Using Vocal Sketching for Designing Sonic Interactions

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ABSTRACT
An increasing number of interactive consumer products make use of the auditory channel. Consequently, sound has become an important part of the interaction designer's palette. Nevertheless, sound is a difficult medium for non-experts to sketch in. We propose Vocal Sketching as a methodology for addressing sounding design, alleviating the challenges inherent for non-experts when thinking and communicating about sound and sounding objects in the early stages of design. The method was tested in a workshop with 35 participants, who, working in groups, used only their voices to sketch sonic interactions for three object props. Observations and results from a post-workshop questionnaire study show this methodology to be feasible and enjoyable, and applicable to the design process even without prior vocal training. The emerging pros and cons of this method, as well as results relating to social comfort in using the voice and group strategies for using multiple voices, are discussed. Further work should include a comparative study of this methodology and other sonic sketching strategies.

Keywords
Sonic Interaction Design, Vocal Sketching, Design Methodology.

ACM classification keywords
D.2.10 Design: Methodologies; H.5.5 Sound and Music Computing: Methodologies and techniques

INTRODUCTION
The design of interactions, at its best, addresses the wealth of the human sensory system. Multi-sensory interfaces, offering the feel of a real world interaction, have been a goal of designers and developers of interactive technologies. Everyday digital objects today have the means to address the user in sound, image, touch... even smell. However, mere access to technology is an inadequate basis for the utilization of this potential. Designers working on everyday interactive experiences—and students of the trade—need to be able to explore ideas in different modalities and choose those best suited for the task. The prerequisite for making informed design decisions is the access to a variety of methodologies to explore the material at hand: the tools that help the designers think, plan, and communicate during the design process.

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Sketching is a fundamental part of the early design process. Interaction designers sketch ideas for behaving objects, spaces and other experiences. Bill Buxton's recent book, Sketching User Experiences [1] has laid out a palette of methods for sketching interactive experiences that involve different forms of visual storytelling. But how do we sketch when designing interactions for other senses? In particular, those with a salient sonic behavior—sonic interactions? What methods do we have when we come to design interactions that use sound as a main output?

This paper deals with a design methodology specifically aimed at early stages of design, focused on the sonic domain: vocal sketching. The voice is easy and accessible, and often intuitively used by professionals and novices alike for portraying and imitating non-speech sounds. We describe the organization and outcomes of a workshop investigating the merits of more systematic use of voice as a sketching tool for sonic interaction design. We propose that the voice apparatus can be to sonic interaction design as pen and paper is to the visual domain: a quick, easy and highly communicative method for thinking and communicating early in the design process.

SONIC INTERACTIONS
The need for informative and expressive sound for interactive artifacts is growing. As technologies become more miniaturized and embedded, and their users more mobile, the auditory domain becomes a natural choice for information and feedback. Embodied interaction [5], in which the user directly interacts with artifacts embedded with technology, often benefits from immediate and highly responsive control-display loops. This has also been called tightly coupled interaction; mimicking real-world interactions, the aim is to accompany the user's every move by continuous response at the interface. The archetypal example of such interaction is the musical instrument. The choice of a sounding example is not coincidental

considering the temporal resolution of our senses; the ear is an order of magnitude faster than the eye.

Designing Sonic Interactions

For those without formal training in the sonic domain, sound is a difficult material to deal with. Discussing sound in depth requires a vocabulary of sound attributes (e.g frequency, pitch, timbre, granularity, band filters and the like), which is not part of designers' education, or of general knowledge. While verbal portrayals and metaphors can be used (e.g., "it should sound like a fire crackling" or "muffled, like under water"), it is almost impossible to accurately describe nuanced modifications to sound, or to explicate the full range of sounds one has access to through imagination.

Most sound design methodologies already start out at a stage that is difficult for novices. For example, in the framework for Sonic Interaction Design described by Brazil and Fernström [4], work starts by *the "definition, selection, creation, and ad hoc evaluation of the sounds"*. Thus a first challenge for the designer trying to sketch a sonic interaction is to select or create sound. Approaches can either be to make use of existing audio material, or to create novel sound. While sound libraries and databases can be found on CDs and on the web (e.g. freesound[1]), the diverse sonic material needed by designers is not readily available, nor easily searchable (in comparison, for example, to searching for an image on the web). Alternatively, producing original sonic material depends heavily on the type of sound to be used. Musical sound requires some knowledge of an instrument or sound generating software. Using everyday objects that make sound, as proposed by Franinovic et al. [6], can indeed be evocative and inspiring, but calls for a good collection of objects to provide diverse sounds. Acquiring sounds in a recorded format demands access to recording equipment, and the skills to use it.

