Closing the Loop of Sound Evaluation and Design (CLOSED)

Deliverable 3.1

Sound Product Design Research: Case Studies, Participatory Design, Scenarios, and Product Concepts

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This is a trick...
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Overview of this deliverable

This deliverable describes work on the CLOSED project comprising three main areas. First, it surveys participatory activities undertaken by the HGKZ toward uncovering basic design opportunities and relevant contexts in the emerging field of sound design for interactive products. Second, it reviews work on a range of context based case analyses undertaken in the kitchen setting, the outcomes of which comprise a set of case documentations in the context of the kitchen, a set of task and sound analyses for the documented cases, and conclusions toward a model organizing this information. Finally, the deliverable presents a set of original scenarios describing new concepts for interactive sonically enhanced proto-products. These concepts are aimed at specifying those artifacts that will be developed through the rest of the project, following sufficient discourse with project partners and subsequent design reviews.
1 Participatory research on sonic interaction design for everyday objects

Sonic interaction design for everyday products is an emerging field of practice that is substantially addressed by the CLOSED project. It represents both a significant trend in the product design arena, as well as one of practical and theoretical import to existing design communities organized around sound. In the latter sense, it may be regarded as positioned at the intersection of such fields as auditory display, product interaction design, and ubiquitous computing.

This section details explorations of this field that have been undertaken by HGKZ in a workshop setting, with an international mix of designers, students and researchers, aimed at investigating new roles for interactive sound design in everyday products, new contexts in which it may be situated, and possible methodologies for designing products. In this section, we describe sonic interaction design and its possible applications, describe the outcome of this workshop, and indicate future directions. The main outcomes of this work are to collect basic knowledge on sonic interaction design, prototyping the processes that may be used, and the way in which contextual factors and design constraints may contribute to the design process.

1.1 Introduction

The field of sonic interaction design is growing in relevance, both as a result of design driven needs, and as economies of scale and miniaturization have contributed to a widening array of everyday artifacts that are embedded with ever more sophisticated sensing and actuating capabilities. An explicit goal of the CLOSED project is to address needs for new methods and methodologies for use by designers in this context.

The result of these developments is that an immense opportunity is appearing for the design of a wider range of auditory displays in everyday artifacts ranging from shoes to intelligent fishing gear. As designers and researchers in auditory display, interaction design, product design, it will be valuable for us to increasingly take note of these opportunities, as they are likely both to influence our practice, and to feed new concepts and challenges back into research in the design and engineering of auditory displays.

A strong argument can be made for a strengthening of research at the intersection of fields such as auditory display and sonic interaction design for products, based on a set of common goals aimed at satisfying design driven needs for interactive sonification in everyday artifacts, many of which may not possess a visual display at all. Indeed, many of the key motivations and roles that have been described and evaluated in the literature on auditory displays are relevant for sonic interaction design in this setting, including the overload of the visual channel, the power of sound to communicate information about a continuous or temporally significant process, to supply ambient information related to a place or activities, or to improve an ongoing continuous control activity, such as a sport.

Other issues raised by the consideration of everyday sound augmented artifacts are complementary to those that have been most prominent in existing areas of the literature in disciplines like auditory display – for example, questions concerning the appropriateness of an object’s sound to its environment and soundscape. Moreover, examining the world around us, with notable exceptions, it is typically populated with artifacts that, even when interactive, are frequently lacking any dynamic visual display.

Having in mind this broader context, HGKZ conducted the first in what is planned as a series of workshops focused on sound design for interaction with everyday artifacts. The workshop was held with a group of designers, design students, and an international group of researchers. The aim has
been multifold: To investigate new roles for interactive sound design in everyday products, embodied by new design concepts and cases uncovered in the field; to address the role of context in contributing to product aims and subjective interactions; and to test methodologies that can be applied to their design. A recurrent theme in this dialogue has been the relation between action, task and sound, and this is reflected in a body of evidence that the workshop has collected. This latter theme was elaborated further through the set of concentrated field analyses described in Part II of this report.

1.2 Sound in Product Interaction Design

Sound design already plays a significant role in many areas of product design, especially those which create products with high functional densities, strong design identities, or which address demanding markets such as luxury goods. Prominent industries that have benefited from it include the automobile and cosmetics industries, but lower profile applications have arisen in other areas, such as kitchen appliances and office equipment.

While sound design in these industries has mainly been concerned with shaping acoustic appearance, establishing identity, and in eliminating “noise”, interactive sound can be integrated more deeply with functionality and the interaction process, similar to the role it plays in auditory display. Recent technological advances have enabled new approaches to interaction design, giving rise to applications that link sound in product and industrial design with formerly exotic but now highly active research fields, ranging from personal robotics, to telepresence, mobile music, and global positioning. A number of parallel developments have contributed to the increased relevance of Sonic Interaction Design today. The ubiquitous nature of computing and communication resources has led to the spread of auditory displays to everyday situations, as the appliances that surround us have advanced to the point that they have ample computing power to actively control their interactive auditory appearances. Techniques for the interactive synthesis of sound, including everyday sounds, have advanced so as to provide new ways for auditory displays in products to be seamlessly integrated into activities and to sonically mesh with needs serving diverse sonic environments. Sensors are readily available to make sounds responsive to human activities, providing new functionalities and enhancing existing ones. These advances are already generating products that evidence a deeper integration of sensing and actuating technologies into the functionalities and activities they serve. Examples of already widely distributed products that exploit a tight coupling between sound and gesture in interaction include the Nike+ running shoe and music player system, the scrolling devices on current generation iPods and mice by Apple Inc., and the Nintendo Wii game controller.

1.2.1 Functional roles for interactive product sound

The term Sonic interaction design (SID) has emerged to describe practice and inquiry into any of several kinds of roles that sound may play in the interaction loop between users and artifacts, services, or environments. The subject raises a number of areas of inquiry associated to the augmentation of sound in everyday products and activities that have been at the heart of discourses in sound-concerned communities for decades. For example, the link between sound and location, and the ability of an artifact to blend in or contrast with its soundscape, or to provide information or new relations that relate to a place and the people in it [9]. Another relates to the role sound can play in providing information about an activity or process, and thereby in allowing to identify activities occurring in an environment, the people performing them, their levels of skill and mannerisms. Walking sounds represent a well studied example.

