DATABASE CONCEPT FOR MEDICAL AUDITORY ALARMS

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ABSTRACT

With this paper we want to explore the benefits of an online available database for medical functional sounds and auditory alarms. The concept is inspired by an extensive context research in the medical field and aims to evoke discussion and trigger possible corporations in the future. The database so far exists as a concept design and aims to be realized as a research project in university using funds form the EXIST program [1] and other interested research institutions as well as hospitals.

The database is conceived to be a WIKI based platform, content will be supplied by manufacturers, hospitals and designers, nevertheless aims are to supply an initial baseline of medical device sound sets to show functionality and benefits for the users in the hospital and company context can draw from it. The paper will introduce basic elements of the database, a brief summary of the current situation and outlook on the possibilities when incorporating the database into a design process.

1. INTRODUCTION

The current situation of auditory alarms and functional sounds in medical devices is characterized through a vast amount of poorly conceived sound design strategies. Originally conceived and explored in the eighties and nineties, auditory alarms and simple sonification models proofed to be more efficient than visual or audio/visual displays in terms of reaction rates as researched by Fitch and Kramer in 1994 [2]. Background for our proposals is a research program that has been established by the University of Arts – Sound Studies – Acoustic Communication / Berlin [3] and the Olympus Medical Systems Group [4] in 2007. Part of this research focused on the current situation in hospital operation rooms and intensive care units and the results led to conclusions and guidelines handed over to Olympus pointing towards an effective redesign of their medical endoscopes and electro surgical units in relation to functional sound design.

The concept for the online database derives from this research program and extends it, aiming for a universal applicable design process in this field. The paper will present methods of categorization, documentation and context sensitive design processes using the database as a baseline to develop sophisticated and context optimized sound design for medical devices. Strategies and inspiration from recent researches in the medical field and more design related techniques are incorporated and compiled into the concept of the database.

2. THE MEDICAL SOUNDSCAPE

The acoustic situation in the operation room and intensive care unit is defined by many elements adding up to what is perceived as one of the noisiest working environments as described and explored in an article by Daniel Schrader and Nicole Schrader [5]. To design sound effectively for medical systems the context in which these are used has to be explored entirely. Therefore we have recorded and analyzed several live operations, categorizing all present sounds emitted by devices, other medical equipment and environmental sound sources. Further on we defined a set of "dimensions" to subordinate different aspects of functional sounds and auditory alarms. The categorization model we introduce here does not relate to other models by the likes of Gaver, UNIVERONA or the CLOSED project group. Although the presented terminology and categorization methods in their works can be applied to some of the presented dimensions we decided to focus on the medical context foremost. Regarding future aims like evaluation of the perceived soundscape or possible integration in other database platforms like the freesound project it would be useful to relate the introduced model back to existing and already applied models.

2.1. "Working Sounds"

We define "Working Sounds" as sounds that are emitted by devices when they are activated. For example ventilators built into devices to cool the electronic circuits in the equipment as the ventilation units in endoscopic processors that are a very present sounding component in the OR and add to the basic noise level. Similarly, anesthesia machines and other electronic equipment use fans to cool the electric circuits in their units.

"Bearhuggers" or patient warmers produce a constant airflow and are comparable to the humming sound of an air-conditioner. Disinfection/cleaning devices for medical hardware, similar to dishwashers, also produce working sounds as compressors for pneumatic surgical equipment do.

2.2. "Operation Related Sounds"

We would like to introduce the term "Operation Related Sounds" as a terminology for sounds that have a physical background and are usually energized upon operative usage. We categorize these sounds as functional sounds commonly without a distinct design quality. They transmit information about the functionality of a device without intention but doctors or nurses can rely on this sound as a positive feedback on the functionality of an operative task while they are performing it. Operation related sounds tend to be perceived without judging musical or physical sound quality instantly but still can be felt as being noisy or annoying. These sounds are for example emitted by suction equipment that is used to absorb blood from an operational wound, endoscopic equipment when supplying N2O or fluid to an inner body space to generate an operative space in the patient's body, artificial lungs that supply the patient with air while she or he is under anesthesia, dialysis equipment and electronic scalpels when applying energy to the device in order to perform "cut or coagulate" operative actions. The cutting or coagulating physically burns flesh of the patient's body and this can be heard (comparable to roasting food in a pan). Also pneumatic operative hardware like pneumatic saws, drills or other attachable tools, operative hardware tools made from metal in general that especially produce sound when being used, taken or returned to the hardware table.