Once acquired, how are sounds used to try out the interaction in the design process? For event-based interactions, where sounds are occur in response to identifiable events, working with recorded or found sound samples can be sufficient. A more elaborate sketching approach, proposed by Pirhonen et al. [11] is the Radio Play method, where the intended sound elements are injected into a recorded narrative of intended use cases. However, the real challenge comes when sketching interactions that are tightly coupled. In this case, samples are fundamentally inadequate, since they do not reflect the continuity of interaction. Moreover, while the Radio play-approach could be extended to depict continuous sonic interactions, such a passive approach sidesteps the active component of engaging in a closely linked action-feedback loop. The same limitation holds true for video prototypes of sonic interactions.

Experts in sound address this challenge with specialized software tools such as MAX / MSP[2] and PD[3]. In these tools, physical sound models are created, which change dynamically according to input from the user (via some form of sensor). These tools and methods are inherently complex and technical, and while there have been attempts to simplify them and make them available to a wider design audience (e.g. [13]), they are currently beyond the scope of the designer making early attempts to sketch or prototype a sonic interaction.

THE VOICE AS A SKETCHING TOOL

Given these difficulties in describing, acquiring and modifying sound, and the need to create tightly coupled sonic interactions; the human voice emerges as an especially simple, available, dynamic, inexpensive and expressive sketching instrument.

Sketching is both a *thinking tool* and a *communication tool*. In terms of thinking, sketching is used both for idea exploration, and as a way to refine ideas. The human voice is suited for exploration in that it is incredibly versatile and capable of exhibiting a wide range of sounds. It is also a "technology" that the designer is highly familiar with, and can control with no training (albeit at different levels of expertise).

As a communication tool, sketching enables people from different domains to use a shared language. Also for this the voice is well suited: while technical devices (computers, software systems, sample libraries) often differ between designers, the voice is in a sense "standard". Despite differences in language and tonal range, the apparatus for producing sound is essentially similar for all people. This is beneficial for communication, as it ensures a good framework for understanding the intentions of the communicating partner.

One must not forget that reading sketches is a skill too. Interestingly, scholars such as van Leeuwen [8] have suggested there may be common links between how we perceive sound, and the emotional and bodily experience involved in producing sound using our own voice. He writes how two listeners are likely to derive the same general meaning from a heard sound, as…

…their interpretations and experiences are likely to be in the same broad area [...] they will derive from and be concordant with an experiential meaning potential, with a knowledge of what it is we would physically have to do to produce this kind of pattern with our voice [8, p.94]

In fact, we are biologically hard-wired for certain types of vocal communication, and for example, able to both express and understand emotion intuitively without training. Vocal sharing of sonic ideas could be just another means to tap into this common meaning potential, originating in each and everyone's individual embodied

[1] http://www.freesound.org/

[2] http://cycling74.com/products/maxmspjitter/

[3] http://puredata.info/

experience of how the human body produces sound. Thus, vocal sketching might help designers access a deeper level of understanding in communication about sound. Importantly, this connection is rooted in common experiences related to *what it takes* to make sound with your body, not on semantic agreements.

Vocal sketching

Making non-verbal sounds to communicate meaning is an intuitive activity, as can be witnessed in watching parent–child interactions, play behavior, or interactions between people without a common language. Vocal sketching at its best should tap into this easy and intuitive feeling.

Generally, communicating *in sound* from the start of the process can help teams focus on the implications that using sound will have in various contexts; in particular, to take into account the various emotional and social consequences arising as a by-product of sounding interactions.