Central to the objective of mapping out the opportunities present in this field is the identification of parts that sound and auditory display play today in product design, or those that it may be expected to expand to take on in the future. Interactive uses of sound should be seen as distinct from applications that serve primarily to signal or alert a human user or neighbor to a notable event, process, or state. Of particular interest for product design are the uses of interactive sound in the roles such as the following.
Creating or revealing new functionalities in a product through sound, when these functionalities may not be apparent through the physical form or other visible indicators that it provides. This can manifest through behaviors such as:

- Displaying new informational capacities, providing access to information either intrinsic to the device (as in the Nike+ system mentioned above) or supplied to it by means of a connection to some external informational network
- Illuminating invisible affordances of a computationally augmented artifact – for example, an everyday object that is linked to a computational process
- Distributing an information load linked to the functionality of a product to senses other than vision [2]

Shaping the sonic appearance of an artifact, where appearance is thought of as primarily referring to the qualities of the sound that is produced through interaction. This can address such issues as:

- Establishing an appropriate sound or sound identity matched to a product, especially its functionality, brand, or other characteristics
- Improving aesthetic experience and sound quality in the interaction, according to existing definitions of quality from the product sound quality community – for example, reducing noise, or shaping the spectral characteristics of incidental sound to make it less annoying [1]
- Augmenting emotional aspects of the interaction [14]
- Enhancing the formal interplay between actions, material, shape, and size

Providing sound to improve performance, usability, and experience in the interaction process, as by

- Providing feedback to aid users’ control over an interface [22], tool, device [18], or physical activity [5]
- Sonifying silent information associated to an action (eg. biofeedback)
- Reducing the perceived effort needed to operate an artifact. A number of perceptual illusions in action are associated to way that the presence or absence of appropriate feedback to an action modulate the sense of effort that users experience when performing them.
- Improving the focus and flow experienced by a user during a task

It is worth noting that sonic interaction design already plays a critical role in creative applications, most notably in musical interaction design, which continues to be an area rich in compelling application concepts. In harmony with current trends in the design of new musical instruments, we may consider the act of endowing experientially rich sonic qualities to everyday products as one carrying significant creative and artistic potential in itself, and which can be amplified by the complex context and meanings intrinsic to everyday contexts and artifacts [7]. As one example, the project Sonic City consists of an augmented jacket that acts as a musical interface, generating a soundtrack in response to features of the urban environment and the wearer’s actions in it [10].

The field of Sonic Interaction Design, which is in its infancy, will benefit from advances in knowledge in related disciplines such as those incorporated in the CLOSED project, including the perceptual, cognitive, and emotional study of sonic interactions, improved models for the reception of sound and its role in the performance of actions, adapted design methodologies, sound synthesis technologies and their use, and finally design and evaluation methods addressing the objective and subjective qualities of sounding objects and the interplays between such objects. For a new generation of sound designers to be capable of addressing the interdisciplinary problems the field raises, a more solid foundation of methodologies needs to be developed that can draw on such bodies of knowledge. The CLOSED project and the workshop described in the following sections serve as elements in a process that intends to improve this situation.
1.3 Workshop description

The workshop has aimed at researching new roles for auditory display in product interaction design, at exploring related opportunities and use scenarios, and new methodologies for sonic interaction design which can integrate into existing design practices brought by our participants. Our approach is based on learning through experience, in the spirit of Basic Design [6], an approach that originates with the Bauhaus school. Lectures aimed at providing participants with core knowledge and special topics in sound and design are tempered with field research and direct sensory exploration.

Participants are asked both to engage in new modes of listening and to experiment directly with physical materials, artifacts, and digital tools. The set exercises has been drawn from design methods that originated in a range of disciplines, including industrial design, ethnographic inquiry and theatre. Some of these serve the role of drawing participants into bodily engagement with the subject, through experience design techniques such as bodystorming [15] (Figure 1.3). We have planned the workshop to mesh with activities of the CLOSED project, in an attempt to integrate our design research and teaching practice with the formation of a group that can be considered to be part of the community the research aims to service. Complementary steps in the same direction will be taken through parallel project-based research practica that will be conducted in the summer of 2007.

We describe the process and outcome of the first workshop below. The results of this workshop are being published and presented in the highly salient forum offered by the International Conference on Auditory Display, which takes place during the last week of June, 2007, in Montréal, Canada.

1.3.1 Audience and context

The workshop was conducted in the design department of the HGKZ. Participants included fourteen students from the departments of Interaction Design (10), Scenographic Design (3) and Visual Design (1). They were in the third and fourth years of their undergraduate study and arrived with a very heterogeneous level of experience with, and prior exposure to, sound. No more than a quarter of the participants had significant experience with sound design, while another quarter had none. The remaining half had completed a project on setting graphic visualisations to sound, and thus possessed some analytical experience. They were joined by two visiting graduate students in Electronic Music from the Conservatorio di Como (with affiliations to the University of Verona), who arrived with a substantial base of knowledge in music technologies and composition, with further participation from CLOSED researchers from the HGKZ, Ircam, and the University of Verona. The latter lent their expertise to the workshop, and participated in the CLOSED winter project meeting at the HGKZ.
1.3.2 Workshop activities

The first week of the workshop was structured around lectures and exercises, while the second week focused on the development of short projects of the participants’ selection. Throughout both weeks, participants gathered a growing set of sounding objects in the working space – ranging from bells and shakers to bicycle parts and computer hardware – as ready case examples, sources of sonic material and inspiration.

Through the lectures we introduced a variety of topics of significance to the process, including basic concepts and terminology related to sound (notions of sound object, soundscape, and sound source), descriptive frameworks (acousmatic, psychoacoustic, ecological), interaction design methods, the physics and phenomenology of sound, sound synthesis methods, and related ideas from the fields of interaction design and musical interface design.

An important initial skill for any design activity is the ability to use the senses in question, and to be able to abstract, communicate and conceptualize about the experiences related to them. This was achieved through measures like daily ”Ear Cleansing” exercises [20], in which participants were confronted with examples of sound, drawn for example from musique concrète, and were asked to describe what they heard.

Field exercises

A set of field recording and analysis exercises were conducted over the course of the first several days of the first week. These included soundwalks [21], and served to focus the attention of participants onto the complexity of everyday soundscapes and the fact that sounds ultimately occur in a context including other sounds and activities. Participants investigated specific environments, including the
train station’s ticket purchasing area, an antique store, a canal-side sidewalk, and many others. These initial explorations were followed by more directed assignments in which participants were asked to record, analyze, and discuss case examples of sound produced through human action. This listening permitted facilitated reflection on the nature of sonic patterns that are typical of human action, and to contrast them with automatic or machine-generated patterns.

A more directly comparative approach was taken in exercises directed toward an examination of product sound quality [1]. Participants analyzed and documented interactions with large arrays of products of a given type and typically made of similar materials. Examples included scissors, zippers, industrial buttons, paper, doors and keyboards. Participants were asked to comparatively describe the qualities of the sounds, based on the frameworks that were introduced in the first lectures, and any other terminology they found appropriate (often using terms such as ”cheaper”, ”important”, ”unstable”), and to present their analyses for discussion.