2.3. "Hospital Communication/Management Sounds"

"Hospital Communication/Management Sounds" are related to every device used for communication within a hospital surrounding. These sounds are designed sounds and are necessary signifiers in daily hospital practice. Problematic is the intended alarming character that some of these designed devices sounds have. For example doctor beepers/pagers can interfere with auditory alarm sounds of medical equipment that are present in an operation. Even though doctors and nurses will be able to distinguish their pager from an anesthesia auditory alarm these sounds add up to the already loud soundscape of a hospital. Pagers/Beepers, Telephones/Intercom, management computers and printers are part of these devices present and sounding in daily hospital care practice.

2.4. "Designed Functional Operative Sounds"

We define "Functional Designed Operative Sounds" as sounds that are artificially produced and played back through magnetic speakers or piezoelectric units in medical equipment to indicate surgical operative tasks. Such sounds can be found within electronic surgery equipment like electronic scalpels that play back sound while energy is applied to the probe. These sounds indicate an ongoing process and should not be underestimated in terms of significance to the patient's health. They can be distractive if their designed sound properties equal the design of alarm sounds of other, analytical medical equipment like anesthesia machines or patient monitors.

2.5. "Functional Program/Parameter Change Sounds"

"Functional Program/Parameter Change Sounds" indicate change of a program status, a setting change or value change within a medical piece of equipment. They can indicate positive or negative feedback on changing parameters in a device or feedback functionality of keypads, buttons and switches contained in the interface of a device. They can be helpful to double up visual on-screen information but can have a quite annoying effect, too and sometimes even compete with lower priority alarms of other equipment. Taking in consideration that nurses or doctors are facing equipment visually while making parameter or program changes arouses the question whether these interface feedback sounds are necessary in the first place or in certain context situations.

2.6. "Functional Observation Sounds"

"Functional Observation Sounds" sounds are the most present designed sounds that intend to aid monitoring the patient's vital functions. These sounds can be relevant for the anesthesia doctor and tend to be monitored constantly. Changes over time like level, pitch or rhythm are characteristic to these sounds. Patient monitors are common devices in the OR (Anesthesia) or the ICU. The usage and reliance of doctors to these sounds is diverse, some purposely shut them off and focus their attention to the visual display instead, other doctors rely on the information submitted and only focus on the visual display in case of an auditory alarm. Knowledge about the situation emerges from interviews held with doctors during the research process for Olympus.

2.7. "Functional Auditory Alarm Sounds"

"Functional Auditory Alarm Sounds" are the most important sounds that are, depending on the context (OR/ICU/ambulant) more or less present but by any means have to be heard and responded to when occurring. The variety of auditory alarms is wide and almost any electric piece of equipment in a hospital has at least one alarm sound to indicate malfunction, need of maintenance or refill. Even more critical are all auditory alarms directly pointing at patients health problems, they have to be heard and responded to immediately. Different device and manufacturer related alarm concepts like "master caution alarm" systems or - in contrary - continuous monitoring through more advanced sonification models add to the complexity of the matter.

2.8. "Human Sounds"

"Human Sounds" sum up all possible emerging sounds like speech communication between hospital staff and patient physical sounds that should not be underestimated during certain medical processes like endoscopic treatments. Speech tends to be influenced a lot by the surrounding noise level and stress level as well. So far we have not researched this topic more thoroughly but properties of the human voice under different stress levels and hearing performance levels are an interesting topic to look at when aiming for good functional sound design in stressful working environments.

