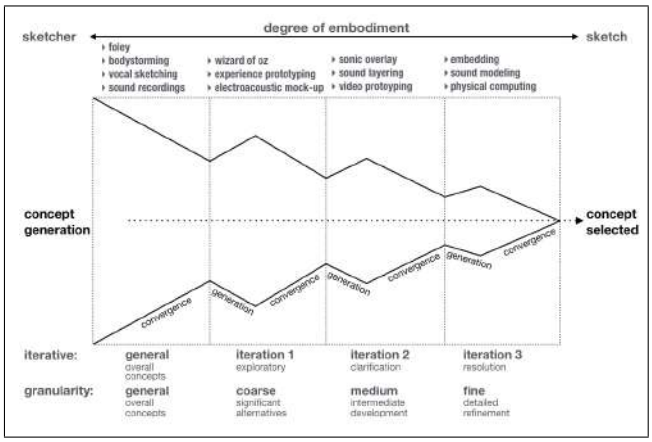


Figure 1: Generation, elaboration and reduction of sound ideas represented as a funnel, with diverse methods suitable to "visualise" the sonic concepts according to the degree of embodiment centred on the sketcher or the sketch (adaptation from [16, p.11]).

2.1 Vocalisations as embodied sketches

The vocal apparatus is the embodied sound producing tool par excellence, available to sound designers. Recent research on perception, articulation and production of sounds shed light on the inner mechanisms involved in the communication of concepts via vocal and gestural imitations [22, 23, 24]. Vocal sketching is the embodied design method to represent concepts, by means of vocalisations [25]. More recent design research on vocal sketching has been systematising this form of expression in well-defined exercises and practices [19].

Vocal imitations are the closest semantic representations, directly ascribable to a person's idea of a given sound. They are more effective than verbal descriptions of sounds, especially when speakers run out of words, and rely on subtle sensory processing mechanisms, that is the selection of the most relevant acoustic features, for the identification of a given sound, that can be produced with the human voice. It has been shown that the human voice can reproduce the pitch, the rhythm, the sharpness (i.e., spectral centroid) of a given sound [24]. Vice versa, when vocal imitations are elicited from memory (i.e., imagery), they rely on some sort of iconic similarity with the thought sound, that is a few salient characteristics picked up and shifted in the imitator's vocal register [23]. In this respect, vocal imitations act much like sound caricatures. Vocal imitations are sketches of auditory concepts, in the same way freehand drawings represent visual objects.

Finally, computing systems aimed at supporting such immediacy of communication and reflection through sound creation, by returning synthetic representations (i.e., configurations of digital sound models) as instances of vocalisations, are making progress. In [21], we showed how SEeD, an embodied-sound-design tool, affords to produce, with a certain degree of reliability, tamed and predictable representations, grounded in vocal motor skills and control: sound designers were able to reproduce, with SEeD, target examples previously created by a third sound artist-designer, with the same tool. A relevant aspect of embodied sound representations is that they are naturally prone to coordination and conflict resolution across internal mental models, and thus available to negotiation and collaborative practices, similarly to collaborative drawing on a shared whiteboard [26].

3. DESIGN RESEARCH THROUGH VOCAL SKETCHING

To our knowledge, the first design research workshop on the methodology of vocal sketching was organised in 2009 by Ekman and Rinott, as part of the COST Action on Sonic Interaction Design [27]. The outcome of that workshop represents a seminal study in the area of sonic interaction design [25]. The two authors conceived a set of warm-up and design tasks in collaborative vocal sketching of sonic interactions, that were assessed through ethnographic observations and post-workshop questionnaire with open-ended questions. In particular, the study aimed at evaluating the usefulness of sketching with voice, and whether and in which way the proposed method may influence the design process. The main findings of the qualitative assessment of the design tasks and process can be summarised as follows:

1. the vocal apparatus provides "instant access to sonic reserves [of complex, organic sounds] that are hard to achieve with current tools, and away from simplistic sound solutions", such as beeps and bleeps [25, p.128];
2. voice is by no means a neutral tool, and yet the inherent limitation and constraints may influence decision-making in design directions, positively and negatively;
3. being the main limitations, the monophonic and harmonic character of the voice, the difficulty in producing and controlling specific, complex sounds, the sound duration due to limited breath cycle;
4. on the other side, vocal sketching as a method does not affect the design process, and provides a rich variety of sonic expressions;
5. effective vocal sketching requires practice and fluency.