Based on these discussions, it was apparent that the field exercises heightened participants’ sensitivity to sounds in relation to their function and context. The approaches that were employed to understanding and describing sounds seemed to vary significantly between cases in which analysis was performed in the field and when it was accomplished with audiovisual documentation. This seemed not only to be due to the quality of the recorded sounds (which depend critically on microphone technique and other factors), but also to result from the many contextual cues which affect ones perception of the sound cannot easily be recorded. Such features appear nonetheless to be highly relevant for sound design.

In subsequent exercises on sound making, participants explored sounds that they produced through physical performance, as in foley work for film. In a variant on the 2006 Freesound competition, participants were asked to produce sounds characteristic of one of the primordial elements (earth, water, fire or wind), in real time, with the added twist of not being permitted to employ material from the element whose essence they were trying to reproduce. The most successful results depended on surprising combinations, such as the opening of peanuts together with the movement of a large cloth, used as a means of simulating the sound of fire.

The final field exercises that were conducted explored the complex relations between the properties of an object that give rise to its overall experience, as opposed to its sonic qualities alone. Interactive artifacts from an array of environments were identified as case studies, and these were analyzed for sonic properties and for actions composing the experience associated to them. Participants were provided with a range of categories of properties relating to interaction and sound, including: the type of interaction involved (e.g. pouring, cutting, stretching), the configuration of the object (its shape, structure, weight), its surface textures, its material properties (especially in relation to vibrational properties, such as elasticity and density), gestalt features or characteristic patterns in space or time, spatial qualities (spaciousness, closedness, echoes), psychoacoustic and other descriptors. We attempted by means of the set of categories of descriptors to link this activity to earlier lectures devoted to Gaver’s and others’ work on the categorization of everyday sounds [8]. Participants selected their own subsets of categories and properties to perform these detailed artifact analyses. The results were used as source material for subsequent idea generation stages.

**Design ideation**

For each of the cases analyzed in the final field exercise, an interaction process, or set of processes, connecting human and artifact were identified and described. As an alternative to detailed analytic methods such as task analysis [3], a more holistic approach was adopted, founded on Basic Design practices [6]. The analyses proved to be useful means of exploring ways in which sound is connected to action in existing artifacts. Examples of analysed artifacts included a wind-up clock, a train station luggage locker, a bicycle lock, a trash bin, and a tea cup [2].

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1 Documented at [http://www.freesound.org](http://www.freesound.org)

2 A good example of these analyses is documented at this URL: [http://sonic.wikispaces.com/AnalysisDelleMonacheFumagalliBugmannLueling](http://sonic.wikispaces.com/AnalysisDelleMonacheFumagalliBugmannLueling)
The exercise that followed was designed to generate new concepts for auditory display in everyday products through a process of remixing those attributes that had been identified in field analyses. This is an activity that has been successfully used in other international workshops we have participated in, as a means of producing ideas to manifest possible directions in an emerging field [17]. Here, it offered participants an opportunity to engage in rapid, intense ideation sessions in pairs (“interaction design speed dating”) with other participants. The aim was to generate an array of new design concepts, and to quickly construct and map an imaginarium representing the future of auditory display, as source material and inspiration for the project phase in the second week. A wall-sized, two dimensional design matrix was created. One axis was enumerated with sonic properties gathered from the prior field analyses, and the other with interaction types. Each descriptor represented the abstraction of a gross characteristic that was determined to be dominant in one of the case studies.

Working in pairs, participants selected an intersection within the matrix, noting the sound and interaction type that met there, and were given ten minutes to generate a design idea based on it (See Figure 1.1). Participants were left free in their idea generation process, the only constraints arising from the pairing of descriptors, and the time limit. After ten minutes, everyone switched partners, selected another intersection and generated another design sketch together. At each completed step, the sketches were placed back on the wall, ultimately filling it with more than seventy concepts (Figure 1.2). After this process, participants gathered to present and analyse the results, and to act them out through “bodystorming”. A number of the ideas that were produced proved inspirational for our ongoing dialogue around the subject of the workshop, and for the projects of the second week. Examples of the concepts that were created include a fondue set to be augmented with the sound of cowbells and alpenhorns, a sonified livestock insemination tool, to guide the placement of semen, and a carpet that when walked upon would produce characteristic sounds and odors.

1.3.3 Short projects

Subsequently, participants formed project groups, and their work proceeded in these collectives. Groups employed methodologies and maintained goals that varied according to their interests, to the needs and the backgrounds of their members. Output of the projects ranged from interactive soundmaps of a location that was considered for an urban sonification, to musical compositions oriented around the sonic domain of an interaction design of interest, a number novel product video scenarios, and a few interactive prototypes (Figure 1.4).

Groups were given feedback from the workshop leaders during discussions that took place on a daily basis. Our practical work during this period was supplemented and enriched by invited lectures from and dialogue with CLOSED researchers on the subjects of physical sound modelling (D. Rocchesso, P. Polotti, and S. Pappetti from the University of Verona) and on sound perception (P. Susini and G. Lemaitre from IRCAM).
Figure 1.5: An embodied game artifact, the jump pad from *Game-all-over* (B. Janke) simulates the technology of fantasy in the real world.

**Project results**

Figure 1.6: Train station lockers were transformed into an emotional or playful experience through sound in the project *Sonic Lockers* (S. Teseo, B. Schuler).

The projects were developed over a compressed, four day schedule. As noted, participants followed varied methodologies, and reached different stages of development in their projects. Due to the deliberately interdisciplinary setting of the course, an effort was made to avoid specifying the nature of the project outcomes beforehand, in order to allow each group to bring their strengths into play, and to observe the range of methods that were employed. Participants addressed wide range of topics through their projects. The projects included:

- *Game-all-over* (Benjamin Janke): Dealt with transformation of exotic virtual artifacts from video game realms – including a jump-pads that can throw the user high into the air – into the real world, via tangible, sonically augmented objects [1.5].
- *Sonic Lockers* (Stefano Teseo, Barbara Schuler): Investigated the sonic augmentation of lockers in the train station. Interactions such as opening, locking, and closing were lent new, playful symbolism, as they were accompanied by sounds that served variously to exaggerate the weight of the locking mechanism, or to suggest that one’s suitcase is being dropped down a fiery chute or is driving away on a tractor (Figure [1.6]).
• **Klingenstrasse** ("Ringing Street", after the name of a street in Zurich. Song Vega, Luisa Beeli). Developed out of an analysis of the spatial and sonic properties of the street Klingenstrasse, this project proposed the sonic enhancement of structural elements such as drains and ventilation openings in buildings, to reflect the activity in the street, and considered the design of sounds produced by patterns over which cars on the street would drive.

