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1. BACKGROUND

The generation of a sound with an object implies the need for an action on the object itself which can be exerted for example either from a person or from another object. The same is true when playing a musical instrument: sound is the results of a physical interaction between the player and the instrument.

2. AIM

In a joint project between KTH Royal Institute of Technology and the Tom Tits Experiment Science Centre (TTE), we have created a permanent installation, with the Swedish name *Musikcyklarna* (the Music bikes). The main aim of the installation is to communicate to TTE visitors, in particular children, basic scientific principles of the relationship between movement and emotion in music performance.

We wanted TTE visitors to understand and start reasoning about the concept that there is no sound, hence neither music, without injecting energy in a sound producing system by using movement. Any musical instrument produces sound only when a player is exerting some kind of movements on it, e.g. think about lip vibrations of a trumpet player or finger movements in piano playing.

3. METHOD

We built an installation (see Figure 1) made by two bicycles, two sensors on each bicycle (one detecting the number of rear wheel rotations and another one measuring the rotation angle of the handlebars, corresponding to the rotation angle of the front wheel), one Arduino sensor board receiving data from the two sensors and connected to a computer, two loudspeakers placed on the handlebars (see Figure 1), one large screen for visual feedback, and some software tools including pDM [1]. pDM is a Pure data [1] path for the realtime expressive manipulation of MIDI files which have been pre-processed using Director Musices [2],

[1] Pure data: http://predata.info
[2] Director Musices: http://odyssomay.github.io/clj-dm/

Figure 1. The *Musikcyklarna* installation with two users at thes Experiment. Notice the two loudspeaker on the handlebars, the rotation sensor for the front wheel and the magnetic field sensor behind the rear wheel. The display shows two blobs corresponding to the position of each bicycle in the activity-valence space

a program implementing the KTH rule system [2]; for example the user can move a mouse pointer (or other sensors) in a two-dimensional space corresponding to the activity-valence space, such as that described by Russel [3], and the performance will change emotional expression by adding deviations of time, sound level, and articulation [4, 5].

We choose to map the speed of the rear wheel (correlated to the speed of pedalling) to the amount of activity to be used in the music performance, and the angle of handlebars to the valence in the performance. Handlebars rotated towards right will direct the music performance towards positive emotions, and towards negative ones when rotated to the left. pDM was used for performing the score with the corresponding amount of activity and valence, that was also graphically displayed on the large screen placed in front of the two bicycles, in which the four corners correspond (clockwise from the left upper corner) to anger, happiness, tenderness, and sadness respectively. When the pedals are not moved, the music stops after 5 seconds. The system selects a new music score each time the system has been paused. The installation can be used both in single-user mode or two-users mode.

Active emotions are displayed high up in the screen so that when users start to pedal faster the corresponding visual feedback is moved towards the top of the screen. When two bicycles are active at the same time (in the two-users mode) the relative distance between the emotions expressed by each of the two users is displayed, and the emotion of corresponding musical feedback is that corresponding to the middle position between the two emotions.

The final design of the *Musikcyklarna* installation was achieved after a few design iterations in which we tested different kinds of both visual and musical feedback after having observed user behaviour. For the visual feedback we tried to make it more clearly associated to musical content and its emotional expression by representing the current position in the activity-valence space with sparkling musical notes changing colour according to the current emotion portrayed by the performance [6]. The musical feedback was made more clear by exaggerating the emotion in the performance, e.g. so that it sounded exaggeratedly sad or happy by increasing the deviations of the acoustic parameters from their average values as defined in a previous study by Bresin and Friberg [5]. This is important specially in the context of TTE in which several visitors are walking and talking in the same exhibition space as the installation, and therefore it can be difficult to appreciate subtle differences in a music performance.

4. RESULTS

The installation has been running in its current form since June 2014, and has been visited by approximately 11000 users. It has proven to be stable also under periods of heavy use (such as Summer holidays and Fall holidays), and engaging.

From observations of user behaviour it clearly emerges that users of all ages understand the metaphors that there is no sound without pedalling and that increasing energy into their actions produces more active performances, either happy or angry depending on the position of the handlebars.

When using two bicycles, visitors of age 10 and above understand the metaphor of collaboration for achieving a joint performance that produces the desired emotion. Younger visitors have a tendency to compete against each other by cycling faster, and producing faster music performances. This is also due to their shorter height that makes it difficult to control the direction of the handlebars.

At the conference we will present preliminary results from interviews to users.

5. CONCLUSIONS AND FUTURE WORK

We are planning a thorough analysis of user behaviour in the near future. We want to make studies based on user age, and this is possible since several school classes with schoolchildren of different ages are visiting TTE during the year. We expect to gather information on children understanding of the interaction between music, motion and emotion, and this varies across children of different age.

Keywords: Emotions, Motion, Music Performance, HCI

Acknowledgments

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Colour Association to Sound: A Perceptual Experiment using a CIELab Haptic Response Interface and the Jyväskylä Film Music Set

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1. BACKGROUND

While some cross-modal associations might have psychobiological basis, other patterns of association might be acquired or cultural (cf. [5], [11], [4]). Stimuli perceived through different sensory organs via parallel brain pathways may be associated at a higher level if they both happen to have the same effect on emotional state, mood, or affective state ([14]). If the perceived input under-specifies an event, more complex cognitive processing mechanisms kick in ([7]). This process is not primarily ecological and might be mediated by emotion ([12]).

Research on crossmodal matching has provided evidence that many non-arbitrary and universal correspondences exist. Audio-visual correspondences may be based on amodal correspondences, for example, the loudness of sound and the luminosity of light ([14]). [13] showed that most cultures display word clusters near 'red', 'green', 'yellow', and 'blue' (in addition to 'white' and 'black'), and argued that "focal colours" really are universal.

Bresin ([2]) derived 24 colours from a scheme of selecting approximately equal distances in colour parameters in HSL (Hue, Saturation, Lightness) "space". This produced a set where the colour patches are arguably more evenly distributed, from a perceptual point of view, than those in the two studies mentioned above. Bresin found correlations between colour parameters and the affective intent in music excerpts, i.e. listeners matched colours to music excerpt played with a certain 'feeling'. As in [1] but more general, colour brightness was associated with positive emotion and darkness with negative emotion.