A specific merit of *vocal* sketching is the potentially engaging experience of making sounds with your own vocal tract and through your own body. Most design methods aim to stimulate out-of-the-box reasoning, or what De Bono [3] has called lateral thinking—the creative, unexpected process that produces new and often surprising solutions. There are a number of ways to tap into this resource. One important aspect is to create a playful and relaxed setting. Another appears to involve the use of the body. In this aspect, vocal sketching bears similarities to a design methodology called *bodystorming* [10], as both methods engage the designer bodily during the design. In bodystorming, designers play or enact the intended interaction context as a part of the design process. The enactment serves as a means of deepening the understanding about the context, as well as a stage for trying out interactions, before taking them to the prototyping stage. Becoming bodily engaged with your design can have other good consequences: the case studies by Oulasvirta et al. [10] showed that concepts and scenarios that were bodystormed were better remembered by the design team later in the design process.

In discussing vocal sketching, we take inspiration from what Bencina et al. [2] have called *vocal prototyping*, a process of vocalizing gesture-sound interactions for artistic performances or installations. In their design process, participants vocalized simultaneously as they demonstrated the physical movements involved in the interaction, thus instantly trying out the designs in the final context. Our work extends this approach to make vocal sketching a group activity, and to systematize its use in the direction of a sketching tool. The group interaction allows exploring more complicated interactions between team members, such as sonic idea generation (brainstorming) and communication. Many voices introduce the possibility for varied sonic realizations, e.g. dividing the vocalization between several people. Most importantly, while Bencina et al. focused on vocalized bodily movements, we want to explore the role of vocal sketching for a wider space of sonic interactions, especially those involving physical artifacts.

The idea of using artifacts—or props—has been suggested by Franinovic [7] as a way of exploring object-related action in a design setting. These props, initially called interaction gestalts and later renamed *functional artifacts* [9], embody certain interactive, manipulatory affordances while otherwise serving as blank slates for imposing meaning through design. Such artifacts can be coupled with sounds to explore the interplay between action and sound (e.g. [7, 12]). We seek a similar approach here in that we introduce objects with specific functional affordances; in our case, to the vocal sketching process.

THE VOCAL SKETCHING WORKSHOP

To investigate the value of vocal sketching in sonic interaction design, we designed and organized a workshop where the voice was used to sketch interactions with objects. This section describes the goals set for the workshop, the detailed plan of the workshop set to meet these goals, and the results of the study in terms of design outcomes and a qualitative evaluation comprised of observations during the event and a post-workshop participant questionnaire.

Goals

Our motivation—to develop and refine vocal prototyping to suit the design process—drove the two main goals of the workshop:

1) We wanted to evaluate the usefulness of vocal sketching to design, and to explore the voice as a sketching tool in such interactions. We included three different design tasks to test various interaction styles and settings. We invited both experts and novices in sonic interaction design, to gather diverse and critical evaluation on vocal sketching as a design method.

2) The workshop was of interest to us as a process. We sought to make the structure and content conductive for vocal sketching. We tried to create the conditions for an engaging, open atmosphere, which allows silliness, and to stimulate out-of-the-box thinking. Particularly, we paid attention to the social barriers to vocal interaction, and ways to overcome obstacles such as shyness in the group setting.

Structure of the workshop

The workshop consisted of the following three stages: a brief warm-up, a series of design tasks, and a concluding session for reviewing the results and sharing some reflections on the process. In the following sections we describe these stages in detail.

Warm-up

For the warm-up stage we created a sonic guessing game. Participants were randomly divided into teams of approximately five persons each. Each group received a written definition of a sound scene (examples include “tennis match”, “video game arcade” and “kitchen in the morning”), and immediately had to stand up in front of the

rest of the participants and create this sound scene using only their voices. The other participants had to guess the scene.

The goals of the exercise were to get the participants up and moving, to act as an initial icebreaker for the teams, and to prime the groups into a creating a shared vocalization. We chose a team-based competition in order to strengthen the within-group feeling of belonging together and to lower social boundaries. The sound scenes were chosen to be not completely obvious but still archetypal enough to encourage sound production, and to benefit from multiple voices.

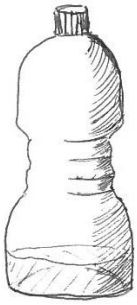
Design Session

For the design session, we prepared three physical object props: the "water purifying bottle", the "energy-aware power charger" and the "health vest". The props were chosen to deal with different types of information (chemical, electrical, physiological) and different forms of interaction (event-based, continuous). The prop qualities are outlined in Figure 1.