2.9. "Music"

"Music" it is not a myth! Some operation teams like to hear music while performing operations, this is often to mask noise produced by suction or other environmental sounds but, unfortunately, music can mask other auditory alarms and functional sounds too, especially when they are designed to submit their information through melodic and rhythmic encoding. Regarding the IEC 60601-1-8 standard proposal that propagates extracts of popular melodies for usage as auditory alarms, music could be a major competitor to those alarms.

2.10. "Environmental Sounds and Architecture"

"Environmental Sounds and Architectural Properties" are notably an underestimated layer of the soundscape within a hospital. There are air-conditioners, sliding doors and beds and equipment being moved around. All these sounds as well as the ones above mentioned are enhanced by the architectural features as tiled floors and walls in a hospital surrounding an can be summed up as being amplifiers to all present sounds.

All in all these sounding elements add up to a hospital's soundscape. Each and everyone should be considered when planning to design functional sounds, auditory alarms or communication sounds for a clinical surrounding. In order to communicate this situation within a workshop held with the members of the Olympus Imagine Group the team decided on producing a multi-channel sound installation that would be capable of simulating a realistic soundscape of an operation room during an operation while still being able to trigger auditory alarms and other functional sounds of a variety of clinical electronic equipment commonly present during operations. The positive result of this installation within the workshop later on inspired the inclusion of a soundscape player module as a part of the database concept. We will introduce the features of this database element later on in detail.

3. CATEGORIZATION OF MEDICAL FUNCTIONAL SOUNDS AND AUDITORY ALARMS

We organize designed functional sounds in the medical context into eight "dimensions", as we call them, each divided in different layers of depth. The grouping relates to the device properties, priority or urgency mapping, human physiological functions as implemented in the IEC 60601-1-8 standard, sonification models, information on the technical acoustic representation of the sound (sound synthesis), information about who the sound is relevant to and an environmental cue that hints to the soundscape the sound is perceived in and to the patient's state of being awake or sedated. All "dimensions" feature sub-layers that describe the range of possibilities of a dimension. Tagging a device's functional sound set by all these dimensions and their properties can easily be applied through a simple check box system and enable a multilevel search of functional sounds by different contexts. This model to categorize functional sounds closely connects to the medical field, comprehensibility and efficiency have to be tested in relation to existing categorization models by the likes of Walker & Kramer and the with the users (hospital staff, manufacturers, designers).

3.1. Device Functionality Dimension:

- Alarm (patient/power fail)
- Operation (action feedback)
- Status/system/parameter (interface feedback, change of parameter/program) / Aid
- Continuous Monitoring/Observation

3.2. Priority/Urgency Dimension:

- High
- Medium
- Low
- Other/Specify

3.3. The Physiological Dimension:

- Cardiovascular
- Oxygenation
- Ventilation
- Infusion
- Perfusion
- Temperature

3.4. Sonification Dimension:

- Auditory Icon
- Earcon
- Hearcon
- Spearcon
- "Language/Speech"

3.5. Sound Design/Sound Synthesis Dimension:

- Click
- Beep
- Pulse
- Buzzer
- Chime
- Siren
- Sample
- Speech Synthesis

3.6. Technical Acoustical Dimension:

- Electro-Magnetic Speaker System
- Electro-Magnetic Transducer System
- Piezoelectric Module
- Piezoelectric Transducer
- Electro-Magnetic Headphone
- Bone-Conduction Headphone

3.7. The User Dimension:

- Doctor
- Anesthesia Doctor
- Nurse / Hospital Staff
- (Amateur)

3.8. Environmental Dimension:

- Operation Room (OP) patient is under anesthesia
- Stationary, patient is conscious
- Intensive Care Unit (ICU), patient might be conscious
- Mobile / on the road

Organizing medical functional alarm sounds by these dimensions and sub-layers provides a wider view of relevant aspects of functional sound design in relation to auditory alarms. It will make searching for single sounds easier and offer a multitude of directions to approach the topic entirely. Users will be able to start browsing for sounds from the direction of their interest focus. Also the introduced dimensions offer a broad look of the disciplines involved in the process of designing sounds for medical devices, by categorizing a newly recorded or designed sound in the intended way one can draw instant conclusions about the quality and compatibility of the sound to the fields it shall serve in. Analyzing and evaluating auditory alarms using these dimensions can disclose possible flaws in sound design concepts on several levels.