Since 2009, vocal sketching as method to support conceptual sound design has been explored in a variety of contexts, was included as reference resource in sonic interaction design education and research, and fostered the development of several voice-driven interactive technologies [28, 29].

3.1 Three workshops on vocal sketching

In the 3-year period (2014 - 2016), we conducted extensive design research on vocal sketching, within the scope of the EU project SkAT-VG (Sketching Audio Technologies using Vocalisations and Gestures) [30]. The workshop was the preferred venue in which *i)* exploring and understanding use strategies of voice and gestures for design purposes, *ii)* studying the sound designers' behaviour in the creative setting, *iii)* developing a propaedeutics on embodied sound sketching, through exercises grounded in phonetics (i.e., elicitation and articulation), and auditory perception of vocal imitations, *iv)* proposing and assessing voice-driven tools for embodied sound design [31, 21].

A workshop format on vocal and gestural sketching emerged from the organisation of several workshops. We refer to the extensive report of the research through design activities and exercises, provided in [18, p.10] . The workshop is normally split in two main parts: A first preparatory phase aims at sensitising the participants to sonic interaction and warming up the use of the voice, and a second phase rather focuses on proper sound sketching and design tasks. Shared doing, reflective practices and inter-observation are instrumental to enable understanding through designing sonic and interactive objects, and $10-20\%$ of frontal teaching is balanced with $90-80\%$ of hands-on, learning by doing activities. The resulting framework can be scaled from one-day to one-week duration.

After each SkAT-VG workshop, a questionnaire was handed out to the participants, in order to collect feedback

on their experience with sound and vocal sketching, and on the effectiveness of the support software tools under development.

In this paper, we present and discuss the results emerging from the analysis of the questionnaires collected in three workshops. Two workshops took place in November 2015: The first (W1) was a two-day edition organised at the University of York, Department of Theatre, Film and Television, with seven participants. The second workshop (W2) was a five-day edition organised at the Aalborg University of Copenhagen, in the scope of the Master in Sound and Music Computing, with twenty participants. The third two-day workshop (W3) took place in March 2018, at the Conservatory of Music "G. Verdi" of Torino, in the scope of the Master in Electronic Music and Technologies of Sound, with eleven participants.

The general background of the participants, across the three workshops, was quite homogeneous, ranging from music composition and sound production for linear media (sound effects, Foley, soundtrack), to sound design for videogames and interactive installations. Yet, no participant had prior experience or formal education in design and product sounds. W1 was essentially based on vocal sketching practices, with no support of voice-driven software tools. In W2, we introduced a sound sketching session using "miMic" [1], a voice-driven environment in which physics-based sound models [32] can be selected as instances of previously classified vocal imitations, and further controlled through vocalisations [31]. miMic provided the skeleton for the development of SEeD, a more advanced system for sketching synthetic sound representations, based on physics-based sound models and corpus-based synthesis [21]. SEeD [2] was instead introduced in W3.

3.2 The questionnaire

The SkAT-VG questionnaire [3], based on the one conceived by Ekman and Rinott in [25, p.131], is arranged in two main parts. The first part contains close-ended, 7-point scale questions on the design effectiveness and appraisal of vocal sketching, and on the general relevance of other forms of sound sketching including the physical manipulation of objects and embodied sound synthesis. From the latter viewpoint, the questions are specifically addressed at assessing the immediacy of use and expression of the Sound Design Tookit [4] (SDT), a set of physically-informed, procedural sound models for the Max environment, developed by SkAT-VG [32], and SEeD tool, in which configurations of SDT models are driven by vocal input and control [21]. The second part, in the form of open-ended questions, encompasses general comments on previous experiences in vocal sketching, and its usefulness and gaps in comparison with Foley and SEeD.

[1] miMic demo: `https://vimeo.com/142351022`.

[2] SEeD in action: `https://vimeo.com/271826511`; `https://vimeo.com/271825753` (0:50).

[3] Questionnaire available for download at `https://owncloud.skatvg.iuav.it/index.php/s/0rBl1NS4QyCvz31/download`.