Palmer ([12]) investigated colour association to classical music excerpt where tempo and tonal mode were manipulated. The authors found that colours of high saturation and brightness, and colours more towards yellow ('warmth') were selected for music stimuli in fast tempo, and that conversely, de-saturated ('grayer'), 'darker', and blue colours were selected for music of slow tempo in minor mode. Furthermore, they claimed strong support for emotion as a mediating mechanism for the cross-modal associations.

2. AIMS

A review of the research provoked the idea that colour association to sound might be context-dependent. When associating colour to music, natural soundscapes, and 'soundscape compositions', do people use different strategies? Which musical features influence colour association? Can emotion mediate between musical features and colour association?

We designed an experiment to investigate a) correlations between visual colours defined by linear parameters and music stimuli with previously validated affect; b) correlations between the colour parameters and computational acoustic and musical features; and c) the multiple regressions onto colour parameters of affective ratings (emotions), psychoacoustic descriptors, and musical features.

3. METHOD AND PROCEDURE

We adapted the CIEL*ax*b space ([8], [10]) and developed a novel interface for selecting colours using a Wacom table for haptic input. Four quasi-continuous visual response parameters (*s, L, a, b*) are sampled at 10 Hz. The 'hybrid' *Lab* space contained 520,252 visible colours.

Eerola & Vuoskoski ([5]) created a set of 110 film music excerpts, rated for perceived emotion on three dimensional scales and six basic emotion scales, and a scale for Preference. We derived systematically a subset of 27 excerpts that optimally span the ten scales. After norming for loudness, sonic features (musical features and psychoacoustic descriptors) were calculated (MIR Toolbox [9]; Psysound3 [3]).

The experiment was conducted in an acoustically and visually controlled space, with a colour-calibrated LCD screen and a reference loudspeaker system. Participants (n = 22; 9 females) were 22…55 years old. Colour association was made individually to randomised stimuli by continuously adjusting colour and size of an on-screen patch with the haptic interface. A short interview concluded the session.

4. RESULTS

The response agreement among the participants was moderately high, with Cronbach's alpha ≈ 0.7 in each of the 4 dimensions separately.

In terms of basic emotions, *Happy* stimuli were associated with lighter colours than each of *Anger*, *Fear*, and *Sad* stimuli. *Lightness* for *Tender* music was borderline higher than for *Fear* music. Similarly, *Happy* stimuli were associated with more yellow (rather than blue) colours than each of *Tender, Sad, Fear,* and *Beauty* stimuli. Similarly, *Anger* music was associated with more yellow colours than either *Sad* or *Tender* music.

In terms of dimensional emotions, the difference between stimuli of high and low *Valence* was expressed in *size*, *a,* and *b* responses, with effect sizes of around half a standard deviation. Low-valenced stimuli were associated with smaller patches, towards red and yellow. The difference between high and low *Energy* was expressed in *s, L,* and *b*, with similarly sized effect. Low-energy stimuli were associated with smaller patches of medium lightness, towards blue. The difference between high and low *Tension* was expressed in *L*, with a larger effect size of 0.8 SD. Low-tension stimuli were associated with lighter colours.

The participants associated significantly lighter colours with the three most clearly liked music excerpts than what they did for the three less liked, with an effect size of nearly 0.5 SD. The female participants in the experiment generally made associations with smaller patches and lighter colours. Further analysis revealed a significant interaction effect between gender and emotion onto *a*, whereby female participants rated high-energy and high-tension excerpts as more red than what males did.

Results from cross-correlation analysis and exploratory regression are beyond the scope of this extended abstract.

5. CONCLUSIONS

For soundscapes, the ecological principle seems reasonable to explain colour association, via physical source identification, in the form of amodal correspondences. For fairly abstract film music, perceptual features might be more important, through the principle of learned intermodal specific associations. For the latter case, perceived emotion could in some cases function as a proxy. That is, people might associate colour to music in ways that are congruent with the emotions they perceive in the music. The present results suggest the existence of such patterns.

In addition to this, we are currently developing a HTML5 version of the *CIELab* response interface, and future work includes deploying a web version of the colour association experiment.

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Crafting Interaction from Sketch to 1.0

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Figure 1. The C3N play app version 1.0 running on an iPad 3 device. A zoomed in view of an arrangement of audio loops called a *performance* which consists of seven *scenes.* Each loop can be attached to any of the seven scenes. The current playing scene indicated by a fully saturated green colour.

ABSTRACT

In the increased design space of ubiquitous devices, interaction design is challenged by the illusiveness of interactive materials. Traditional design materials do not provide the talkbacks to appraise innovative and highly interactive designs. Interactive prototypes facilitate the appraisal of designs when the interaction idioms are initially unknown. This paper portrays the design process of an app for music creativity. The early stages relied on paper based design materials. The interactive research prototype was built with dynamic script programming. The development from the interactive research prototype to version 1.0 of the app was conduced as a design project. Artists play loops, and create performances to arrange the loops, figure 1. The content is presented on an infinitely large zoomable surface navigated through zoom and pan gestures. The paper contributes to the interplay between design and engineering for artefacts for creative use.

1. INTRODUCTION

Designers often hand over design requirements to a software engineering process [1-5]. However, the interplay between interaction design and software engineering is problematic [4, 5]. Engineers fail to attend to user experience qualities [6]. Software engineers solve a well-defined specific problem [2, 8], and describe themselves as engineers or scientists [1]. Interaction design, however, is a design practice [7]. Designers see a plethora of future designs for a situation. Exploratory programming allows various designs to be investigated to set a problem