4. THE DATABASE

4.1. Auditory Database Concepts So Far

While conceiving the database for medical functional sounds and auditory alarms we searched for existing databases on the web to learn about structures and concepts. We want to briefly explore two existing databases in this paper: one online sound database for sound in general and another, medical context specialized but hard disc based database.

The online database we explored is labeled "free sound project" [6] and addresses sound from every field except music. The structure of the database and its content relies on users to submit and comment on sounds and, in addition, it features the possibility to respond to submitted sounds (labeled "remix tree") and edit existing sounds and post them in context with the original file. The content can be downloaded and is licensed using the "creative commons" copyright system. The file system of the

Free Sound Project allows users to rate and comment on the sound content, add tags and descriptions to the sound files. Files are named, tagged and described by the user who submits them initially. The database features a waveform overview of the sound file and playback possibilities.

Researching medical alarm sound related databases resulted in discovering only one database exploring medical alarms. This database has been established as part of a study in 2006 by a Japanese university team [7]. The team recorded, categorized and evaluated the alarms of medical electrical equipment within one hospital in Japan. The alarm sound database is delivered in the form of a Microsoft Excel file organized by device category, manufacturer, model name, priority, sound profile, fundamental frequency, sound pressure level, alarm condition, a sample of the auditory alarm and a photograph of each device. It features 41 devices by 28 manufacturers and all alarm sounds of each device, classified by device functionality (as mapped by the IEC 60601-1-8), alarm priorities (high, medium, low and informative) and sound design properties (buzzer, beep, siren, pulse and chime). In addition, an alarm sound simulator ("AlmSS") has been programmed with the ability to play back simultaneously up to 3 sounds of those contained in the database and also it allows the user to design his/her own auditory alarm with the purpose to match the ISO recommendations. The effectiveness of the recorded auditory alarms was evaluated by the hospital staff.

> *"The AlmSS was used in the assessment procedure to determine whether 19 clinical engineers could identify 13 alarm sounds only by their distinctive sounds. They were asked to choose from a list of devices and to rate the priority of each alarm. The overall correct identification rate of the alarm sounds was 48%, and six characteristic alarm sounds were correctly recognized by between 63% to 100% of the subjects. The overall recognition rate of the alarm sound priority was only 27%"*

Conclusions and further goals were to extend the database by auditory alarms of further medical devices and encourage manufacturers to rethink and communicate future design concepts of medical auditory alarms.

In general the idea to use an existing platform to integrate the conceived database is appealing but taking a closer look at concepts and features of the two explored databases reveals certain disadvantages that could keep users from actually using it. First of all the Japanese approach lacks the online accessibility and although it already combines the database with images of the devices and categorizes sounds by medical auditory alarm standards (IEC 60601-1-8) and urgency (High, Mid, Low) the handling and limitation is unattractive for users who want to explore the content intuitively.

The Free Sound Project database is much more appealing to be used as an existing framework to inhabit medical auditory alarms and already features many useful tools like a search function by different parameters, a tagging function and rating as well as commenting options. Nevertheless we doubt that the interface is sophisticated enough to be approached easily by people without a certain affinity to sound and the lack of embedding multi format media content like images and videos is inappropriate for the features that are conceived to be incorporated in the database. Another critical point is the universal content that might mislead certain more specialized users. However the option to use this platform could serve as a secondary solution if the programming of the originally conceived platform cannot be realized due to lack of resources in the first place.

4.2. The Database

The database features medical electronic devices, their auditory alarms and functional sounds. In this respect the organization is hierarchical and each device is listed by name, model number and manufacturer. Adding single designed sounds or single layouts for auditory alarms will be referenced under the topic design patterns and we dive into this terminology in depth later in the paper. In general the database follows the concept of an online WIKI: Each auditory alarm will be treated as a single dataset containing all further information, rich media (audio, images, video) as well as a creation history, discussion forum and rating options. The single datasets will be connected through a tagging system that is context sensitive to the medical field. The database will be structured as follows and features additional elements that are described in more detail:

Context Space:

> This part of the database will be described in further detail in the next part of the paper (see chapter 5), the context space serves as the connection between the single sound and device datasets of the library and enables easy and intuitive access to the database content.