[4] `http://soundobject.org/SDT`.

In the following section, we reflect on the picture emerging from the analysis of the answers to the range questions, and the written comments collected. The analysis of videos and design outcomes per workshop is beyond the scope of this paper.

4. RESULTS AND DISCUSSION

The results of the survey are represented in Figure 2. The bar charts report the answers relative to the three main topics of the questionnaire. The median ratings by participants per workshop are arranged in a row, and in a chronological order from left to right, to ease both the reading of the emerging picture, and the comparison between the three workshops. Note that in Figure 2c, the W1 chart does not include the last three questions ($Q12 - 14$), as software support to vocal sketching (SEeD) was not available yet.

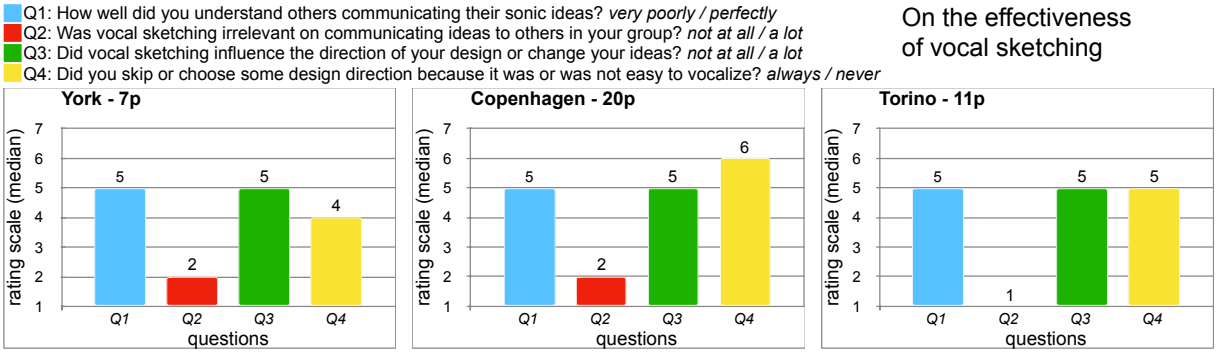
4.1 On the effectiveness of vocal sketching

From the inspection of Figure 2a, it emerges a relatively good commitment of participants to the exploration of voice as means to communicate sound ideas ($Q1/Q2$). Representing imagined sound by means of individual or collaborative vocalisations is generally found effective. This is corroborated in the open answers, according to which sketching with voice was found useful for a variety of reasons: It emerges that, based on the participants background, the proposition of 1) considering sketching in sound creation, 2) considering an embodied approach to early representations, 3) using voice as sketching tool, was reflected in diverse understanding of opportunities.

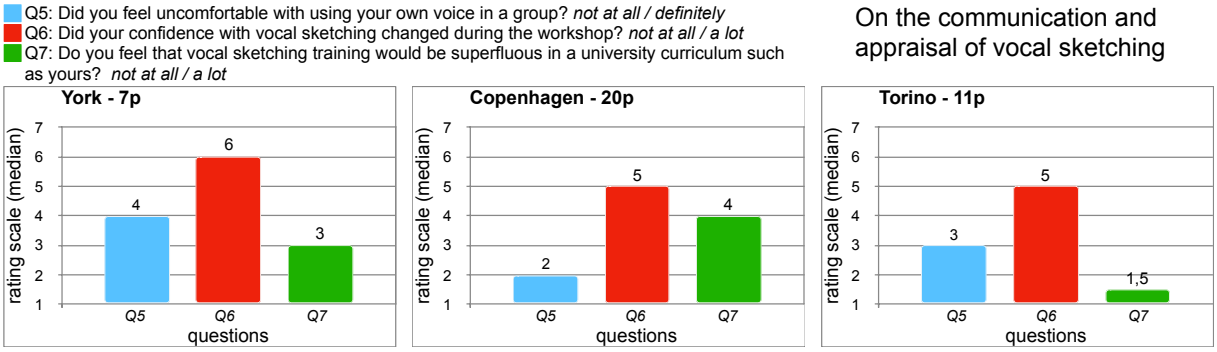
Influence on the design process: Participants with prior experience in interactive, cross-media installations reported that sketching with voice is "interesting and helpful for interaction design" and "product sound", it is "fast and efficient, and not bound to language barrier", it "can help to think out of the box", and "provides an intuitive and explicit way to adapt to experimentations and obtain simulations", "free from hardware and software constraints". The interest is focused on the immediacy and speed of production, intrinsic to vocalisation, in designs characterised by inherent perceptual relations in temporal dynamics.