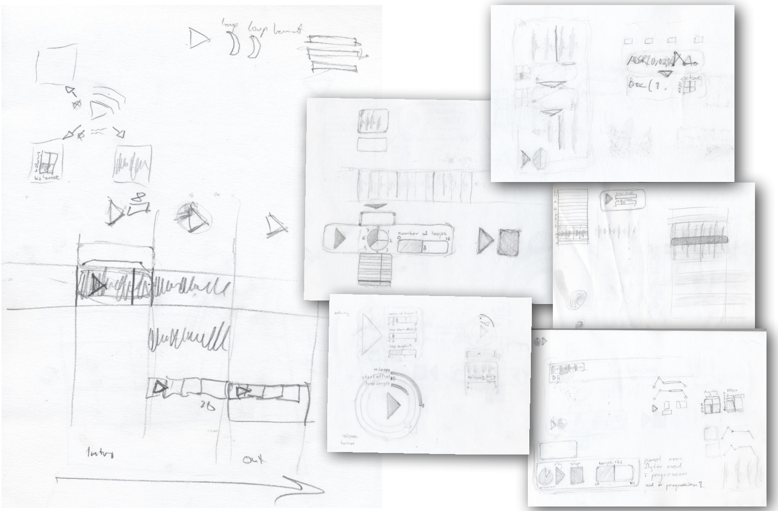


Figure 2. A selection of early sketches. The design decision for zoomable interface was already taken. These sketches explore the arrangement of music and temporal media. For instance, the leftmost sketch suggests relative time presentation of media loops in a timeline.

Figure 3. This figure shows a paper prototype for playing media. The prototype was explored with music and video artists. This design introduces phrases – later called scenes – that would play a collection of media loops to allow live performance. This structure remains the same in version 1.0 of the app.

[4], and to validate possible solutions [9]. Programming is, thus, a useful tool for designs that are difficult to portray on paper. What happens to the the design process when the programming starts?

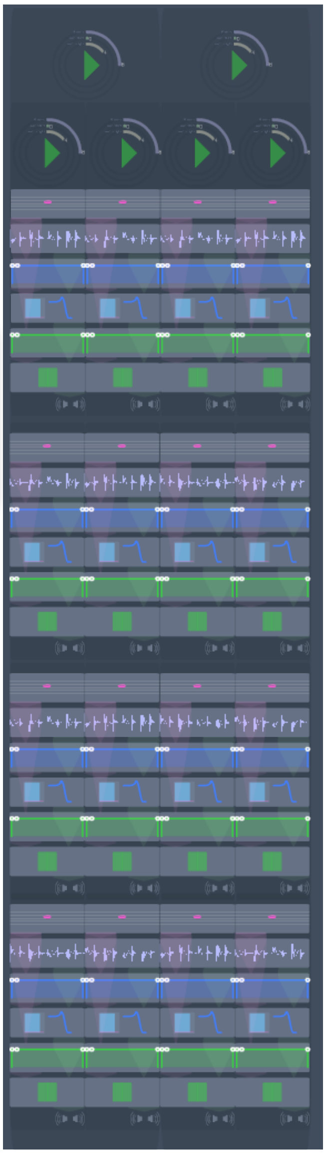


Figure 4. This figure displays how the design ideas of the previous sketches and paper prototype appears in pixels.

2. THE DESIGN PROCESS

This project began by exploring zoomable user interfaces for collaborating music and video artist. What design for zoomable user interfaces supports collaborative live performances? The design began in divergent sketching, figure 2, which converged to a paper prototype, figure 3. Exploring this design with artists suggested a structure for playing media that persisted. However, the appearance in pixels, figure 4, was insufficient for zoomable interfaces. Figure 5 portrays divergent sketching to find a more aesthetically pleasing and consistent design. The sketches were transformed into a paper prototype that was used in a wizzard-of-oz workshop with artists, in figure 6. The artists suggested several improvements of the design.

3. DESIGN MATERIAL

Figure 7 shows some aspects of the interactive research prototype. The design was done through exploratory coding in the material of dynamic script programming. Design problems emerged and were solved through scripting. The goal was to make a sufficiently reliable artefact for a field study for a performance by two music artists and a video artist at a music festival. The collaborative design allowed the video artist to be more involved in the performance. The design in combination with touch screens gave the prototype the experiential quality of a music instrument. Encouraged by these results and with the advent of the iPad, I decided to make an app.

4. “PRODUCT DEVELOPMENT”

The field study showed that the prototype design had loose ends. The design idiom inspired to use symbols instead of words; for instance Maya signs, electric symbols, and signs in astronomy, figure 8 and 9. Crop circles, patterns created by flattening crop, reviled to have inter-

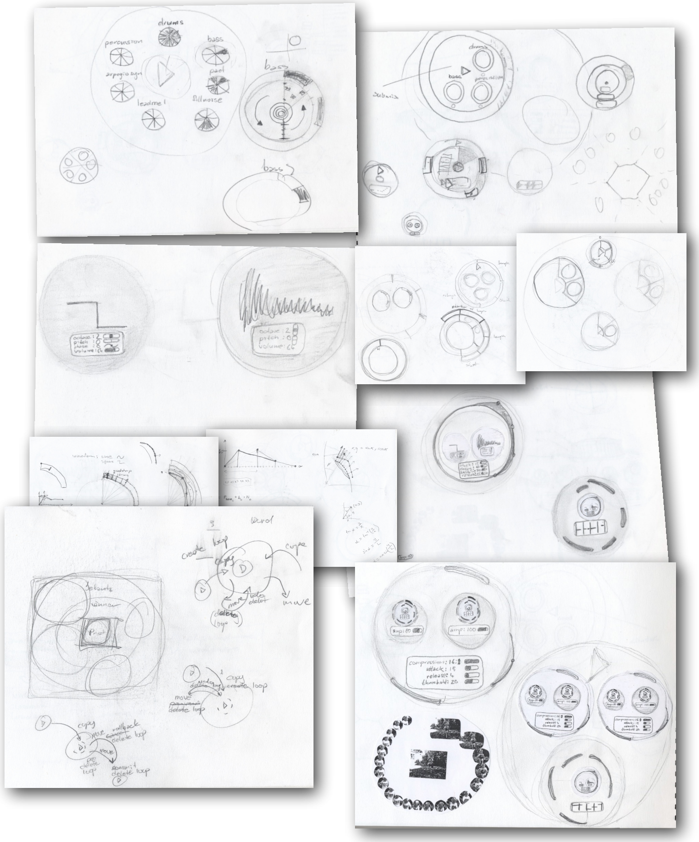


Figure 5. The design in figure 4 indicated that the approach with a traditional timeline lead to an undesirable design. These sketches sought a more aesthetically pleasing design with different approaches for time-bound media and circular shapes.

esting characteristics, figure 10, they are recognisable, and distinguishable from each other. The implementation produced the symbols, figure 11, from data analogous to a string of characters.