The design task was to create an interactive sound design for the prop. Prop descriptions aimed to flexibly allow the teams to define their own story for the interaction, while being fixed enough to provide a reasonably defined design context.

The following three props and descriptions were used:

- The *power charger* was a standard mobile phone charger described such: "the charger gives information about its status, and prompts you to save energy". The charger was chosen since it has only a small number of discrete actions (plugging and unplugging from a power outlet, plugging and unplugging the phone). The energy saving aspect was introduced as an additional motive for the user-initiated interaction.
- The *health vest* was a large denim vest described such: "in this technologically enhanced garment, pressing specific areas on the vest provides diagnostic health information". The vest was chosen as a design task



Design assignment	Power charger	Health vest	Water purifying bottle
Physical prop	Mobile phone charger	Adult size denim vest	Clear 1,5l water bottle (containing some water)
Information content	Battery status, own state (is the charger currently plugged to a power outlet)	Diagnostic information about the wearer's health	Purity of the contained water
Use	Used like a normal charger	Pressing areas on the vest gives diagnostic information	Purifying water by shaking the bottle
Interaction affordances	Discrete event-based interaction	Discrete interaction moments (pressing), however the pressing itself may be viewed as a continuous action.	Continuous interaction.

Figure 1. The props for the workshop were selected with an aim to cover different types of information and various interaction affordances.

focused on the body, and was less defined in its interaction (*pressing* can be both event-based and continuous, depending on how it is realized).

- The *water purifying bottle* was a transparent plastic water bottle. The function of the object was described such: "the bottle purifies water as you shake it". Using the bottle requires continuous gestural action, a particularly salient topic for sonic interaction design. Some water was intentionally left in the bottle to have an existing sonic response during use, and to encourage focus on continuous sonic feedback.

The design session was run as follows: all teams worked in parallel, every group performing two sketching sessions, each with a different prop. About 20 minutes were allotted for each sketch, after which teams were instructed to go to one of three available *recording stations* to document their design. These stations had a video camera with a separate boom microphone, with a dedicated person operating the equipment. To document designs, the teams performed an enacted demonstration of using the object, while creating the sound of the interactions using their voices. The films were shot such that the voice sources were not visible in the scene on the video.

Concluding Session

The concluding session had two parts: a shared viewing of the recorded videos, and an open discussion related to the experiences of the participants. The session was conducted with all participants seated in a circle, and was guided by the workshop organizers.

Data Collection

The workshop was held in November 2009, at the Holon Institute of Technology. There were 35 participants from various backgrounds and from 15 countries. The two predominant groups were a) an international body of delegates of the EU-funded Sonic Interaction Design (SID) research group, and b) local practitioners of design (not sound-specific). In addition to the sound design background held by many SID participants, some non-SID participants had a music background, and thus were familiar to working with musical sound.

During the workshop, the authors observed the team design processes. Design outcomes of each of the teams' vocal sketching sessions were recorded on video, at one of three recording stations (see Figure 3). Video recording was also used during the concluding session discussion.

Participants formed 6 teams, and completed a total of 11 vocal sketches: 4 for the water purifier, 4 for the power charger, and 3 for the health vest. From practical observation of the workflow, it seemed that all groups, despite background and nationality differences, managed to get into engaging, and productive, vocal interactions. Apart from one group who returned only one design, the rest of the groups were able to reach a sound design for two objects within less than an hour of sketching, and to perform with voice and body for the camera.

After the workshop, an online questionnaire was sent to participants. This questionnaire regarded the participants' prior experience with sound and vocal sketching, and addressing their experiences during the workshop. Out of 35 participants, 20 answered the online questionnaire after the workshop. The responses were almost equally divided between the two backgrounds, SID-action delegates (45%) and local designers (55%).

Most participants designed sound for two (of the three) props. Figure 2 details the number of responses we received regarding each design. Even if all respondents did not provide answers on every prop they designed for, questionnaire results nevertheless covers all three props and as such, offers information about the design process for the three different cases. The slightly lower rate of answers on the health vest is probably explained by the fact that there was one less design for the health vest than for the other two props and thus fewer respondents overall who had experience with the health vest.