Vocalisations as communication tool: Participants with major prior experience in sound effects for linear media and video games highlighted the sharing aspects of early drafts made out of vocalisations, when ideas need to be communicated to peers, especially in teamwork. They found vocal sketching useful "to express my sound design ideas in a more direct and clear way", "to describe the sound in another way", "to convey ideas on how something should look like", "when we wanted to make some sound, but we couldn't find one appropriate". In particular, vocal sketches, both as process and product, are seen as means " to quickly produce video prototypes in a group", and especially "useful in the pre-production stage". However, several participants stressed that the great effort required to articulate continuous sounds, due to the limited breath capacity, severely affected the sense of continuity.

Voice as sound generator: This is the most apparent, and



(a)



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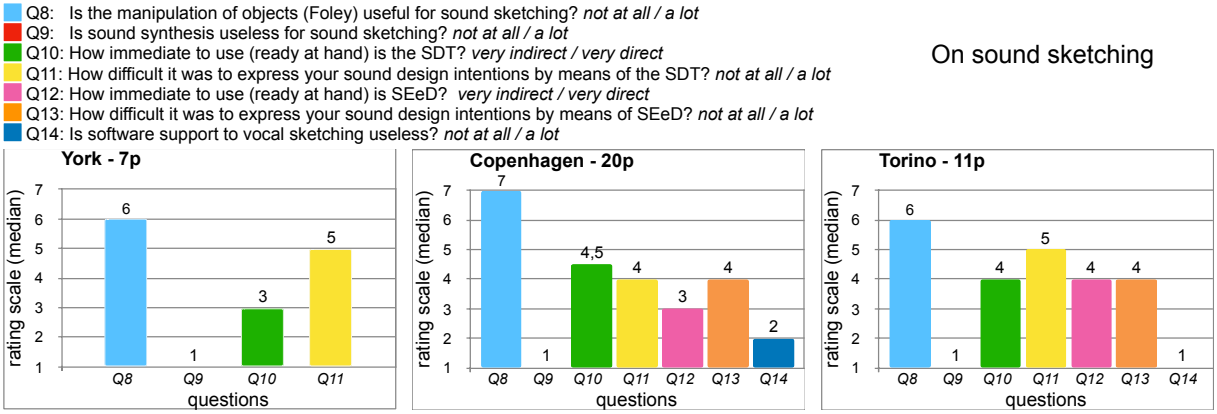

(c)

Figure 2: Bar charts with the median of the answers to the range questions, arranged per topic, and workshop.

misleading understanding of sketching with voice, which reflects the established cast of mind in sound creation and design. Vocal sketching "is an extra tool to use", suitable to produce "brief, immediate and general effects", such as "impact sounds", "noises" and pitched mechanisms (e.g., engines), and "to create atmospheres". On the other side, common comments on the deficiencies of voice are the difficulty in "creating futuristic and machine-like sounds", producing "high-pitched, morphologically complex" (e.g.,"metallic and large", "low and dense"), "refined and outer" sounds that "do not have an equivalent in the real world", "obtaining smooth changes in sounds". In addition, "vocal sketches sound often too similar to onomatopoeia", and "voice drew us towards the same kind of sound design, drones, humming etc.".

There are several considerations entangled in these answers, that we may group from three main arguments. The first is clearly rooted in the perception and cognition of vocal imitations, and auditory experiences in general, as discussed in Section 2.1. The second reflects the general expectation of having an all-in-one solution to produce sound, a sort of tool capable to interpret internal image of sound kept in the mind, and externalise it in its most complete form. Sound creativity in the digital age is much retained in the mind, by relying on mental synthesis processes, rather than enabling discovery in the observation-imagination continuum [12]. The dependence on software tools (e.g., DAWs, plugins, and programming environ-

ments) to create sounds can be ascribed to the idiosyncrasy emerging from the inherent need to fix a time-frequency representation on a meaningful support, and the creative, abstract (we prefer to say disembodied) approach to sound, inherited from the early computer music legacy [33].

