A Case of Cooperative Sound Design

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Abstract
In this design case study, protocol and linkographic analysis are applied to a task of cooperative vocal sketching, proposed in the scope of educational research activities. The understanding of the cognitive behaviors involved in sound creation is aimed at setting the ground for the development of rigorous, designerly evaluation practices tailored to sound design, all the way to the final interactive product. Relevant qualitative and quantitative information about the creative process informs the assessment and possibly improvement of sound design methods.

Author Keywords
Sonic interaction design; product sound design; design theory; design cognition; vocal sketching

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Sonic interaction design (SID) is becoming a distinctive design discipline within human computer interaction [2,6]. It has already specialized methods of inquiry and an education space around it [1,2]. SID primarily aims for continuous interaction between people and artifacts. It relies on multisensory feedback with a prominent sonic component to guide the interaction. SID has

brought about a variety of methods and techniques [1,6], some of which were reviewed in [2]. Despite these efforts, however, SID propositions hardly find place in the real-world practice; they are mostly confined in the labs and the fictive realms of educational workshops. For example, cooperative processes based on incremental iterations of crafting and evaluation are far from entering the *de facto* workflow of sound practitioners. Instead, projects are mainly carried out individually, the sound designer is left alone, immersed in software tools to transform early, conceptual ideas in refined realizations [4,9].

Design methods, proposed by the academy, fail to breach the professional practice because they are developed in playgrounds which are essentially research-led rather than practice-led [5, 9]. It is not only a concern of magnitude of resources to assess the effectiveness of a design method in a real-world context, it is rather a matter of user research and testing. In fact, despite the general advocacy of a user-centered design, many scholars often fail to take in account designers as end-users of the methods under development [5]. The proposed methods are mostly assessed qualitatively through observations collected in the lab environment or educational contexts, with the aim of setting points for analysis and future work.

We feel that a step forward in the consolidation of SID would benefit from the application of rigorous, designerly evaluation practices, starting from the educational contexts. Here, we report a design case extracted from one-week workshop on the theme of vocal sketching for SID. The workshop took place at Aalborg University Copenhagen, with the participation of eighteen students of Sound and Computing MSc program, forming six teams. Based on our previous experiences, we carefully paced the activities with the aim of maximizing the learning (develop cognitive abilities in compositional skills beyond the preparatory exercises), and yet having a controlled environment in order to assess the activities.

In this design case, we address the assessment of the creative processes of a team of 6 students involved in a task starting with a cooperative vocal sketching, and ending in individual sonic interaction design. We analyzed quantitatively and qualitatively the efficiency of the design process of this team, and we wanted to see how skills and knowledge are transferred in the individual design assignment.

The design task at hand required to sketch the engine sound for a concept car, and produce a sonic overlay out of vocalizations [6]: A video-prototype of the vehicle was produced, by adding the sonic elements as layers of a silenced video of the car motion. The design session was constrained to a maximum duration of sixty minutes.

After this training activity, the participants were asked to design an interactive application, which should extract selected parameters from the human voice, and use them in sound models. Each participant was asked for a meaningful scenario and justify her choice on input and output parameters, as well as on mapping strategies.

The present design case study is part of a broader research project aiming at developing a fine-grained understanding of the unfolding of design-thinking in sound design process. The objective is to produce

comparative analyses of the creative processes in order to assess the effectiveness and appropriateness of approaches and tools. In the next section, we present an analysis of a 1-hour segment within a 1-week cooperative sound design workshop, followed by an individual follow-up assignment.

Analysis of the Sound Design Case

In a previous study [4], an application of linkographic analysis to cooperative vocal sketching was presented. In particular, the authors discussed the calibration of the analysis to the early five minutes of the audiovisual recording, and showed how sentences, vocalizations, and gestures by participants can be extracted, coded, and related to each other to extract qualitative and quantitative summaries of design processes.

Protocol analysis is a method to study design cognition [7], and *linkography* notates and analyzes the protocols [8]. The design process is segmented in *design moves*, that is, minimal, sequential semantic units representing increments in thought [7]. Once the protocol is parsed in design moves, a coding scheme is applied in order to categorize the segments. In [4], the Function-Behavior-Structure (FBS) ontology of design was exploited to code elementary design moves.

The FBS Scheme and Design Moves

The FBS generic categorization of design moves is showed on Table 1. The FBS framework is used to produce the coding of elementary design moves [7]. The audiovisual recording is segmented in relevant elements in the three channels: verbalizations, vocalizations, and gestures. Then, these elements are put in relation according to the categorization scheme, in order to create links between design moves.