Device Layer:

> This section will display sounds and further information organized by device. Additional information like an image, model number, production year and functionality can be found here. Even if the datasets are conceived to focus a single sound the option to browse sounds by medical device is necessary for a better overview.

Sound Layer:

> This is where sounds can be searched independently of manufacturers and device brand. Listening to sounds in relation to certain categorization parameters like "priority – high" can easily reveal occurring problems. This layer is closely linked to the device layer and the user can easily switch to the complete sound set of the device that features the single sound.

Design Pattern Library:

> The design pattern library is described in detail later on in this paper (see chapter 6). Design patterns can be searched, submitted, completed or edited in this section. The section relates more to general design aspects and shall serve as a source for approved or new design approaches while it is growing, alongside the submission of sound content. Even if this feature addresses foremost the sound designers, interaction designers and technical engineers it can be a useful tool for manufacturers to look for publically approved design solutions when conceiving new devices.

Soundscape Player:

> To listen to auditory alarms in context, a player module has to be supplied with the database that enables the user to drag and drop devices into a virtual space to explore auditory alarms in relation between different devices and a context related baseline soundscape, consisting of the hospital soundscape elements mentioned at the beginning of the paper. At the heart of this users are enabled to test and verify their own design approaches in relation to existing sound design. Additionally, hospital management can test certain auditory alarm concepts before choosing devices to be present in one operation room (OR) or intensive care unit (ICU).

User Area:

> To contribute, rate and comment on devices, auditory alarms and design pattern the user has to be logged in. This also enables the user to organize his submissions and content of the database to his own special interest. Another more advanced feature could allow manufacturers to restrict access to certain device content to a limited range of users, which is not intended at the heart of the open source concept but might persuade manufacturers to participate in the first place and deliver them with an easy tool to gain evaluation data from a limited circle of medical specialists.

Forum:

> The forum page is basically supplies members with the possibility to communicated with each other. Topics can be added and users can contribute to each topic. Aims are to enhance the communication between manufacturers, doctors/pro users and designers.

Glossary:

> The glossary can serve as an extendable baseline for auditory, medical and design related terms. It can be revised by every user whilst growing and can be completed in addition to the content of the database.

The Device, Functional Sound and Design Pattern sections feature a "blog" for each content entry that supplies a history of its creation and the possibility to comment and rate its content.

5. THE CONTEXT SPACE

5.1. The Context Space (C. Fraunberger et al.)

How can content be organized in the most intuitive way possible? Christopher Frauenberger et al. [8] attempt to deliver a solution to this problem. The "context space" delivers a dynamic way to link related patterns on several levels to each other. By adding multiple layers of contextual information to a design pattern (the term "design pattern" will be introduced in the next chapter more precisely) it can link on more than one level to other patterns, making it easier to pinpoint and combine related patterns into a language.

> *"The context space serves as the organizing principle for design knowledge. It is a multi-dimensional space in which design problems, design solutions and design patterns can be classified according their context. According to Fincher and Windsor (2000)* [9]*, an organizing principle for patterns in UI design should provide a taxonomy, means of expressing proximity, means for evaluation and generative power. Similarly, the purpose of the context space is to be able to conceive the design space and efficiently match design problems and design knowledge. Therefore, the context space is not only home to patterns, artefacts and design problems, but also links patterns to other patterns by their location in the context space and provides the syntax to a pattern language."*

We regard the concept of the "Context Space" as introduced by Frauenberger et al. as a very interesting approach towards a dynamic environment to search, explore and syntactically link design knowledge by several dimension with a high usability factor.