• **Thirsty bottle** (Daniel Senn, David Herzog, Johannes Kiesbauer) Aimed to create a sonically augmented bottle that might invite to drink, and enhance both functional and emotional aspects of drinking experience. The bottle, presented in a video scenario, invites one to drink using the sound of sparkling fluids, and accompanies the drinking with music that might be linked to the beverage or brand.

• **Sonic Fishing** (Marcel Tanner, Daniel Volzke, Daniel Fischer) In Sonic Fishing, a fishing pole augmented is augmented with sound captured underwater that is used to semantically sonify information about the quantity of fish, their size and distance from the hook and bait. The user is equipped with a set of headphones that are connected to the fishing rod. A sensor on the hook, similar to those used in current fish finders, provides the data for sonification. The aim of the project is to improve fishing performance, by displaying proximity to fish, but equally to articulate and amplify the emotional experience – that of having a fish approach or nibble the bait – a process which is otherwise nearly imperceivable. Consideration has also been given to the sonic augmentation of the process of catching and reeling in the fish. Once it has been hooked, the fisherman hears additional information related to the tension in the line between him and the fish, which assists him reeling it in without breaking the line, and provides a soundtrack to accompany the struggle between man and fish. In the development of this project a range of methods including bodystorming were used, and the results were presented in a form of video scenario featuring actors in a fishing performance augmenting with related imagery (Figure 1.7).

• **Gamelunch** (Stefano Fumagalli, Stefano delle Monache, Stefano Papetti, Simone Lüling) This project focused on sonically enhancing the culturally complex and emotionally rich experience of dining, by making it more playful and performative. The Sonic Dining table accompanies actions performed while eating with a responsive soundtrack. Cutlery, dishes and the table surface itself become expressive interfaces. When a plate is moved or a fork is put down, sound is emitted from the table in a playful and changing way. The project explores the transformation of everyday objects and interactions surrounding them into a creative performance and expression. A water pitcher was designed to emit a musical interpretation of a pouring sound, depending on the amount of tilting exerted. The Sonic Dining table was implemented as an interactive prototype, using sensors including contact microphones, wireless accelerometers, a custom designed segmented table surface, and sound synthesis software based on physical sound models developed at the University of Verona. (Figures 1.8, 1.9).

These examples evidence a wide range of new roles for auditory display in everyday interactions, and further argue for the potential for extending the focus of research in this area to include a diverse array of contexts and applications.
1.4 Conclusions

1.4.1 Workshop Assessment

Interviews with participants were conducted following the workshop, to gather feedback about the efficacy of the methods used, and to collect further thoughts from the participants summarizing their findings. Some of the conclusions that could be drawn included these:

- Sound design for interaction takes time. Participants, even those with prior experience with sound, are challenged to complete a sonically-dependent scenario or prototype in a compressed period. Significant time is needed for experimentation with sound.
- The subject area is rather complex and interdisciplinary. Even a cursory survey of the theory required is sufficiently complex as to challenge a design-oriented audience. Providing a glossary and reducing expert vocabulary seem like measures that will help.
- On balance, an earlier integration of creative sound design (or sound making) exercises would have been an advantage, as participants like to be able to explore the tools and techniques needed in a trial and error fashion, and want the flexibility to experiment with multiple ideas.

Figure 1.8: Gastronomy and performance collide via the sonic dining table and sonically augmented water pitcher from Gamelunch.

Figure 1.9: For their project Gamelunch, participants constructed a custom sensing scheme based on an acoustically segmented table with contact microphones attached to each segment.

The HGKZ workshop organizers found this experience further cemented their conviction that there is a need for new methods capable of assisting designers with the many tasks involved in designing for auditory display in everyday artifacts. Analysis exercises carried out by workshop participants confirmed the fact that the many dimensions of such objects that come into play (their appearance, design affordances, sonic qualities, interaction possibilities) seem to demand new approaches to organizing
and managing the complex design space they suggest [16]. Physical, sonic, haptic and visual qualities of an artifact and its interactive capabilities are strongly linked, and there is a frequent tendency to describe sound in terms of cross-categorical attributes [19]. One solution that has been suggested is to adopt a fixed lexicon of action categories and terminology to constrain and facilitate such analyses. The need for such categorization and accompanying lexicon for sound designers was described by Ozcan in ICAD 2005 [16]. One point that has emerged out of CLOSED work so far is that any steps that can be taken toward such a categorization may be extremely valuable.

Experience with the field exercises that were integrated here suggested that design reflection analysis are strongly context-dependent, and this suggests that such analyses should be carried out in context, when possible. At least in the practice of industrial sound design, this is an uncommon practice. When it is not done, it is clear that many qualities of the experience and its relations to the context are lost. Notions as to the importance of contextual considerations have gained significant attention across other disciplines. As the anthropologist David Howes puts it: “Bringing the issues of emplacement to the fore allows us [researchers] to reposition ourselves in relationship to the sensuous materiality of the world.” [11]

Regarding creative research for new products, it is valuable for sonic interaction designers to have some understanding of the sensing and actuating potentials of new technologies in order to use them in their exploratory practices. Until now, such technologies have not been extensively applied in most areas of product sound design, and interaction designers have often had limited training and experience with sound. A further broadening of exposure to such tools is called for on both sides. Collaborations and the exchange of ideas between researchers in auditory display, musical interaction design, and product interaction design seem also to be of substantial value.

1.4.2 Complete Documentation

Audiovisual documentation from the workshop, as well as lecture slides and other supplemental materials, may be viewed and downloaded from a dedicated wiki whose URL is:

http://sonic.wikispaces.com

1.4.3 Future Plans

The organizers plan to conduct further workshops around this subject, building on the approach that has been developed in the CLOSED workshops. As it has proved to be a revealing and inspirational experience, linking design education, creative ideas for new sonic interaction design concepts, and a wealth of information in the form of documented field cases (several hundred), we are looking forward to future iterations, and to sharing the results, and reflecting on them collectively, with members of the sound design community.
2 Case Analysis of Sonic Feedback and Action in Everyday Contexts

2.1 Introduction

Bill Verplank is credited with once having asked the question (paraphrasing): “Why can’t I be as expressive with the computer as I can in the kitchen?” The present section can be read as a formal study that aims in part to illuminate this question, by gathering rich data from just this context, toward informing the design of new computational artifacts that produce sound.

In the real experiences of sound production through action with everyday objects, a number of complex relations between artifact, action and sound coexist. These relationships cannot always be addressed through existing design approaches that are focused solely or primarily on sound. This study focuses on understanding the elements that compose an action, and the ways in which sonic feedback shapes performance in different stages of an interactive experience. Through field studies with an adapted version of hierarchical task analysis [4] we investigated everyday interactions in a kitchen environment. This part of the current report describes the aims, the main questions that were explored, the methodology that was used, and the main findings. This study is available in a more comprehensive form, illustrated with transcripts from several examples, at this URL: http://actionanalysis.wikispaces.com

2.2 Aims

From the outset, the aims of this analysis are the following:

To concretize the relationship between sound and action, using objects and processes from the kitchen context. A central aim of this action analysis is to consider action and sound as applied to a concrete everyday scenario. The kitchen setting was chosen because it is one in which a variety of actions are performed with a range of tools, whose form, material and function of the latter are varied, offering the opportunity to utilize different actions and generate various sounds.