Figure 6. The sketches in Figure 5 was transformed into a paper prototype used in a wizzard-of-oz workshop with one video artist and two music artists. The artist got involved in the design. They reshaped the functionality and appearance of the design, they drew and discussed the design lively. This study suggested the design for the performances (see figure 1).

The slider design was also an unresolved problem. The sliders were arcs with various positions for the head, figure 7. In a zoomable interface position and scale varies. Thus, the design needs to be stable. In figure 12, old dials and a coffee cup lid inspired the design in figure 13.

Figure 14 shows an overview of C3N play. The circular design is also reflected in the spiral layout of content. The app was built on low level APIs, for instance CoreAudio and OpenGL ES 2.0. The development required a disciplined quality-driven open-ended process that accommodated continual change, simultaneous problem-setting and problem-solving, and material consciousness. These are characteristics of craftsmanship [10].

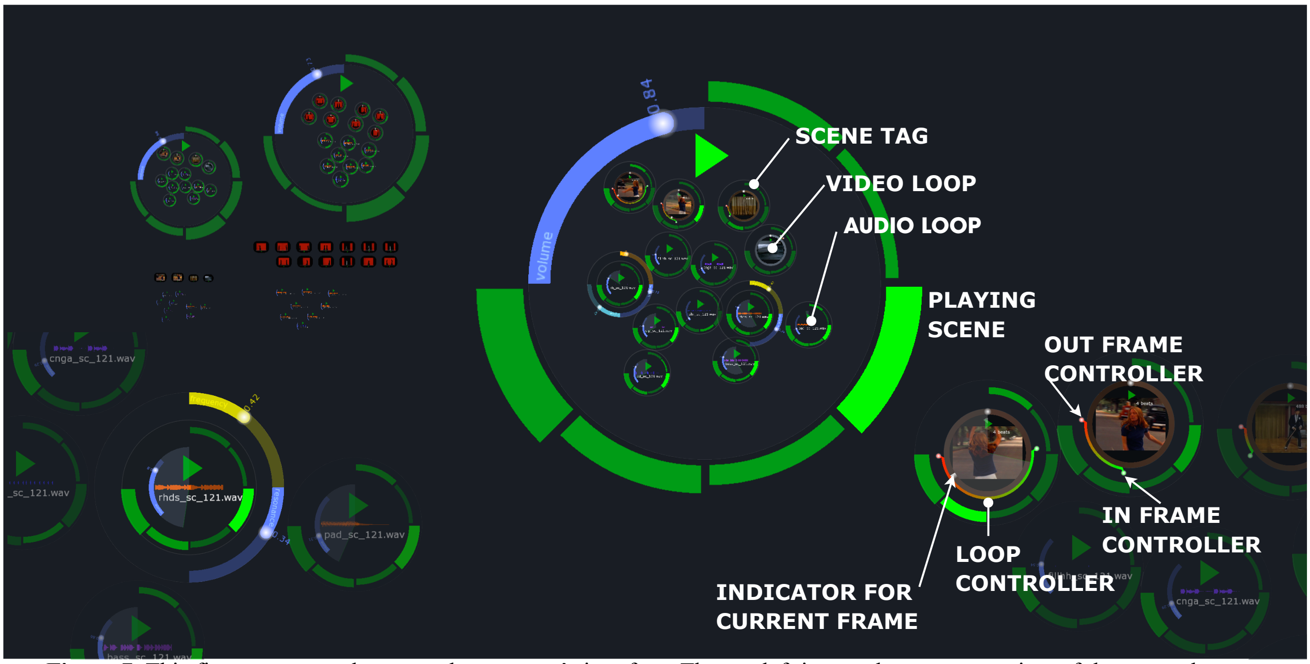
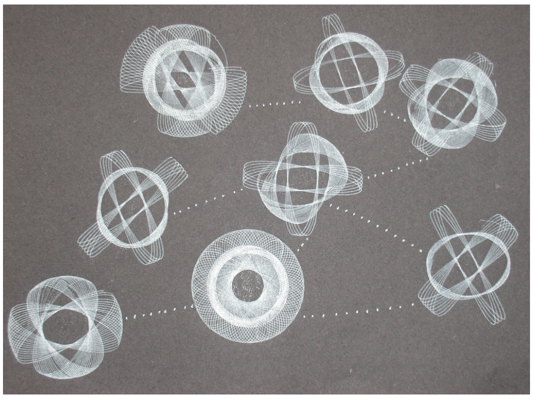


Figure 7. This figure presents the research prototype's interface. The top left image shows an overview of the research prototype. The top middle shows a performance containing audio and video loops. Bottom left shows audio loops. Bottom right shows video loops and their controls for selecting sub-loops, beginning at IN FRAME and ending at OUT FRAME. The LOOP CONTROLLER dynamically play different parts of the underlying video stream.

Figure 8. Three proposals for symbols.



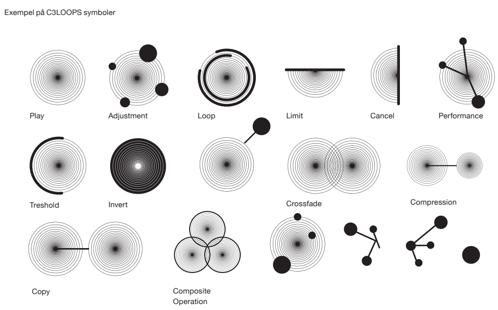


Figure 9. Suggestion for a symbolic language based on symbols from astronomy.

Figure 10. Crop circles as inspiration for a symbol language.

Figure 11. Crop circle symbols. Each symbol can be described from a string of

Figure 12. A design problem with the zoomable interface is to enable automation. With zoomable interfaces, position and scaling may be arbitrary. Therefore, the design needed controls with fixed interaction position regardless of the value it presents. Vintage telephones dials and plastic coffee cup lids inspired the design of sliders.