5.2. The Medical Context Space

Here we wish to apply a similar but more specialized approach to deal with the special case of medical functional sound design. Even if the design problems might be the same as every other auditory design task, the medical context is far more specialized and the defined space is more effective in relation to this specific context. The categorization attempt made earlier when breaking down the database sounds into eight dimensions and layers can serve as a blueprint for creating a sophisticated and easily applicable tagging system based on the dimensions and their properties within the medical functional sound context space. The layers in each dimension will describe the relation of the pattern to other patterns and provide an easy way to describe and tag sounds and patterns instantly upon their submission. In these terms the user can observe the relation of sounds and patterns to each other like a dynamic syntax establishing connections between related datasets. The eight dimensions introduced earlier are:

1) Device Functionality Dimension

2) Priority and Perceived Urgency Dimension

3) Physiological Human Data Dimension

4) Sonification Dimension

5) Sound Design/Sound Synthesis Dimension

6) Technical Acoustical Dimension

7) User Dimension

8) Environmental Dimension

In addition to the eight organization dimensions for functional sounds in the medical context, we want to introduce two more dimensions that relate to the "super-patterns" introduced in the next part of the paper. They link and complete the context space to other design disciplines like human interaction / human computer interaction (HCI) design and graphical user interface

(GUI) design. Hence, we want to add point 9 and 10 to the context space:

9. The Visual Dimension (GUI):

- Monitor/display (dynamic content / needs attention)
- Numeral display (dynamic content / needs attention)
- LED/light feedback (might attract attention)
- No GUI present

10. The Interaction Design Dimension (HCI):

- Response required (alarms of any priority)
- User action / input (feedback on action)
- Setting / parameter change (feedback and approve)
- Continuous Monitoring of a task (i.e. anesthesia)
- Other/specify

6. DESIGN PATTERN LIBRARY

In addition to the database and its embedded context space that allows users to submit and explore medical functional sounds and alarms a design pattern library should serve the needs for new and collaborative design approaches.

6.1. "A Pattern Language"

Design Patterns are a kind of vocabulary (or in combination: a language) meant to document design problems and its solutions for later reuse as well to enrich information transfer between designers, engineers and users. The term originates from the book title "A Pattern Language" by Christopher Alexander [10]

> *"The elements of this language are entities called patterns. Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice." [10]*

The book compiles a set of 253 patterns that are exclusively architectural based, in combination with each other they should supply the reader with solutions to almost all architectural problems she or he could run into. The combination of the single patterns that each carries a name/title as a header adds up to a language. At the time, Alexander received a lot of criticism about his approach from within the architectural field for being restrictive to creativity. The only architectural project that has been realized upon the usage of these patterns has been conducted by Alexander himself and is documented in the book "The Oregon Experiment" [11].

This book, in combination with "A Pattern Language" and "The Timeless Way of Building" [12] build a trilogy and are connected as a philosophical, conceptual approach and practical effort to architectural and connected social issues. Incidentally, they were published in the opposite order Alexander refers to when organizing them by volume one, two and three starting with "The Timeless Way of Building" continuing with "A Pattern Language" and finally "The Oregon Experiment" which reflects his ideas about the creation of design patterns and their usage later on as a form of progressive language.

The books did not gain a lot of attention and popularity at the time of their publication, nevertheless, years later the concept found a revival in software programming with the publication "Design Patterns" by Erich Gamma et al. [13]. The book describes recurring problems and solutions in object-orientated programming languages (like C++ or Java) and is divided into two parts, one describing and exploring benefits and tasks of object-orientated programming languages as well as supplying a case study of a design patterns syntax and how to use a design pattern. The second part is a collection of design patterns categorized by "Creational Patterns", "Structural Patterns" and "Behavioral Patterns". The last part "Behavioral Patterns" already implies the later on very popular usage of design patterns as a design tool in human computer interaction (HCI) design and user interface (UI) design.