To explore and experience directly the importance of everyday sound for action. As designers it was our goal to learn through experience and observation in a structured and methodological way. Therefore we chose to use ordinary cooking activities in our own kitchens as the material of these investigations. By collectively analyzing the video documentation so obtained afterward, we were able to reflect upon our own experience and on those phenomena that were encountered. This was an important inspiration for future designs and scenarios described below.

To understand the relation between function, task, action and sound. A goal was to investigate, how the device’s function, the intended task and the resulting action correlated. Also it was important to find out what kinds of actions could be identified in a specific context. Most importantly, the intention was to explore how sounds relate to the functions, tasks and actions, in order to discover connections that might be used in our later design activities.

To gain insights into the significance of context. The specific context that was explored is domestic, and encompasses an array of social situations (cooking alone, with friends, with family).
To produce a critical mass of documentary material on sonic actions. This material can be used for further research, design-creation, and reference.

2.3 Methodology and Development

The selection of specific interaction scenarios weighed heavily the degree of manual interaction with the tools involved. The kitchen tools we focused upon range from simple manual tools, such as knives or spoons, to mechanical tools with moving parts, such as garlic squeezers, and finally to the vast array of electromechanical kitchen appliances, such as toasters, coffee grinders and blenders. The latter of course possess interfaces separated from their mechanisms, while in the first two groups the operation is more transparent, as the action and its effect are directly linked. Moreover, sound is also generated through chemical and physical processes (fizzing, boiling, cooling down) in electronic appliances such as the stove, or the freezer. Due to the focus of our research on design for action, we did not include such processes in our study, as they did not involve performative engagement from the side of the user.

This field study began with video documentation of a number common cooking activities. The recordings were done with a single video camera and one microphone placed close to the interaction locus, so as to be able to capture sonic details. The cases so examined resulted in forty eight individual video documentations of kitchen processes, with the recordings ranging in length from approximately twenty seconds to a few minutes. These recordings were archived to be viewed and heard at the wiki [http://actionanalysis.wikispaces.com](http://actionanalysis.wikispaces.com)

The analysis process consisted of three main parts: the action analysis, the sound description and an assessment of the relevance of sound for action. In order to find the appropriate way to describe an action, we performed background research on action and task analysis. The action analysis consisted of a decomposition of the task into smaller task and action primitives, similar to the decompositions used in task analysis for human factors engineering [4]. It also included a detailed description of the ways the action is performed. Action primitives were identified as those actions which repeatedly appeared in a number of studied examples, and to which no specific meaning could necessarily be assigned when isolated from each other or a task context. The sound descriptions were based on common methods from psychoacoustics, from musical sound, and from ecological everyday sound categorization [8] (see also the prior report in deliverable 2.1 by the University of Verona), along similar lines to the approach used the exercises conducted in the workshop described in Part I. Evaluation of relevance of sound for action was based on a subjective accounting of the phenomena observed, with hypotheses formulated as to what sounds meant for our performance in the relevant situation. Revisiting the situation through documentation with the sound removed provided valuable knowledge toward demonstrating the existing value of sound in relation to action, as well as toward revealing new design opportunities (for example, those in which the sound produced in interaction is of rather low volume).

2.3.1 Action Analysis Description

The action analysis for each task was formulated in terms of a range of descriptors of different qualities.

**Force** Judgment of whether a force was relatively small or big is based on subjective evaluation. It also includes the sense of speed describing whether the person perceived it as a short energetic movement or a long powerful one.

**Duration** The force can be used very shortly, repeatedly or steadily.

**Type of manipulation** Describes the way the object is handled (holding the object with one or two hands, holding the object with lips and hand).

**Form and configuration** Weight, size, structure, surface properties (slippery, hot, rough) and other physical properties of the object that affect the action.
Related to the description of aspects of force and energy, we also investigated the use of musical notation, such as signs for piano (p) or forte (f), diminuendo (> or crescendo (<). We found this appropriate, because this already describes a type of physical energy put into a note or a melody. Such notation systems for action-sound relationships may be important to explore further as they seemed to hold potential for accelerating the process of analysis. Also, they appear to be a useful toward relating sound descriptors (envelopes of pitch, loudness, amount of noise, rhythmic patterns) to action descriptors (manipulation or process envelopes). This connection may be achieved through parameters which may applied to both sound and action such as a force descriptors.

2.3.2 Sound Description

The modes of sound description that were used included primarily the following:

**Psychoacoustic descriptors** Pitch, perceived loudness, timbre, roughness, brightness

**Aspects of time** Duration (very short, short, a few seconds, longer), development over time, envelope (attack, decay, sustain, release) speed

**Rhythms** Rhythm of vibration, rhythm of repetition of sound events such as bouncing

**Sound source** Aerodynamics sounds, liquid sounds, vibrating solids, fire sounds, specific movements of the source causing a sound (vibration, bouncing)

**Other description** Associations, onomatopoeics (squeek, whoosh, clack)

In the sound analysis, it is important to be aware of the fact that in addition to the sound, silence is also salient for affecting action.

2.3.3 Relevance of Sound for Action

A sound is considered relevant to the action, if it is associated with executing the action, either by being tightly coupled to it or as a sonic sign which would affect an action.

**Direct vs indirect** Sound in such interactions may be direct (when grating a carrot, the sound is directly linked to the movement of the hand) or indirect sound (when the action triggers another movement, that produces sound, like closing a cupboard).

**Continuous versus discreet** This contrasts continuous processes with discrete sound events (putting a glass on a table). The occurrence of the sound influences the way the action is exerted.

**Manipulative action vs. the initiation of action** In the latter case, an action may start or trigger a self running process. In both cases the sound can be related either to the action itself, or to the process, or to both.

2.4 Analysis Examples

Following are excerpts of three action analysis transcriptions. In the transcriptions we used the following abbreviations:

**Abbreviations used to describe actions**

AD Duration of action in seconds (approximate value)
AE energy excreted during manipulation

**Abbreviations used to describe sounds**
**MS** Manipulative sound (sound as a result of direct manipulation and processes directly linked to it, can be produced by the interface itself or the medium being influenced through the interface)

**AS** Automatic (machine) sound - (sounds from events or processes not linked to a direct manipulation)

**NS** No sound

**Abbreviations used to describe relevance to action**

**NSf** Not very relevant or strong sound feedback for action (like wobbling of the coffee maker top while moving it from one place to another or)

**RSf** Sound feedback relevant for action

### 2.4.1 Preparing Coffee

This process transcript is an excerpt from a longer action/sound analysis.