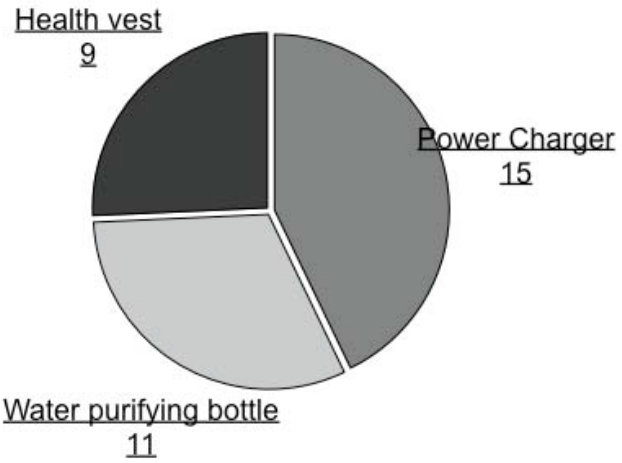


Figure 2. Questionnaire responses sorted by design case. All three cases are covered in the questionnaire answers.

Results and observations

The post-workshop questionnaire (included as Appendix A) consisted of 14 open-ended questions. In composing the questionnaire we aimed to gather information about five general topics: prior experience with sonic interactions and vocal sketching (Q1–4), the designs reached (Q5–7), the design implications of sketching with voice (Q8–10), social comfort and communication (Q11), and general appraisal of and future ideas for developing Vocal Sketching (Q12–14). The following sections briefly present these topics, based on the questionnaire answers and on observations made during the workshop. An analysis of the video material is beyond the scope of this paper.

Prior Experience

Roughly half of the participants reported prior experience of using their voice for sketching. However, from the actual descriptions it seems respondents included a wide range of voice use into this category. Only five respondents describe using sketching similarly to how it was used in the workshop, as a design tool. Furthermore, of these five, some had used their voice only in private, not to communicate ideas within the design group "Yes. Usually on my own. Sometimes I record my voice […]" (R4/Q4[4]). Even when sketching was performed in a group, the social aspect of using the voice was evident, and sharing was only done "In a small group of close collaborators and friends" (R9/Q4) It appears that one significant barrier to using the voice as a design tool is the fear of being perceived as foolish, especially in the work environment.

Nevertheless, respondents' answers illustrate a multitude of ways to use voice in various situations, which all closely *relate* to sketching. These answers stand to demonstrate that vocal sketching (in the form of imitation, expression and demonstration) is not completely alien even to serious adults, quite the contrary. For example, one respondent reported often using voice in storytelling: "when telling a story, I tend to use vocalizations to express scenes and actions." (R14/Q4). Another respondent had used vocal sketching in teaching: "I describe to my students what to play using my voice […] I use sounds to describe a musical atmosphere, or I imitate a certain musical instruments" (R20/Q4).

Looking at the specific use of sound, regardless of the context, many responses brought up the notion of using voice in a deictic way, to *point out* something sonic: "when I need to point out something in an interactive experience, or emphasize some aspect, I find myself vocalizing the interaction" (R9/Q4). Notably, also participants who were musicians stated the utility of the voice for this purpose. As one described: "vocal sketching is also a very important part of musical creation, mostly when communicating between musicians" (R19/Q4). Another musician stated, "I make music, so often I roughly sketch melodies or rhythms" (R12/Q4). Interestingly, musicians have access to—and competence with—musical instruments, and yet many choose to use their voice. Indeed, this suggests that the voice is more than a substitute, used merely for lack of better tools.

The designs reached

All teams reached designs that made use of the vocal apparatus. Observation during the workshop showed that there was a wide range of sound designs achieved, indicating that the vocal apparatus and vocal sketching method provide ample space for design. Interestingly, the questionnaire descriptions indicate that groups often chose similar strategies and metaphors for the objects. Specifically:

- For the power charger most solutions made some kind of personification or animation of the charger, making it hungry, feeding, gulping, burping, and sucking in response to the different statuses.
- For the water purifying bottle, two types of strategies emerged. One involved moving from disharmony to harmony as the water cleaned. In the other, the sound of a chosen material changed as the purification progressed (e.g. from water on rocks, to water on sand, to clear water).
- For the health vest: in all solutions, each body element was assigned a sound. Some approaches explored references to the physiological sound (e.g. heartbeat) while others made behavioral associations (e.g. percolator sound for caffeine level).