6.2. Multi Modal "Super-Patterns"

We would like to approach this problem and offer a frame set for a multi modal pattern library that copes with design problems on the auditory, visual and interaction layer. The framework for a design pattern will feature three categories, similar to the ones found in the context space:

Sound

Graphic

Interaction

Sections for the name, problem description and context will be the same in each category. Nevertheless the solution offers a distinct way to approach a special field of design (for example interaction design) and the rationale will draw from the knowledge and expertise in that particular field. We call these specialized frames "X Design Solution" and "X Design Rationale" adding the name of the discipline in question. Although it is possible to submit a suggestion that covers all three designs categories it is also possible to supply a suggestion that applies to one design field only. The overall solution, rationale and example can be added later on when the pattern is rewritten.

The aim for interdisciplinary design concepts is the driving force of this frame set and in this respect we would like to add three more frames to each design pattern named "Super" following a description of a solution, rationale and example. We don't expect "super patterns" to be completed instantly upon the initial creation of the pattern but to be revised and rounded-off in teamwork.

6.3. "Beta-Patterns"

It is common knowledge that design patterns should not be recognized and documented by the creator. Nevertheless in this case hardly any patterns exist and therefore we recommend designers to submit their design solutions themselves as well. Another unwritten law is that a pattern is only a pattern when it has been applied and used several times successfully. We think that this is a good practice and should be kept up, although we would like to additionally open up a space entitled "Beta-Patterns" for patterns that have so far not been applied. This space or rather "Beta-Check-Button" is meant to encourage designers to create and think of new problem solutions as well hinting at users to explore and comment these beta patterns. As with good software, beta versions supply the creator with worthy feedback from experienced users to enhance and develop her / his creation further.

6.4. "Collaborative Design Patterns"

As in collaborative projects, a design pattern can be developed further and enhanced for the usage and throughout a lifetime a "super-pattern" might be rewritten and enhanced by the participation of a huge group of users. Accordingly, a creation history of the pattern is crucial and in order to work interdisciplinarily in a team structure, a place for exchange has to be supplied. Each "super-pattern" will have its own blog or history page that follows the evolution of the pattern and supplies a space for exchange when a pattern is created in teamwork.

6.5. The Pattern Syntax

The pattern library syntax will incorporate the following sections that are inspired by existing design pattern collections like Yahoo's [14] pattern library for instance:

> Pattern Name: Naming a pattern is an important task, not only will the name be one link to the pattern when searched for but also it has to be suitable in the sense of creating a language when combining more patterns with each other. The name itself should be descriptive and submit the aim of the pattern in the most understandable way. Users will decide on taking a closer look inside the pattern's content when the name successfully represents the problem and solution they are looking for.

> Problem Description: Taking notice of a problem and describing it in a few words already delivers parts of the solution. A problem description should be brief and expose the problem's nature immediately.

> Context Situation: The situation that the problem is linked to and where the solution delivers improvement. The context also hints at the solution of the problem as many problems are initially caused by the designer's misunderstanding of the context in which hers / his design is used. In any case, a refined description of the context is valuable to the understanding and successful implementation of the pattern.

This part of the pattern description is exclusive to all three design categories and offers space to deliver distinct design expertise on the special layer of design. (ID) interaction design, (GUI) graphic user interface and (SD) sound design solutions, rationale and examples will be added here.

> ID/GUI/SD Solution: The solution delivers all valuable information to solve the problem entirely. It is formulated in an easy manner to guarantee wide understanding across different knowledge bases and disciplines.

> ID/GUI/SD Rationale: Solving specific design problems often incorporates a certain expertise and background knowledge. The rationale sheds light on the background and techniques incorporated in the solution to the problem.

> ID/GUI/SD Example: An example is crucial, not only to validate the efficiency of the submitted pattern, also an example implicates the solution itself. In the realm of sound an example would be deliverable as a sound file but adding additional information visually might help to abstract and communicate the solution on more than one level.

This part of the pattern framework envisions the interdisciplinary super structure of the pattern library:

> Super Solution: Here the creators can describe the multi modal approach to the problem and its solution.

> Super Rationale: The pattern creator or the team supplies background knowledge on how to integrate each design discipline to a "super solution".

> Super Example: If an example exists that follows a multi-modal approach it can be submitted here. For instance the example will be video, multi media based.