![Image of preparing coffee](image_url)

**Figure 2.1:** A frame from one audiovisual documentation of the act of preparing coffee.

Step 1. Unscrewing the coffee maker

1.1 Taking the coffee maker with two hands
   1.1.1 Wobbling of the coffee maker top

1.2 Exerting a lot of pressure until the top part starts turning
   1.2.1 Pushing 2 parts in the opposite directions (AD: few sec. AE: high)
     • **NS**
   1.2.2 Release of the screwed parts (AD: less then a sec. AE: dropping)
     • **MS:** short sound at the end
     • **Relevance for action:** the sound communicates the release of the energy that is felt though action

1.3 Turning the top part three times with one hand (grasp, turn, release, grasp in a different place, turn, release), while keeping the bottom with the other hand
   • **MS:** unscrewing sound. longer, repetitive, friction between 2 metal parts
• Relevance for action: the looseness of the two parts can be heard (At the beginning I keep the bottom part strongly and the top part I turn, release and grasp in a different position, then repeat. As this process comes to an end I can hear when I need to keep the two parts strongly because they are separating). The continuity and speed of action are audible.

1.4 Separating the two parts (AD: short. AE: medium)
• MS: opening sound, continuous sound interrupted by silence
• Relevance for action: the action is finished, the task accomplished

2.4.2 Peeling Carrots

This process transcript is an excerpt from a longer action/sound analysis.

Figure 2.2: A frame from one audiovisual documentation of the act of peeling a carrot.

1. Push onto the bottom of the carrot with the peeler
2. Pull/slide toward the top end of the carrot until the peeler touches the thumb.
• MS: sound of cutting into the carrot and scraping its surface
• Relevance for action: provides feedback about the speed of action, depth of the cut, eventual irregularities of the carrot surfaces
• MS: sound of wobbling metal
• Relevance for action: provides feedback of how controlled the movement and the contact between the carrot and the peeler is.

2.4.3 Grating Carrots

This process transcript is an excerpt from a longer action/sound analysis.

1. Push the carrot onto the surface of the grater
2. Slide the carrot down while pushing strongly onto the surface of the grater (AD: few sec. AE: high)
• MS: the sound is louder when pushed in this direction (top-bottom).
• Relevance for action: the sound accentuates the haptic feedback of the carrot encountering the bumps of the grater and passing through them while being cut.
3. Slide the carrot in the opposite direction to come back (AD: few sec. AE: low)
Through the process of analysis we identified a number of action primitives that were relevant to
the processes investigated here. Some actions observed were notable as having appeared in a num-
ber of studied examples. Separated from their context, these actions had no specific meaning. We
grouped the actions that were uncovered into two categories. Those which cannot be decomposed
into smaller actions perceived by the performer as actions we call basic action primitives. These
included directional movement and pressure (push, hit, slide), embracing pressure (squeeze, grasp),
displacing while holding (elevate, put down, remove) and rotation (tilt, turn, spin). Composed actions
are those actions which can be split into basic action primitives. For example, pulling is composed
of squeezing and moving in a certain direction, and picking something up is composed of embrac-
ing, squeezing by keeping constant pressure, so the object doesn’t fall out and finally displacing. A
complete inventory of these actions is available in the complete documentation of this study, at URL
http://actionanalysis.wikispaces.com

The actions and action primitives discovered in this study facilitated our design process, and al-
though we were not able to compile a taxonomy of such design elements, we believe it is a complex
but necessary research for establishing the design for action approach to everyday interactive product.
The action and sound examples that were gathered proved useful as source material generating ideas
for abstracted sound artifacts described in Part 3, in the spirit of basic design.
3 Scenarios and Concepts for Sonically Enhanced Products

3.1 Introduction

The final component of this CLOSED deliverable consists of a set of design concepts for sonically augmented, abstracted sound artifacts. The complete set of these concepts is available at a dedicated wiki whose URL is: http://sound-scene-storm.wikispaces.com

The broad aim of this activity is to present a set of concrete examples, each illustrating a sonically-enhanced abstracted artifact. At their most basic level, the examples are composed of a physical artifact, a basic mode of interaction (action primitive or primitives), a sound design that expresses this action, and a task and context that unifies these characteristics in a compelling way. As we discuss, additional elements are needed to bind these attributes together into a functional and cohesive interaction – most notably, appropriate control mappings linking action to sound are needed.

A more concrete aim of this activity is to identify scenarios that may be best suited for use in the CLOSED research cycle – that is, toward integrating the physically based sound models, tailoring with the predictive measurement tools, and conducting the human reception experiments. Toward this end, the designs here will serve to focus immediate discussion on those examples (or variants thereof) which will be most effective in pursuing this research.

Finally, the concepts that have been developed are a vehicle to communicate the vision CLOSED proposes for future sonic interaction design to the wider design and research communities that may be interested. HGKZ has the aim to further refine the presentation of these examples and to organize their inclusion in a relevant design-oriented print publication. In addition, these provide a range of directions for the sound product prototype that will be developed to exemplify the CLOSED process at the end of the project, in deliverable D3.3.

The current report largely avoids discussion of technical details that will arise in the realization of the artifacts concerned. Such issues range from industrial design considerations (materials, processes), to physical computing in sensing (sensor selection, integration, signal conditioning and acquisition) and actuation (mechanical design, actuator selection, signal transmission), and software integration (control and sound synthesis models, task implementation, hardware interfacing). A few of the issues involved have, however, been noted in the comprehensive scenario documentation on the wiki noted above.

3.2 Control, dynamics, and task

One critical facet of the variety of sonic interaction design exemplified here is not apparent from the descriptions alone. It concerns the nature of the mapping from the physical affordances of the artifact to those parameters that control the sound synthesis algorithm (or indeed, other sources of real time feedback supplied by it). As noted in Part 1, determining such mappings (or defining criteria to guide their design) constitutes a significant outstanding problem in the highly related domain of digital musical instrument design [12].

In this section, we briefly note some of the control mapping challenges that are particular to the design context addressed in the CLOSED project, and describe strategies that we have begun to adopt toward meeting them. Work in this area is expected to be an ongoing collaboration between the CLOSED partners. Currently, work between the HGKZ and the University of Verona on control
models for the Verona crumple synthesis model has been initiated. A new initiative to develop a tool based on machine learning algorithms (perhaps reinforcement learning) to assist automated control mapping design is being explored by the group at TU-Berlin in collaboration with HGKZ, focused initially on a pouring-bottle scenario. This latter initiative poses a significant challenge, because the required mappings may, in general, be both nonlinear and may possess temporal state, a problem that intersects with the field of nonlinear systems identification.