Voice is certainly a sound generator, but the purpose of using it is not to model or implement a sound, in the same way the purpose of a drawing is not to physically build an object. Yet, it has to be noted that there are designs in which the distance between intermediary representations and the final product may vary dramatically. The design of an artefact is a different activity from its realisation [7]. In this respect, if the vocalisation is the closest semantic representation of a given idea of a sound, then the problem is that of the effective control of the sound generator, i.e., the vocal apparatus. An embodied approach to design requires fluency and expertise, but not virtuosity in the production of external representations. These are not mere reflections of images in the mind, they are proper thinking tools. Sketching and mental imagery go together, and the sound sketch represents a volatile, yet stable enough, external memory.

Answers to $Q3$ and $Q4$ much reflect this state of things. Vocal sketching as a method allows to progress in the design process, by means of non-verbal sound representations, despite the constraints and effort required to vocalise them. In this respect, these results are in line with the conclusions by Ekman and Rinott, according to which voice is by no means a neutral tool. Vocal sketches are effective externalisations of ideas and represent the first physical encounter with the image held in the mind, they are idea or thumbnail sketches meant for personal use [11].

As a final remark, participants with a background focused on music composition did not find vocal sketching very useful for their type of work. As prior experience in the use of voice, they reported the imitation of music parts, especially in "a cappella" music. This is plausible, since music sketching make large use of spatial representations (i.e., music notation, even abstract), often integrated by the direct support of the musical instrument. On the other side, the value of the musical sketch in the compositional process has been traditionally considered problematic, in the light of "the utopia of unhindered musical imagination developing on its own terms" [34, p.5].

Therefore, it comes at no surprise that the current generation of sound designers, essentially coming from music studies [2], are not acquainted with sketch-thinking [18, p.34]. In other words, despite the word "design", a proper attitude and knowledge is still missing in the creation of aesthetic functional sound [26]. This motivates academic research in developing meaningful curricula for future generations [4].

4.2 On the communication and appraisal of vocal sketching

The picture emerging from the answers in Figure 2b is that bodily involvement in communicating a design idea can be distressing. Nonetheless, the social discomfort in teamwork can be overcome through practice and shared activities ($Q5/Q6$). The hosting context of the workshops is reflected in the answers to $Q7$, about the convenience of a training in sketching with voice, within the curriculum of study. Considering the film sound production orientation of W1 participants, the rather engineering and technological attitude of W2 participants, and the artistic and music-oriented participation in W3, the usefulness of a training in vocal sketching received neutral or low scores, thus meaning that a training is not superfluous at all.

To test the hypothesis that the different scores in $Q7$ might reflect diverse appraisals of sketching with voice, a Kruskal-Wallis non-parametric test was run ($H = 10.53$, $p < .05$). Hence, there is actually a difference between the three groups, with respect to the attitude towards the use of voice as sound representation tool. We hypothesise that W1 participants may have mainly focused on the communication aspects, since no voice-driven tool was provided; W2 participants may have been attracted by software support opportunities; whereas W3 participants were rather involved in the creation process. The post-hoc pairwise comparison test revealed statistical significance only between W2 and W3.

Since the answers to questions $10 - 13$ (Fig. 2c), on the expression and immediacy of use of the SDT and miMIc / SEeD, are essentially overlapping, we further investigated $Q14$ on the usefulness of software support to vocal sketching. We could not find any statistical significance in the difference between W2 and W3 (Mann-Whitney U, $U = 56$, $p = 0.0735$). Certainly, the minor interest by W2, in sketching with voice, cannot be ascribed to the fact that miMic [5] was apparently less ready-at-hand than SEeD ($Q12$, Mann-Whitney U, $U = 40.5$, $p = 0.49$).