Figure 3. Documenting the sonic designs was facilitated by *recording stations* with dedicated personnel operating camera and recording equipment. The picture shows an ongoing session at a recording station, with participants working on the design for a water purifying bottle.

Most sounds used in the designs are complex, ecological sounds, many of a distinctly organic nature. These sounds would be hard to produce by synthesis, and using them in a design in an interactive way would require substantial sound manipulation skills. Yet, the vocal apparatus provided instant access to these sounds in the sketching process.

Equally interesting to examining what sounds are included in the sketches, is to look at the sounds that are absent: There were no documented attempts to mimic simple sinusoids, clicks or beeps, the sounds most often encountered in early sonic sketches (but almost never in nature). With the exclusion of the concept of harmony, sketches also made surprisingly little use of musically encoded meaning. Vocal sketching thus seems to drive design into sonic reserves that are hard to access by current tools, and away from simplistic sound solutions.

[4] In references to questionnaire answers, running numbers R1–R20 are used as subject identifiers, while questionnaire items are identified as Q1–Q14.

Design implications of sketching vocally

We asked whether participants felt that different objects called for different voice behaviors. All respondents answered positively. Many mentioned the process as the selection of a story or metaphor, which then drove the sound design, such that both the type of information and the interaction affected the way voice is used. “Different objects suggested different (interaction) stories, and the voice behaviors were linked to these stories rather than with the objects” (R11/Q8). In this sense the design process was not dominated by the design method (vocal sketching) but evolved through a healthy process of concept development and sketching.

We asked participants what impact using the voice had on the design decisions they made. As expected, some respondents felt that the limitations of using the voice had an influence on the direction the design took. As one participant noted: “we couldn't create boiling water sounds so we decided to go a different direction” (R3/Q10). However, design directions were influenced by voice abilities in the opposite manner, too: “a burp sound was inserted in the Power Charger scenario because one of the designers was able to produce it at will” (R5/Q10). This goes to illustrate that voice is by no means a neutral tool. However, we do not view this as a fault: in the extent that creative process can benefit from limitations (and, indeed, many design methods work by imposing arbitrary limitations to spur creativity), the specific attributes of the voice may have helped the groups reach and select a solution.

It is interesting to note that most groups exploited the multiple-voice opportunity in their designs. The most challenging solution in this sense may have been the disharmony evolving to harmony, which assigned each team member a different vocal role. In other groups, the different members chose to create a shared chorus, with all making the same sound. One group used a process of temporal sequencing, with each member making a short part of the sound and handing the object—and vocalization—to the next group member.

Social comfort and communication

During the workshop, we observed that many groups started out talking, but soon got off demonstrating their ideas and communicating by vocal sketching. Often what was needed was one brave individual to break the ice and “when the first examples kicked in, off we went” (R9/Q11).

Most respondents acknowledged that using the voice might raise an issue of social comfort. However, the vast majority reported that they felt good about the sketching session. In fact, even if we did not ask about that directly, six respondents spontaneously described the vocal sketching session as “fun”. Furthermore, all participants who found vocal sketching embarrassing also reported that the feeling of discomfort decreased throughout the workshop. The warm-up session, in particular, was very successful in preparing the teams and lowering the threshold of discomfort to make sound.

Communication through vocal sketching proved to have a unifying effect. One participant noted: “it was quite amazing to discover the similarity of the vocal language as well as tremendously funny” (R10/Q9). Participants also reported that the use of vocal sketching had an effect on the decision dynamics within the group. As expected from results on bodystorming, demonstration and enactment might have had an influence on the choice of ideas: “usually the ideas that were selected by the group were the ones that were sketched by the initiator” (R20/Q9).

An appraisal of Vocal Sketching

Our motivation for the workshop was to introduce voice as an accessible sound sketching tool. While the voice is not equally versatile for all participants (like any skill, vocal sketching improves with practice), our assumption was that the everyday experience with voice provides adequate background for sketching, without additional training. Indeed, during the workshop, we observed that vocal sketching was accessible to most group members. While one group chose a solo “vocalist” to perform their group’s final design, voice sketching was used throughout the process of the design. As one of the participants noted, “ease of vocalization didn't seem to be a problem, although some virtuosism helps in some circumstances” (R5/Q10).