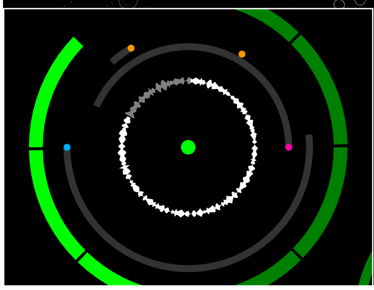


Figure 13. Zoomed in view of a loop in a performance. The seven green tags around the loop indicates which scenes the loop is attached to. The artist tap the scene tags to attached or detach the loop to the corresponding scene. The green dot in the middle affects the current playing scene. The blue, orange and pink dots are slider heads.

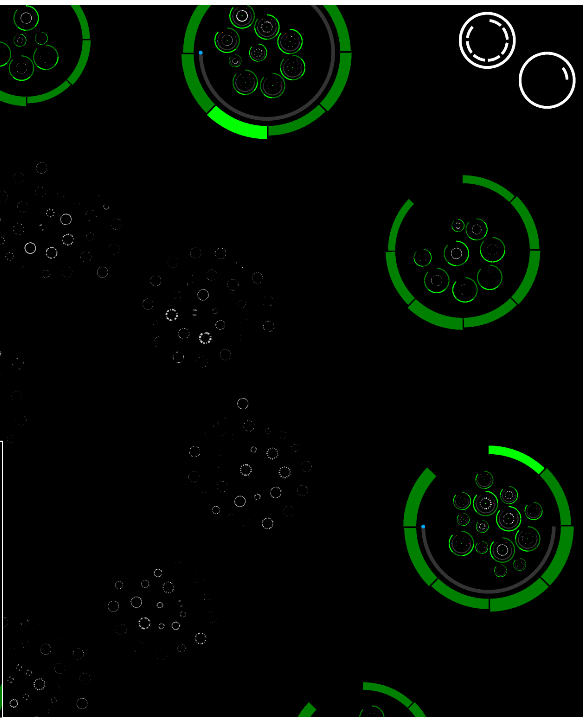


Figure 14. An overview of the C3N play app version 1.0. A spiral of audio loops collected in subspirals is shown in the middle. The symbols in the top right of the figure indicate that there are loops playing on the surface outside a performance. A tap in the left symbol collects the playing loops and creates a new performance. A tap on the right symbol adds the current playing loops to the last playing scene.

Tutorial video of the app:
http://youtu.be/gOdJwlvMOFA

Field study of the prototype:
http://youtu.be/xslEtVnBnEo

CCC pad video concept:
http://hakanlidbo.com/archives/2377

5. DISCUSSION

The transition from design to product development reviled issues of software engineering when attended to experiential values. Usability has become increasingly important in software engineering [1]. However, Lárusdóttir et al [3] and Memel et al [5] showed that it is difficult to attend to experiential values in the engineering process. This can be explained by the different epistemologies of design and engineering [4, 8]. In the project presented here, the focus was on artistic musical expression which forced the development to constantly revise the design; hence, it became a design process. The metaphor of design material for programming language code supported a design oriented approach to product development. This suggests that working from sketches up to version 1.0 as a design process helps attending experiential values of an interactive artefact.

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Building for the Future

Research and Innovation in KMH's new facilities

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ABSTRACT

This studio report describes the design of a new building for The Royal College of Music in Stockholm (KMH) and the plans for research and artistic activities which the facility will afford.. The new facilities will be completed and inaugurated in the Fall 2016.

1. A NEW BUILDING

The Royal College of Music in Stockholm (KMH) is currently in the historic process of building completely new facilities. The modern, purpose-built campus will provide—for the first time in KMH's long history—not only a vastly improved home for the current activities of the college but will also realize an exciting opportunity for innovative development. Designed for a diversity of performance and research situations, the complex of studios and concert halls concretize a modern paradigm of advanced, multi-purposed spaces with variable acoustics, flexible seating and high-tech audio-visual capabilities. In short, a new home for music and a hub and technical instrument for research, as well as a cultural nexus for Stockholm.

KMH's new building comprises five performance spaces, six control rooms, three recording studios and twelve production suites. The backbone of these performance spaces and studio complex is based on fiber-optic and Ethernet networks and features comprehensive input/output matrices for highly flexible digital routing and facilitates the integration of future developments, eventual intramural re-configurations and expansion.

Best described holistically, the complex is conceived as a fluid system; public spaces and studios converse with each other as if through permeable walls. As the facilities can be re-defined and re-configured according to changing conditions, it is perhaps useful to apply metaphorical descriptions to reveal aspects of the projected research and artistic activities. These are:

- laboratory/studio
- concert hall/theater
- network of audio and visual media.

In the first, the studios may be dedicated either to audio research, music production or both. For research on a larger scale, the performance spaces can be configured as laboratories and then re-purposed for public activities. Second, the design paradigms of a concert hall, theater and cinema are fused into a single flexible performance space with the potential to go beyond traditional strictures. The third metaphor, an audio/visual network, is intended to highlight the diversity of media that flows through the complex.

2. AN INTEGRATED VIEW

A total of six control rooms will be housed in the new building, three of which are designed more traditionally for music production with 5.1 monitoring. All of them will be equipped with video for mixing to image, audio-visual production and communication with other localities.

For electroacoustic music, two of the control rooms will feature multichannel monitoring in all industry standard delivery formats (stereo, 5.1, 7.1) plus eight channels (8.1), all on the horizontal plane. These will be clustered about a common recording studio with one of the aforementioned control rooms, which although initially based on 5.1 can be retrofitted to the same configuration as above. The flagship main studio will also offer this flexible solution plus five loudspeakers in the ceiling to add a vertical dimension resulting in a 13.2 configuration that is directly compatible with the Audiorama concert space in Stockholm. The studio has its own adjacent recording studio.

The audio network will be built around a combination of fiber-optics (MADI) and audio-over-ethernet (DANTE) which will link not only the control rooms with the recording studios and performance spaces, but also with numerous alternative spaces for public activities in the building complex such as the large foyer at the entrance. The DANTE system permits anyone with virtual soundcard software to access audio hardware anywhere in the facility, and video signals will also be routable to many locations in the complex.