Code	Definition
Function (F)	The purpose of the artifact, set by the designer or redefined from the reformulation of the emerging structure (S). They correspond to the set of sound functions, e.g., ignition, engine idling, engine revs-up, etc. *Example: braking in move 14*.
Expected Behavior (Be)	Emerges from the formulation of the function or from the reformulation of the structure (S). Includes basic attributes of the sound behavior, and can be represented by verbalizations, vocalizations, and gestures. *Example: accompanying gesture in move 14*.
Structural Behavior (Bs)	Derived from the analysis of artifact configuration, that is the structure. Evaluation occurs when the expected and structural behaviors are compared against each other. *Example: "should be … because" in move 12*
Structure (S)	The configuration of the sonic elements and their formal relationships, as emerging from the synthesis of the expected behaviors. *Example: "woosh" in move 10*
Documentation (D)	Represents the set of design descriptions as outcomes of the FBS process. *Example: produced videos.*

Table 1: The FBS characterization of design moves.

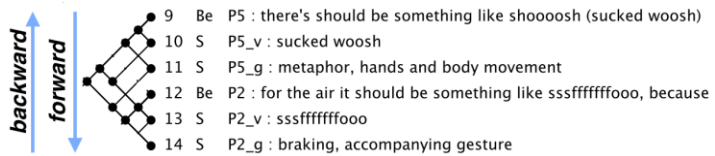

Figure 1: Snapshot of the coding. Forward links denote acts of synthesis; backlinks denote evaluation steps.

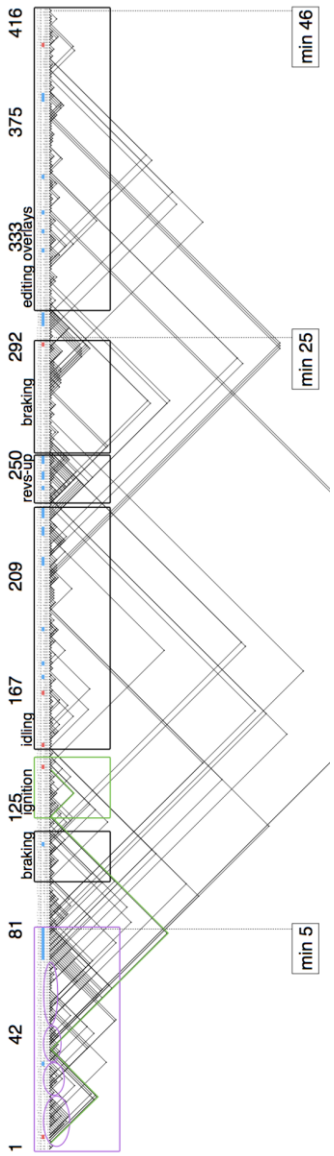

Figure 2:Linkograph of the session (see text for details).

The emerging reasoning is represented through nodes in the linkograph. Figure 1 presents a snapshot example of the reasoning around the braking sound function. Forward links denote acts of synthesis. Backlinks reveal evaluation steps in design thinking. The number of the move, the participant type label, that is verbalization, vocalization (_v), or gesture (_g), are reported for each transcription.

Figure 2 presents the entire session as a linkograph. The first segment corresponds to the early five minutes of the session. In this segment and the rest, documentation and the function are represented by dots in the FBS framework.

Summary of the early five minutes
The early five minutes correspond to the segments 1-81 on Fig. 2. These segments were isolated to calibrate linkographic analysis methods, because it encompasses a complete cycle of design process, from the formulation of functions to the production of early documentations. The application of linkographic analysis to the early five minutes of the design session has been extensively discussed elsewhere [4]. Here, we report only a few points to link the observations to subsequent analysis and final outcomes.

In this section, the structure codes are the most influential elements. These can be read in terms of functional fixation on the initial ideas, thus impairing the generation of alternative concepts from the iterative inspection of the representations being produced (i.e., the structures). The analysis of the linkograph also unveils an early collaborative process, which is mainly focused on searching a shared and steady arrangement and progression, rather than exploring alternative ideas, to the detriment of creative and out-of-the box solutions.

Summary of the whole session
The application of linkographic analysis to the one-hour design activity has been also discussed in [4]; here we report only a few relevant points. After a brief discussion on the sonic features of the concept car, the group formulated a basic set of car sound behaviors, namely the ignition, engine idling, engine revs-up, and braking. One idea per sound is quickly sketched, and an audio-visual documentation is produced by recording a live collaborative performance on top of the car video. Tasks are divided between participants, and the individual sounds are developed through iterative sketching and discussion. Finally, the documentations of the single sounds are edited and added to the car video.