The majority of participants felt the voice was useful for describing some aspects of the props. However, some felt the lack of complementing methods in the workshop: “sometimes a verbal description is more potent and convincing than someone trying to reproduce the sound themselves” (R12/Q9). Others felt the desire not for words, but for other objects to make sound with.

To our question, participants found the following limitations to using the voice:

- The monophony of the voice. One person cannot make many sounds at once (thus, sketching harmony was possible only in teams)
- The difficulty in producing specific, complex sounds.
- The lack of specific auditory control (available in sound processing software).
- Limitations due to breath cycle (e.g. long continuous sounds impossible).

When questioned about alternatives to vocal sketching, participants mentioned using sounds made by other parts of the body, sound making objects and materials (water, fire), as well as real-time digital sound processing tools, parametric sound synthesis engines, sound libraries, and sound authoring software. However, answers also acknowledged that there “are really no alternatives for producing sketches of sounding objects with such a speed. For static sounds one could use sample libraries, but these become almost useless for continuous interactions” (R5/Q13). Suggested solutions included augmenting the

vocal apparatus with real time audio processing tools, by use of real-time effects such as distortion.

CONCLUSIONS

We have presented a design methodology addressing the very first stages of designing sonic interactions, and demonstrated its use by a practical workshop. Our findings show this new method was usable and mostly enjoyable for participants, and produced rich outcomes in terms of sonic designs. While the voice was felt to have some inherent limitations, the observed variety in vocal strategies and sonic designs indicates that vocal sketching does not force designs into narrowly defined designs, but offers a wide variety of sonic expression.

This is not to say that voice is a neutral tool. It would seem, that the use of voice does promote the use of complex, ecologic sounds in favor of simplistic but easily synthesized sonic material (like sinusoid waves and clicks). While this driving force needs to be accounted for, it is not an argument against the use of voice for sketching. If anything, it can be seen as a rather beneficial property, since vocal sketching seems to drive design particularly into those sonic reserves that are hardest to access by current tools. In fact, vocal sketching may prove valuable as a way of balancing the early stages of design, providing an organic counterforce to the sounds produced by synthesizers. Future work should further address this issue, possibly by comparing designs reached with vocal sketching to those reached with other methods in a similar setting.

Another direction for future research is the combination of vocal sketching with other, complementing tools, to create a complete sketching palette. In particular, providing some (simple) technical augmentations to vocal sketching may be beneficial: rudimentary audio processing functions on site could expand the versatility of the human voice without adding (too) much complexity to the design process. The same technical setup could be utilized for recording and documenting the designs.

In future workshops, we hope to continue to refine both vocal sketching methods, and the general workflow, such that it can be optimized as a practical method for the early stages of sonic interaction design. We share the current results with a hope that this process can be used to introduce elements of sonic interaction in the education of new students in the field of interaction design.

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APPENDIX A, POST-WORKSHOP QUESTIONNAIRE

1. Do you have a background working with Sonic Interactions? If so, please describe it shortly:
2. Are there some specific types of sounds you usually work with? If yes, which?
3. Do you normally sketch/prototype with sound? If yes, how?
4. Have you ever done any vocal sketching? If so, where & why?
5. Shortly describe the sound design your group reached for the Power Charger. What types of sounds did you use and why?
6. Shortly describe the sound design your group reached for the Water purifying bottle. What types of sounds did you use and why?
7. Shortly describe the sound design your group reached for the Health Vest. What types of sounds did you use and why?
8. Did different objects call for different voice behaviors?
9. Did vocal sketching influence how you communicated ideas to others in your group? How well did you understand others communicating their ideas?
10. Did vocal sketching influence the direction of your design or change your ideas? Did you skip or choose some design direction because it was or was not easy to vocalize?
11. How did it feel to use your own voice in a group? Did this feeling change during the workshop?
12. Where did you find your voice especially useful?
13. Where did you find your voice especially lacking? What tools could you have used instead of voice for prototyping those sounds?
14. Do you feel that students of Interaction Design would benefit from vocal sketching training? If so, what classes would you like to see included in vocal sketching education?