The large concert hall will provide KMH with a modern multi-purpose facility for orchestral music and larger ensembles, but with the possibility of realigning the traditional audience/stage orientation by making the concert hall floor flat and thus encouraging alternative types of production. The remaining performance spaces include a Black Box, which will provide an additional open space for experimentation, a large choral hall with floor to ceiling windows overlooking Valhallavägen and a chamber music hall that also contains a pipe organ. Of course, they will all double as recording studios.

The small concert hall is particularly configured for both research and experimental performance and will be one of a handful of similar large-scale installations internationally. A flexible system of up to 49 loudspeakers affords a platform for a wide variety of projects including sound spatialization either in the acousmatic tradition or together with acoustic and electronic instruments. The system will create an immersive sound environment while providing precise sonic imaging for studies in spatialization and cognition.

For intermedial purposes, large-scale, flexible video resources are required. The development of audiovisual music lies close at hand, extending a Swedish tradition and incorporating current trends. The video components can also potentially serve as virtual scenography, a highly intriguing area of investigation that has been undertaken at KTH. Moreover, by bringing the above potential together with new media and its latent telematic aspects into the creative mix, new spaces can be opened for the exchange and development of research and artistic expression that extend far beyond the locality of Valhallavägen and concerts performed in virtually any part of the world may potentially be enjoyed at KMH.

3. RESEARCH DEVELOPMENTS

The particular strength of the nascent research environment at KMH is a broad artistic competence. Our current research focus is narrativity, interaction and music and drama, and, in conjunction with the aforementioned infrastructural developments, new research initiatives are being formulated. For example, spatialization is anticipated to become a significant area of research and artistic activity. The combination of our new studios and public spaces will provide the college with a prominent position in this respect.

We envision a variety of collaborative structures with some of the major music and music technology research centers in Sweden as well as abroad. Indeed many obvious collaborators are already here in our local neighborhood. Thus, all in all, the coming resources will afford us, along with associated research partners, the opportunity to advance to the forefront of this exciting area of artistic potential.

Goodbye Reason Hello Rhyme

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ABSTRACT

This licentiate thesis (Falthin 2011) comprises two articles based on qualitative empirical studies and a theoretical introduction. All three texts deal with the same problem area concerning musical meaning making and the concept development process (CDP), as described in the cultural historical theory (Vygotskij 1978, 1987, 1999), in the course of composition learning. The participants in the studies encountered techniques new to them with aesthetic implications they at first had trouble to relate to.

1. INTRODUCTION

In the theoretical introduction, boundaries and interplay between semantic significance and syntactic meaning are examined and discussed, as is the relation between aesthetic meaning making and learning. The articles deal with these issues in the context of composition learning at a music program in upper secondary school. The composition tasks in the empirical studies both deal with electroacoustic music but the research problems and findings concern a broader sense of composition learning and even musical learning in general.

2. SYNTHETIC ACTIVITY

Synthetic Activity (Falthin 2014) is about fundamental aspects of soundgeneration and hence directed towards semiotics in the form of phonology and significance in connection to musical gesture and spectral content. The learning and meaning making processes of two composition students are studied as they engage in additive synthesis to build sounds, musical phrases and eventually a short musical composition.

One of the most striking results is that the project came to be as much a listening experience as one of creative music making, and that the concept development process included rehearing and reassessing familiar sounds and music. The students use different strategies to bring what they initially consider abstract and remote aesthetics and techniques together with their internalized musical knowledge and preferences. One student does this by putting the somewhat sterile done-like synthetic structure in contrast to an ambient real-life space with people moving in a large reverberant hall. In hermeneutic terms this may be seen as creating a horizon for the object of meaning making. The other student applies a mimetic strategy by shaping the synthetically generated sounds to mimic physical instrument and arranging the music as if it were an ensemble with drum-set, bass, three chord-instruments and melody playing tonal music in 4/4 meter. In both cases, the CDP gains momentum at the point when the students find their method for connecting the new knowledge to familiar musical thinking.

3. CREATIVE STRUCTURES OR STRUCTURED CREATIVITY

The article *Creative Structures or Structured Creativity* (Falthin 2011) deals with form and syntactic structure, as the students learn to develop and apply composition algorithms to further their creative thinking.

The results show that there are several different layers to the concept development processes in this project. One layer concerns the ability to structure musical parameters on an aggregate level; to learn to plan musical developments as space of possibility rather than as a determined linear sequence of musical events. Another layer comprises problems of learning the programming environment and how to embody the musical algorithms in working computer-code. A third layer concerns letting the algorithmically generated materials influence one's creative thinking.

The students learned step by step to set up rules and restrictions for random generation of pitch, rhythm, articulation and dynamics. Then they recorded the randomly generated material and subjected it to manual editing applying traditional contrapuntal techniques like canons, inversions, retrogrades etc.

4. CONCLUDING REMARKS

Tokens of the concept development process as described by Vygotskij (1987, 1999) in language-based learning were prominent also in the music composition learning of these studies. Implications for further research include formalizing criteria for the developmental phases of the concept development process in musical contexts. It also involves elaborating the design of the study engaging video footage to capture communication between students and between students and teacher, screen- and audio tracking to continuously monitor the CDP and stimulated recall after the finish of the project to record the continued CDP.

Keywords: algorithmic composition, sound based composition, concept development process, musical meaning making, creativity research

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Sonification of Haptic Interaction in a Virtual Scene

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ABSTRACT

This paper presents a brief overview of work-in-progress for a study on correlations between visual and haptic spatial attention in a multimodal single-user application comparing different modalities. The aim is to gain insight into how auditory and haptic versus visual representations of temporal events may affect task performance and spatial attention. For this purpose, a 3D application involving one haptic model and two different sound models for interactive sonification are developed.

Keywords: *interactive sonification, haptic feedback, spatial attention*

1. BACKGROUND

Integration of haptic feedback in computer music applications, especially in the context of Digital Musical Instruments (DMIs), is a growing research field (see e.g. [1, 2]). Numerous studies have focused on how force feedback devices, i.e. controllers that read position information and provide continuous force feedback as a response to user movements, can be used in applications involving both sound and haptics [3, 4, 5, 6].

Audio-tactile and audio-proprioceptive interaction has been found to play an important role for spatial orientation in virtual scenes [7]. Moreover, it has been suggested that auditory and tactile signals are more effective than visual signals when it comes to drawing cross-modal attention to particular positions [8]. The current study is motivated by the fact that few previous investigations have focused on cross-modal links in spatial attention for sonified 3D haptic interfaces.