A possible reason can be found in the answers to $Q2$, on the relevance of vocalisations as conceptual sketches. The Kruskal-Wallis test showed only a marginal difference between W1, W2, and W3 ($H = 5.909$, $p = 0.0521$). The post-hoc test reported a significant difference between W1 and W3 only. The pairwise Mann-Whitney testing of the three groups reported the statistical significance between W1 and W3 ($U = 15.5$, $p < .05$), and between W2 and W3 ($U = 54$, $p < .05$), but not between W1 and W2 ($U = 51$, $p > .05$). In other words, the different appraisal of vocal sketching, by W3, can be explained in terms of a higher involvement in the use of vocalisations to embody and communicate *concepts*, compared to the other two groups. W1 and W2 either resorted on other means to communicate ideas, that is verbal descriptions, sound samples, Foley, others, or focused on the use of voice as a mere sound generator. Hence, we can infer that W1 and W2 attitude to skip or choose a design direction, based on the complexity of vocalisations, rather reflects a similar behaviour, namely a lesser engagement in conceptualising the vocal representations. In our previous work [26], we showed how protocol and linkographic analysis of cooperative sound design sessions can provide relevant qualitative and quantitative information about the use of vocalisations in the creative process. A further consideration is

[5] miMic can be considered an early version of SEeD. In the practice, W2 and W3 made use of two different releases of the same software.

that while the exercises of the SkAT-VG workshop were still in an explorative fashion at the time of W1 and W2, W3 workshop could benefit instead of an overall refined program and pace.

4.3 On sound sketching

The bar charts in Figure 2c report the attitude of participants towards other complementary means to sketch sounds. As expected, the two main alternatives, that is physical manipulation of objects (Foley) and sound synthesis, scored a high preference ($Q8/Q9$). The open answers on the use of Foleys mostly focus on the expression and convenience of this sound production technique. A Foley approach is considered useful to make "sounds that are hard to access or obtain", and especially "simple effects and unrelated sounds, not existing in the real world", "for the interaction with the objects". Foley, as a form of representation, was found effective when "creating quick prototypes" in "later stages of the sound design process", because "hands and feet afford a more subtle control of the dynamics". On the other side Foley sound production "takes too long" and "requires more teaching in technical tools", since " it is difficult to produce a definite sound, kept in mind, if all the material properties are not well known and mastered". In particular it is found difficult to create "subtle and ambient sounds" with "dynamic, highly variable events, which would be easier to synthesise.

Answers ($Q10 - 13$) on the immediacy of use and expression of physically-informed approach to sound synthesis (SDT) [32], and voice-driven synthesisers [21], as production means to support the embodiment of concepts into sound representations, depict a neutral to positive reception, mostly undermined by the steep learning curve, and the existing flaws of the research software. The potential of a software support to vocal sketching is reported in $Q14$.

Indeed, this interpretation is suggested by the participants' comments on both the effectiveness and flaws of SEeD. The embodied sound design tool was found "relatively fast and immediate as a high-level application", especially for "live syncing and dubbing of sonic elements in video editing". "The management of the SDT models seems quite intuitive", and the voice-driven sound synthesis "quickly denatures the idea from the vocal character, thus allowing a timbral search in the development of the idea". Major flaws concerned instead "the creation of melodies or some sound with harmony", and "the development of complex sounds with specific behaviours". On the sound implementation side, participants reported the "lack of a direct access to all families of sound models", "the limited number of available sound models and synthesis techniques", and in general "the need of sound libraries pliable to multiple solutions".

Here, the relevant aspects are not the technical limitations and flaws, certainly representing an issue in terms of effective vocal control. What matters is the rationale underlying the development of any sound design tool aimed at empowering imagery through motor skills and control. Indeed, any creative freedom is necessarily bounded to the expression space afforded by the tool at hand, just as the choice of a set of crayons and a certain paper would constrain a drawing act and give a material character to a visual sketch.

5. CONCLUSIONS

In Section 1, we posed the question about a terminological difference between designing sound and designing with sound. The question was instrumental to problematise the established view on sound design. A dual, apparently misleading, essence seems to emerge. The first is more traditional, and anchored in continuity with musical advances in computing technologies, in which designing sounds echoes implementing sounds with certain given aesthetic functional characteristics. The second perspective considers sound as a medium that can be a more or less appropriate host for representing abstract and concrete attributes of the artefact under conceptual inquiry. Designing with sound stresses the importance of embodied representations, internal or external, abstract or precise, etc., to cope with the complexity, ambiguity and incompleteness of design problems.

In this respect, an embodied approach to sound design and research may provide a key to understanding the problem of the perceived short distance between a sound design concept and the final product [23].

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