### 3.2.1 Control mappings from physical artifacts to physically-based sound simulation

The control mapping task in many of the concepts developed here is both strengthened and simplified due to the fact that the setting involves the mapping of physical affordances of an artifact (tilting, crushing, rotating) to sound synthesis models that are based on the simulation of a physical event or process (friction between two objects, collisions of many small particles, the dripping of water). This facilitates the development of a mental model that associates the action with the resulting sound in a way that leverages users’ abilities to readily intuit the action-perception linkages in real-world physical interactions. Such mappings may be thought of as conceptually direct.

**Example: Crushhh**

This concept (Table 3.1) involves a cylindrical object that is to be compressed from an initial height to a smaller height. The user accomplishes this by applying a force to a top surface, while the second surface rests against another solid (table or similar). The accompanying sound is envisioned as similar to the crushing of a loosely packed material, thus reinforcing a mental model of the cylindrical object as the container of some virtual material that is in fact being crushed by the user. Control of the crumpling model is facilitated by prior work on a crumple control model at the University of Verona which was further extended by HGKZ (in work to be described in a subsequent report) by means of a stochastic model for mapping an input force signal (pressure applied to a tile on the floor) to the event density of a stochastic process for producing crumple events. The Crushhh scenario differs to the extent that in it crumple control is to be effected through a mapping of the change in height of the cylinder to a similar crumple event distribution.

### 3.2.2 Action, dynamics, and task

In other cases (e.g. the Whiskie scenario described below), it is desirable to integrate modes of interaction that do not merely involve the manipulation or change in the configuration of the artifact, but which may also depend intimately on the temporal qualities of the change that is effected. More generally, the mapping might depend on some notion of internal state of the system. In such a case, one would like the sonic feedback to be appropriate not only to the physical manipulation that is performed, but to the salient quality of its performance relative to the afforded action. Moreover, if the performance is linked to some higher-level task, composed of a sequence of actions or a sustained action, for example, then one would like the sonic feedback to likewise be salient to performance of this task.

One strategy we are adopting toward accomplishing this is to encode the informational state of the interaction with the artifact by means of a simulated dynamical system whose moving elements can be associated to physically-based sound models, in a way that might be either conceptually familiar or otherwise. In some cases, this might suggest that the composite dynamics and sound synthesis algorithm together constitute a higher-level sound model (similar to certain models, such as crumpling or rolling, that have already been developed at the University of Verona). In other cases, the control dynamics might be better seen as an intermediate mapping layer that lies between the synthesis model and the artifact or input device, such that the separate mapping level dynamics recapitulates performance on the task involved in some way.
Example: Spinotron

The Spinotron (Table 3.1) involves an artifact that must be rhythmically pumped to energize it to a certain level. In one of the envisioned tasks, users attempt to energize the device to a given level and sustain that level of energy within a certain range for a certain amount of time. The sound design is to be composed of the rolling sounds produced by of a number of hard balls. The control dynamics is based on the notion that the user is causing a cylinder inside the Spinotron to rotate by pumping, and that it is on the floor of this (vertically oriented) cylinder that the balls are rolling. (The display of information relevant to controlling a continuous process by means of the sound and mental model of a virtual rolling ball was investigated in the prior Sounding Object project [18].)

3.2.3 Movement analysis

Beyond the cases noted above, in which the task affordances may be encoded in the internal dynamics of the control model, it is sometimes desirable to extract continuous performance measures directly from the sensed actions of the user, in order that these measures may be used in controlling characteristics of the continuous sonic feedback that accompanies these actions (eg. the Whiskie, below). The controlled characteristics might be any parameters relevant to displaying the desired measure. A related problem is to infer aspects of the nuance with which an action is performed, so that this may be reflected in the nature of the output (eg. the digital ink in the Shape Shaker, below). The problem is then to design a computational algorithm that is capable of computing the desired measure from the input sensor signals in real time. Appropriate methods range from signal analysis techniques (signal statistics, peak detection, correlation measures, spectral measures), energetic measures, and various methods for tracking a movement relative to a template, path, or prior model. A detailed discussion of this subject exceeds the bounds of the current activity, but we will return to it in the next stages of this research.

3.3 Selected Scenarios

What follows is a summary of a selection of the sonically augmented artifact concepts that have been generated so far. As noted above, more examples and more complete documentation may be viewed and downloaded from a dedicated wiki whose URL is: http://sound-scene-storm.wikispaces.com
<table>
<thead>
<tr>
<th>Title</th>
<th>Summary</th>
<th>Sound</th>
<th>Interaction Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crushhh</td>
<td>An empty vessel to be crushed, compressed to a (predetermined) smaller vertical height.</td>
<td>Metallic or plastic crumpling; liquid vapor coming under pressure and escaping</td>
<td><img src="image" alt="Interaction Sketch" /></td>
</tr>
<tr>
<td>Spinotron</td>
<td>A device that one rhythmically pumps to energize or pressurize it, via a piston that must be compressed at a regular rate</td>
<td>Rolling particles in a cylinder recapitulate the “energy level” of the device. Possibly sounds of liquid/gas pressurization</td>
<td><img src="image" alt="Interaction Sketch" /></td>
</tr>
<tr>
<td>Nuke Tea</td>
<td>A shake-able, liquid-containing, self “heating” cup. One shakes it in order to energize it, and upon sufficient excitation, the cup heats up, glows, or otherwise becomes charged with energy (see also Shake-ometer, below).</td>
<td>Sound is based on collisions between virtual particles and walls of the vessel. Liquid sounds are excited by the particle movements.</td>
<td><img src="image" alt="Interaction Sketch" /></td>
</tr>
<tr>
<td>Tea for 2</td>
<td>A pair of glasses for a pair of partners, who share the goal of drinking at the same rate, or of being aware when the other is doing so. Sonic feedback through one glass is provided in response to the drinking of the other glass. Association is initiated with a toast.</td>
<td>A virtual ice cube liquid sounds when the parter drinks. The sound may be one or more of the following: a resonant “singing glass”, glass impact sound, or liquid drinking sound. Informs about the partner’s drinking state, and possibly the amount of liquid remaining.</td>
<td><img src="image" alt="Interaction Sketch" /></td>
</tr>
</tbody>
</table>