2. AIM

The purpose of this study is to investigate how visual spatial attention and haptic spatial attention correlate in a single-user application comparing combinations of different modalities. We aim to investigate how different representations of temporal events affect task performance by triggering a shift of attention. The following proposed hypotheses will be tested : 1) by providing auditory and/or haptic feedback a visual attention shift will be triggered, and 2) auditory feedback can elicit an increased sense of effort; a user's gestures can be affected by ecological knowledge of sound producing events related to the implemented sound model.

3. METHOD

A SensAble^{TM} Phantom® Desktop haptic device [1] is used together with eye-tracking technology to analyze how focus of attention is affected by combinations of different modalities. The haptic device has a pen-like stylus, attached to a robotic arm, which is used to haptically interact with objects in virtual environments. A 3D application based on a simple task where the user is supposed to throw a ball into a goal (see Figure 1) has been developed. The application provides haptic, visual and auditory feedback.

Eye-tracking data will be correlated with haptic tracking data in order to investigate hypothesis 1), i.e. if focus might shift from the ball to the goal depending on the provided feedback. Hypothesis 2) will be tested through comparison between the haptic and non-haptic condition.

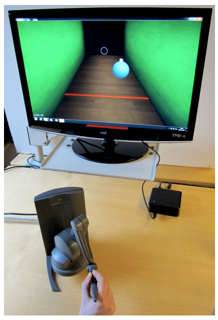

Figure 1: Experimental setup with the SensAble Phantom Desktop, Tobii X2-60 eye-tracker and 3D application.

Experiments with first-year students from the Computer Science program at KTH Royal Institute of Technology will be carried out. Initially, pilot experiments involving vocal sketching [9] will be carried out. The pilot tests will provide ideas for design of two different sound models, but also serve as a first evaluation of the entire setup.

[1] http://www.dentsable.com/haptic-phantom-desktop.htm

The subsequent experiments will contain auditory-haptic, auditory-visual, auditory-visual-haptic, haptic-visual and visual-only conditions. A between-group design will be adopted, where each group will solve the task in one of the conditions.

Subjects will be given a period of 5 minutes for practice before the actual experiment starts. After the practice trial, they will be instructed to try to throw the ball into the goal 40 times. Task performance, defined as a quota between 40 hits and total number of trials, will be computed for each subject. We define visual attention in terms of time that a user is focusing on a specific area of the screen.

3.1 Apparatus

The 3D application, based on the haptic software library Chai3D [10], is written in C++. As previously mentioned, a SensAble Phantom Desktop device will be used to provide force feedback. The sound models for providing auditory feedback have been developed in Max and sound synthesis is done on a separate computer. Communication between Max and the 3D application is done via OpenSoundControl (OSC) [11]. A pair of Sennheiser HD 433 headphones will be used for auditory feedback. Eye-tracking data will be recorded using a commercial X2-60 eye-tracker from Tobii Technology [2]. The Morae software [3] for usability testing will be used to set up, record and analyze study data.

3.2 Sound Design

A summary of different interaction events and suggested corresponding auditory feedback can be seen in Table 1. Most interaction sounds were designed as Earcons [12], since many of the sound-triggering events in the 3D application have no intuitive mapping to an auditory event. As for the sonification of the interaction with the haptic ball, i.e. the gesture where the user is aiming at the target, we compare two sound models: one simple model based on filtered white noise (simulating a whooshing sound), and one sound model designed using the friction preset from the Sound Design Toolkit [13].

The models are designed in such a manner that sound changes in terms of stereo panning and frequency depending on movements in the x- and y direction respectively. Velocity is mapped to volume and a specific mapping for movement along the z-axis is adopted for each sound model (see Table 1).

Table 1: Auditory feedback and mapping.

EVENT	AUDIO MESSAGE
goal	MIDI sequence, increasing pitch
miss	MIDI sequence, decreasing pitch
hit wall	impact sound model: dissonant bell (SDT)
grasp ball	filtered noise, increasing frequency + click
ball bouncing	impact sound model: wood (SDT)
aim at target	velocity mapped to volume
	movement in x,y,z mapped to:
	panning, frequency, comb-filter characteristics$^{\diamond}$
	panning, frequency, rubbing force*

$^{\diamond}$=filtered noise model, *=friction model (SDT)

4. PRELIMINARY RESULTS

Pilot tests involving vocal sketching are being performed at the time of writing. Initial findings have led to conclusions regarding adjustments that are required in order to ensure robust behaviour and reliable interaction in the virtual 3D environment. Improvements on the application as well as sound models will be done in an iterative manner as the pilot tests proceed, until the setup is stable enough for the actual experiments to be carried out.

5. FUTURE WORK

As a continuation of this study, future investigations could involve assessment of how visual spatial attention could be affected by auditory and haptic feedback in a multi-user setting.

Acknowledgments

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Interactive sonification in circus performance at Uniarts and KTH: ongoing research

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INTRODUCTION

Contemporary circus artists are beginning to use new tools and technologies. Aligned with this trend and with interest to applying interactive sonification to circus performance a collaboration is currently in progress between the *Sound and Music Computing Team* at KTH Royal Institute of Technology and the *School of Dance and Circus*, part of Stockholm University of the Arts. The collaboration includes the Gynoïdes Project[1] and also works on a series of proofs of concept. This collaboration allowed us to gain experience and mature practical knowledge (see [1]) and a range of further activities are planned in the near future of which a description is given herewith.

1. MOTION SONIFICATION AND CIRCUS DISCIPLINES

Motion sonification will be further experimented in four circus disciplines, each named after the tool used i) Cyr Wheel, ii) Aerial Hoop, iii) Sway Pole, and iv) Tight Wire.

The Cyr Wheel is a large metal hoop used by a performer to roll around the stage keeping him/herself suspended inside by pushing the arms and legs on its inner side; the Aerial Hoop is a 1.5 meters in diameter metal ring hanging from a single rope with a swivel so as to rotate freely, and where the performer can hang from or sit in; the Sway Pole is a long pole or bar that can be pivoted for body lifting or hanging; the Tight Wire is a horizontal metal wire lifted off the ground, on which the performer walks, jump and dance, optionally using a balancing tool (e.g. an umbrella, a fan, or a balance pole).