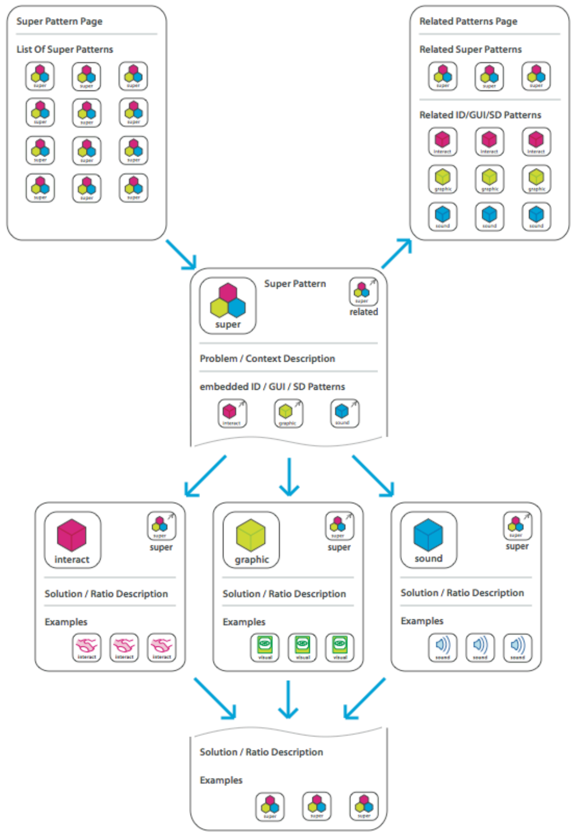

Figure 1. *Shows the structure of a "super-pattern".*

7. CONCLUSIONS

Regarding today's situation in hospitals and their soundscapes opens many ways for possible intervention and enhancement. Medical devices in this context are sounding objects that influence the soundscape to a large extend and shape its quality for patients and doctors. Although if the sounds physically produced by devices (previously categorized as "Working Sounds) are not explored further on in this paper manufacturers should still aim to reduce the noise levels emitted by their devices. Within the research project for the Olympus Medical Systems Group we explored the acoustic quality, meaning and the current state of auditory alarms, pointing out that the actual situation is determined by medical device companies which, with more or less effort, design and conceive the auditory communication of their devices. The lack of effective standards and in depth design knowledge in the auditory realm is part of the problem. Other research groups have focused on these issues more extensively i.e. Sanderson et al. [15]. As a reaction to the situation we introduce two contributions to the field of auditory alarms within the medical context: One is the database for auditory alarms and functional sounds, the other is the contained and closely connected design pattern library, introducing multimodal "super-patterns". Both services are supposed to enhance interest, knowledge and foremost communication linking manufacturers, users and designers of various disciplines to each other. At this point in time, this is still on a conceptual level. The proposals that we submit with this paper have to be implemented in the next step and evaluated by the users of the platform.

8. DISCUSSION AND FURTHER PROCEEDINGS

Efficiency and usability of the database still needs to evaluated and confirmed by programming the database in the next step following the proposed concept. The quality of the user interface is one crucial aspect, determining the success of the proposed concept. Beta versions of the database will most likely need further reprogramming and extension of features requested by the users.

In addition the role of the manufacturers is crucial by the means of constant supply and richness of the content. Corporation policy regarding open source content made available to a wider public is a critical stake for the database. Convincing manufacturers of the benefits they will draw from making content available will be challenging, by these means we intend to supply a baseline of content in cooperation with hospitals and ask for support of hospital management and doctors.

Thinking of evaluation and scientific studies one can regard the concept of the database as a tool in addition to scientific based research. On the one hand side the availability allows collective ratings and comments from a wider user group by evaluating comments and ratings. The evaluation of these parameters needs sophisticated programming within the database to allow viewing of the datasets from a variety of perspectives. Features like this could also help to persuade manufacturers to supply content.

We are eager to collect feedback and comments on the submitted proposal and concept and are actively looking for corporation with sound design related institutions, hospitals, doctors and medical manufacturers to be able to further develop and realize the database to be made accessible for a wider public.

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