In the protocol analysis, generally verbal-thinking is prevalent, however some participants are more prone than others in using vocalizations as means to externalize sound ideas, as shown on Table 2. Gestures have a limited use, mostly in a dual function, 1) as iconic means to signify aspects of sounds that cannot be produced or controlled with the voice, and 2) to physically affect the vocal sound, e.g. a damper effect obtained with the hand on the lips.

The direct effect of this distribution is scarce productivity in terms of documentations. This analysis suggests that, despite the effort and the engagement, the team suffered from lack of knowledge and attitude to evaluation and critical thought. Mastery of vocal production is certainly another important issue.

P#	Verbalizations	Vocalizations	Gestures
P1	40	44	7
P2	101	41	8
P3	40	2	0
P4	25	33	12
P5	9	22	5
P6	15	9	3
Total	230 (55.3 %)	151 (36.3 %)	35 (8.4 %)

Table 2: Distribution of activities in the workshop.

A design progression, as the one followed by the group may lead to a low rate of iterations. The design issues at hand are not really deepened, and rather resolved as they are. In practice, it is likely to have a design process stuck on one issue, or hopping from one issue onto another. In both cases, the process is inefficient in producing documentations.

The linkographic analysis in [4] was useful to reflect on the design task and its rationale in order to understand whether alternative measures can be undertaken to effectively achieve the objective. The linkographic analysis of this specific team work showed that the group effectively created a self-contained sketch in the early five minutes of the design session.

Independent Design Assignment

Table 3 presents the sonic interaction design assignments submitted approximately one month after the design workshop. As stated above, the assignment was to design an interactive application that allows to extract selected parameters from the human voice, and uses them to drive sound models. Each student justified their choice on input and output parameters, as well as mapping strategies. Complex mappings on Table 1 correspond also to complex scenarios in all cases. An example of a complex scenario is "Life on Mars, with different natural and artificial surface types" (P4), whereas that of simple scenario is a generic "Bubble simulator to be used in film sound design" (P5).

Discussion

While we did not monitor the longitudinal, macro-level details of their collaboration, the participants seem to carry the themes and activities of the design workshop to the assignments. The most nuanced case is that of P6, who remained rather silent until the "breaking" part of the workshop (see Fig.2), but his activity in this part defined the theme of his assignment.

The most vivid design, and also the most complex one in terms of sound models, interactivity, and mapping between the voice input and sound output was completed by P4. From Table 2, we see that participant has produced the highest number of gestures during the workshop, but only a moderate number of verbalizations and vocalizations. On the other hand, P3, who has produced no gesture in the entire workshop also completed a relatively complex assignment, carrying out the workshop themes into the final design. The role of gestures in design [3], particularly in sonic interaction design, therefore requires further analysis.

The participants P1, P2, and P5, who were most active in the workshop in terms of verbalizations, vocalizations, gestures, and critical design moves choose to complete the assignment in a group. This has resulted in iterating the early design ideas without much refinement, and consequently, in simple themes.

P#	Domain	Summary	Theme/Mapping
P1	Fluids (Bubbles)	Voice input co-triggers musical and nonmusical physical models	Complex
P2	Fluids (Bubbles)	Pitch continuously controls bubble formation	Simple
P3	Fluids (Flow) / Motor	Fluid-flow co-modeled with a motor.	Complex
P4	Wind (Blowing)	Blowing against, inside and across surfaces.	Complex
P5	Fluids (Bubbles)	Bubbles simulator: Pitch controls bubble size	Simple
P6	Friction (Rubbing)	Voice-controlled rubber surfaces	Simple

Table 3: Overview of the student projects

Conclusions

We presented a design case where protocol and linkographic analysis were applied to a task of cooperative vocal sketching. The understanding of the collective behaviors involved in sound creation is aimed at setting the ground for the development of rigorous, designerly evaluation practices tailored to sound design, all the way to the final interactive product. Sonic interaction design, in our opinion, is one of the keys for game-changing design. By sharing relevant qualitative and quantitative information about the creative process with the HCI community, we hope to inform the assessment and possibly improvement of sound design methods. Currently we are also analyzing how cooperative sound design unfolds in industry.

Our main contribution is the recognition that a substantial part of SID method development efforts, especially those in academia, are not carried out as collaborative design processes. Based on our findings, we believe that SID methods could benefit from adopting more of the core characteristics of cooperative process. However, the virtues of non-commitment to the early design ideas, the possible negative impacts of group consensus, and the need for individual reflection and refinement need also to be addressed.

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