Within above mentioned collaboration we plan to track movements of both tools and performers by means of wireless inertial sensors. The choice of this particular kind of motion tracking comes from the experience gained in previous research: wireless inertial sensors fit better to the onstage circus performance compared to optical motion systems, allowing movement in much bigger spaces and not subjected to lighting interference problems.

For each of the four circus disciplines tests will be conducted in the form of performances. Motion data and video data will be recorded and evaluated also by means of a comparison with the related performance video recording, so to choose the most suitable motion parameters to represent the movements, and to be mapped to sound.

Figure 1. Sarah Lett performing with a Cyr wheel (photograph by Einar Kling Odencrants).

Three different kinds of sound source will be experimented in order to represent the motion: pre-recorded sounds, synthesized sounds, and live sound and noise generated by the performers and captured by the sensors.

Pre-recorded sounds will be just triggered, or processed in real time using techniques such as scratching and filtering, that proved to be suitable in the past research.

Synthesized sounds will be produced by using computationally efficient algorithms such as Scanned Synthesis (see [2]) that has already been positively tested in interactive gesture sonification (see [3]).

Live sounds will be processed in real time using mainly filtering techniques, as already tried succesfully in a preliminary test. In the case of the Tight Wire an electric guitar pickup will be employed to get a signal from the wire oscillations, as if it was a big monochord.

Mapping strategies for the sonification of physical quantities identified by Dubus and Bresin [4], will be taken into account, compared and evaluated, with respect

[1] http://www.cirkusperspektiv.se

to each of the four circus disciplines considered. In addition to quantitative mappings also qualitative mappings will be tested, e.g. as in the Elementary Gestalts for Gesture Sonification approach [5] where the geometrical features of the trajectory are considered.

2. TECHNICAL ASPECTS

We will use wireless inertial sensors for tracking both performer's and tool motion, but instead of using those built in the Nintendo Wii remote controllers[2] will use those on x-OSC boards[3], that are better in many respects to include:

- usability, due to the smaller size
- lower system latency, due to much higher data rate transmission
- data transmission via OSC messages over WiFi and not Bluetooth, allowing for faster connection and better range from the base station
- a magnetometer, in addition to accelerometer and gyroscope, so as to be able to track the orientation with respect to all three axes of the terrestrial reference system, by means of sensor fusion algorithms such as those described by Yun et al [6] or those already implemented in Max MSP library AHRS[4].

3. METHODS

The sonification design process will be run according to the so-called spiral approach. The experiments on the four disciplines will be done in parallel and diversified in the choice of motion parameters, type of sounds, and type of mapping. First tests will be evaluated, positive outcomes selected and negative ones discarded. Thanks to the knowledge gained new models of sonification will be created to be tested again, thus creating a virtuous loop that allows to get better and better solutions.

4. EXPECTED RESULTS

All four new interactive sonification environments will be developed and tried during public performances of circus art. New insights in sonic interaction applied to circus art will be achieved. Several diverse interactive sonification mapping strategies will be implemented, compared and evaluated. For each circus discipline considered the most suitable motion parameters, to provide an expressive representation of the movement, will be identified. Taking into account the circus tool's characteristics, 3D rotations data will be extensively employed and new sound design competences for that kind of movement will be acquired. New compositional strategies in circus performances will be achieved.

[2] http://en.wikipedia.org/wiki/Wii_Remote

[3] http://www.x-io.co.uk/products/x-osc/

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Puff, Puff, Play: The Peripipe Remote Control

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ABSTRACT

We introduce the Peripipe, a pipe-shaped tangible remote control using breath as input, and demonstrate how it can be used to control a music player. The pipe works by sensing changes in the air pressure and determining whether the user has performed a puff, double-puff, sip, double-sip or a continuous suck or blow action. Additionally, inspired by ephemeral user interfaces [1], the Peripipe provides fumeovisual feedback, using color-illuminated smoke to display the system status. The pipe makes use of an rFlea, a hardware prototyping platform based on Arduino with built-in wireless communication, to send commands to an Android phone over the ANT+ protocol [2].

Figure 1. The Peripipe remote control uses illuminated smoke for feedback

1. DESIGN MOTIVATIONS

With the Peripipe, we wish to challenge the expectations of the traditional tangible interface as the most obvious and appropriate implementation of a remote control. Current remote controls are often just tools to operate appliances at home or in a mobile setting, designed without much thought of the emotion or attachment they instill in the user. Moreover, physical knobs and switches, though precise and natural-feeling in their interaction, often rely on highly abstracted representations of the system status. They also have strong connotations of machinery, industry and automation, giving little room for personality and self-expression.

We argue that conventional controls for music players, while functional, remain detached from the emotional experience that is listening to music. Designing a remote control for a music playlist, we wanted the method of interaction to correspond with the qualities of the action performed. As the use of breath is both natural (used since your birth), emotionally loaded (blowing out candles on a birthday cake) and connected to music (wind instruments), we feel that it is an appropriate metaphor for controlling music playback.

Previous implementations of breath-controlled interfaces for accessibility applications have also demonstrated that it is possible to achieve a very high level of control by changing the air pressure using one's mouth [3, 4].

Constructing the remote control as an artifact that users actually want to touch and feel for its own sake also helps to build up a relationship between user and technology. The Peripipe is lovingly handcrafted from Swedish cherry wood and makes use of the unique aesthetics and qualities that organic materials bring [2]. Additionally, the form factor of the pipe carries cultural value in itself, as smoking pipes have been around for a long time and are connected to meditation and relaxation. Unlike more traditional remote controls, you will want to hold the Peripipe in your hands. Therefore, using a pipe for controlling music with your breath seems like the perfect amalgamation of interaction, physicality and emotion.

2. LIVE DEMO

At the live demo, conference attendees will be able to try the pipe themselves and control a music playlist with sips and puffs. A short video demonstration of the Peripipe can be found at `https://vimeo.com/109721625`.

3. KEYWORDS

Tangible interfaces; natural materials; remote control; sip-and-puff

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