Table 3.1: Selected scenarios and concepts.
<table>
<thead>
<tr>
<th>Title</th>
<th>Summary</th>
<th>Sound</th>
<th>Interaction Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portapump</td>
<td>A portable device for pumping and processing liquid, possibly from impure sources. To operate it, you stomp on it repeatedly with the foot.</td>
<td>Liquid and/or aerodynamic sounds recapitulate the “quality” of the liquid, as measured along several metrics. Sounds become rougher, more wheezing, when quality is lower, as if choking on the “pollution”.</td>
<td><img src="image1.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Batterer</td>
<td>A batter-squeezer. Assists in depositing a fixed amount of glutinous or gelatinous liquid (“batter”) from a reservoir onto some surface, into a cavity, or into a mould.</td>
<td>A cavity excited by air bubbles entering through a viscous/lumpy fluid. Sound provides feedback about rate at which batter flows. It might exhibit changes in relation to the total amount that has been deposited.</td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Exactopour</td>
<td>A vessel or a bottle, used to pour exact amounts of liquid, independent of the size or dimensions of the destination vessel.</td>
<td>Pouring. The sound of filling an empty cup to its end. The sound provides information about the quantity of the liquid to be poured.</td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Autostair</td>
<td>A compact platform that can lift you up. You walk in place on an ordinary-looking tile. As a result, the tile rises into the air. A pause and a stomp later, the tile gently descends back to ground level.</td>
<td>The sound provides feedback about the relation between the firmness of walking-in-place, as registered, in relation to the rate at which the personal elevator platform rises in response. The sound may be similar to an inflating balloon, with a mental model based upon a pneumatic rubber tire or jack. Alternately, the sound might be more like walking on wooden stairs.</td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Shakesometer</td>
<td>A handheld implement with its own, integrated renewable energy source. You shake it a bit to hear a sound, telling you how much energy remains. You may shake it (significantly) more to charge it.</td>
<td>The sound is of gravel or small grains being shaken in a small container. Depending on the device’s actual material (plastic, metal) the sound may vary. If the energy source is near empty, one hears only a few “grains”, if it is full, one hears many grains.</td>
<td><img src="image5.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

Table 3.2: Selected scenarios and concepts. For complete descriptions, see http://sound-scene-storm.wikispaces.com
### Summary Description of Sonically Augmented Artifact Concepts

<table>
<thead>
<tr>
<th>Title</th>
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<th>Interaction Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prospector</strong></td>
<td>A two handled pan, bowl, or other vessel. Handles on either side. Used to “reveal” its contents, to “filter” them in some way, bringing certain ones to the fore, others to the background, removing clutter through a cleaning/filtering motion.</td>
<td>Sound could be one of the following. Rolling: A virtual ball or balls in the pan rolls along its surface, the sound changing as it rises to a higher trajectory on the side of the pan; Sloshing of water within the pan, and over its real or virtual contents (in a virtual way).</td>
<td><img src="image" alt="Prospector" /></td>
</tr>
<tr>
<td><strong>The Whiskie</strong></td>
<td>A stirring implement that assists its user in manually stirring in a perfectly uniform manner.</td>
<td>The device produces a sound that becomes more harmonic or more regularly rhythmic as the movement is performed more closely to an ideal, specified as a periodic trajectory of some shape. Two possible aesthetics: A polyrhythmic pattern transitioning between the physical sound produced by the whisk and an augmented sound related to it; a more harmonic sound.</td>
<td><img src="image" alt="The Whiskie" /></td>
</tr>
<tr>
<td><strong>Sipper</strong></td>
<td>A straw or tube for drinking in a way that is sensitive to the type of liquid being taken in.</td>
<td>Water or aerodynamic flow. The sound provides information about the liquid entering the straw, similar to the portable pump, described above. As the type, quality, or substance of the liquid changes, the sound likewise undergoes a change to reflect it. Sounds become rougher due to variations in liquid quality (color, opacity, contents, contaminants).</td>
<td><img src="image" alt="Sipper" /></td>
</tr>
<tr>
<td><strong>Shape Shaker</strong></td>
<td>A device or vessel that you shake to deposit digital color onto a surface in a locally directed way.</td>
<td>Shaking, as if particles inside shaking vessel. Alternately, liquid sounds, like paint splattering. Sound provides information about how much color has been deposited by a given shake.</td>
<td><img src="image" alt="Shape Shaker" /></td>
</tr>
<tr>
<td><strong>Liquid Sound System</strong></td>
<td>The device resembles a bottle or other pouring vessel. The act of pouring into a receptacle initiates or augments sound emanating from the receptacle.</td>
<td>Direct layer: responsive water or other continuous medium that indicates how much sound has been poured. Secondary layer: the sound that is excited in the destination vessel. The secondary sound layer persists in the destination vessel until it is extinguished.</td>
<td><img src="image" alt="Liquid Sound System" /></td>
</tr>
</tbody>
</table>

Table 3.3: Selected scenarios and concepts. For complete descriptions, see http://sound-scene-storm.wikispaces.com
<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th><strong>Summary</strong></th>
<th><strong>Sound</strong></th>
<th><strong>Interaction Sketch</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Twistcaffe</em></td>
<td>It is a vessel with two halves that screw shut into one another, forming a seal (as on a caffettiera).</td>
<td>The vessel furnishes assistive sound when being assembled. The feedback informs about the assembly and level of tightness. Rubber-squeaking, friction, metallic sounds.</td>
<td><img src="image" alt="Interaction Sketch" /></td>
</tr>
<tr>
<td><em>Bottle Accordion</em></td>
<td>A liquid container or bottle with handles on either end. Using handles to stretch and compress the vessel allows to control the flow of fluid out of it.</td>
<td>The sound of sucking or fire crackling accompany stretching. Blowing sounds are associated with the speed of compression: if it is faster, more air is pushed.</td>
<td><img src="image" alt="Interaction Sketch" /></td>
</tr>
<tr>
<td><em>ActTwo</em></td>
<td>Two sonic artifacts must be operated in parallel, either by separate hands, or by two people simultaneously. A single person operates <em>Shape Shakers</em> with each hand, or two individuals drink from the <em>Sipper</em> synchronously, or pour from <em>Exactopour</em> simultaneously.</td>
<td>The original sound of the artifact is preserved. An additional sonic information channel (parameter or added timbre) transmits the degree of synchrony.</td>
<td><img src="image" alt="Interaction Sketch" /></td>
</tr>
<tr>
<td><em>The Udder</em></td>
<td>A vessel with a pliable rubber spout serves to draw quantities if liquid from the vessel’s reservoir and deposit it into a target receptacle. It must be milked, in a manner loosely analogous to a cow, goat, or other. A priming squeeze determines the amount of liquid to be deposited, while a sequential contraction of the fingers forces the liquid into the receptacle.</td>
<td>A liquid/aerodynamic sound similar to slurping accompanies the priming squeeze. A squirting noise and cowbell sound accompanies the contractive action.</td>
<td><img src="image" alt="Interaction Sketch" /></td>
</tr>
</tbody>
</table>

Table 3.4: Selected scenarios and concepts. For complete descriptions, see http://sound-scene-storm.wikispaces.com
References


