Creative exchange through joint responsibility: designing performances in multidisciplinary teams in the educational context

Inês Rodrigues Neves, Claudia Diaz Reyes, Ismini Pachi,
Arife Dila Demir, Kristi Kuusk
Estonian Academy of Arts, Estonia
ines.rodrigues@artun.ee

Biography

Inês Rodrigues Neves is a Portuguese illustrator and graphic designer currently attending a master's degree in Textile Art and Design at the Estonian Academy of Arts. Her artistic work explores the relationships between 2D & 3D and craft & drawing as tools to transpose the unique material and immaterial qualities of the maker towards the physical and visible space. For the past year she has integrated the curatorial and organizational team behind the student-run gallery Vent Space.

Claudia Diaz Reyes is a textile designer from Colombia. She is currently studying at the Estonian Academy of Arts towards her MA degree in Textile design. Her interest lies between sustainable design and technology, searching to establish a fertile ground on how these two disciplines can melt together and affect one another. She sees textile as a living organism that coexists with the environment. In her MA project she researches how weaving textiles based on music can revive memories.

Ismini Pachi is a special education teacher and jewelry designer from Greece. She is currently studying at the Estonian Academy of arts towards her MA degree in Jewelry and Blacksmithing. Her artistic work encompasses psychology and art where these two fields seek a common ground of expression. Her strong interest in human behavior and the way creativity is affected by the latter, leads the whole artistic process in an endoscopic journey that involves the senses and is formed by them.

Arife Dila Demir is a Ph.D. student at the Estonian Academy of Arts where she worked as a contractual lecturer. She focuses on combining her interactive textile practice with embodied design thinking. She worked as an e-textile costume designer for the project funded by Vertigo STARTS Residency. Recently, she was a resident of STARTS.EE, collaborating with a theatre director, where she developed interactive costumes and designed the stage for an audio-journey game.

Dr. **Kristi Kuusk** is associate professor and senior researcher of Design Research Group in Estonian Academy of Arts. She is also Head of the Textile Design department and co-head of the Art & Design doctoral school. Her interest is in finding alternative futures for clothing and textile design via implementation of technology. She combines practice (of collaborating as selected laureate in EU projects such as STARTS Residencies, WORTH Partnership Project) with presenting and publishing research in international venues.

Abstract

In this paper, we present a collaborative course born from the intersection of Textile Design, Human-Computer-Interaction (HCI), Composing, and Choreography departments with the ultimate purpose of co-creating multidisciplinary performances. Thereby, we present an in-depth analysis of two student projects that emerged from this collaborative course. In contemporaneity, many disciplines, including arts and design, and their various practices, transform to adapt to the newly forming space of multidisciplinary collaboration and its inherent shared responsibility. As educators and design students, we advocate for the invaluable input of collaboration during these times. We deem it essential to promote multidisciplinary thinking in groups within the educational context, promoting individual strength. To provide a comprehensive understanding of all fields included in this study, workshops, and crash courses were organized to engage the students with the different disciplines. During these

courses, students also got the chance to become acquainted with each other, which later helped them build their groups, integrating a student from each field. Apart from structured courses, students were independent in organizing their schedules in order to develop their performances. Throughout this study, students gained embodied knowledge of shared responsibility in multidisciplinary teams, which also allowed them to develop expertise within their own fields.

Keywords

Joint responsibility, Multidisciplinary collaboration, Performance, Textile design, Design education

Introduction

The world today is in an unprecedented situation. Many of the ecological and societal contemporary challenges are being faced for the first time on such a global scale, resulting in the necessity to find new solutions within different creative areas to keep up with the fast-paced evolution of contemporary society and the art and design fields. Within this context, new spaces of multidisciplinary collaboration are starting to appear to respond to these changes.

During the past decades, design research has evolved towards more participatory practices such as co-creation that deals with "any act of collective creativity" (Sanders and Stappers, 2008, p. 6) and co-design more specific to the design practice and field. This phenomenon results in the democratization of the design process, which opens the ground for a creative scene set on the interaction of hybrid disciplines (Sanders and Stappers, 2008). Consequently, multidisciplinary exchange normalizes and becomes an intrinsic part of the professional practice

within the creative fields, such as arts. The term "multidisciplinary" refers to something that involves "several different subjects of study" (Oxford University Press, 2020, para. 1).

According to Fleischmann and Hutchison (2012), participants from a specialized educational background (e.g., textile design) often find it hard to deal with the dynamics and challenges implied in multidisciplinary collaboration. Fleischmann and Hutchison stress the importance of engaging the students in multidisciplinary projects in the educational context. This would allow them to learn how to successfully communicate and collaborate with other disciplines, hence acquiring the necessary skills to navigate projects in their future professional experiences.

In this paper, we as design students and educators reflect on the impact of our practice in the context of a collaborative course involving Textile Design, Human-Computer Interaction (HCI), Choreography, and Composing specialities of various academic institutions.

Textile is one of the oldest creative mediums used by humankind. It became our home when collecting seeds, berries, and other necessities and evolved as a material and as a societal instrument. Today textiles express our personality, preferences, status, belonging, identity, and much more (Lurie, 1981). As textile design students and educators, we have the mission of questioning how the meaning and qualities of textile could propel through innovative solutions. We explore the implementation of new technologies and collaborations in the field. Technology carries the potential to transform textiles from passive to active elements. As textiles can become interactive, the already strong relationship with the body expands.

HCI studies the interactions between humans and computers. Even though initially the field mainly concerned computers, HCI has expanded to many other aspects of information technology design (Interaction Design Foundation, 2020). Recently, textile designers have started to collaborate with HCI practitioners to develop e-textiles (Hertenberger et al., 2014) and wearable technology solutions.

The dynamic properties of e-textiles can expand the bodily interaction experience through body movement. These interactions can be either active when the body can sense the effects of technology; or sensorial when technology is used to gather bodily characteristics or movements.

Body movement allows human beings to experience the world and understand their experiences. As we engage with the world, we form a kind of unconscious choreography of daily activities. On the other hand, choreography is a form of art defined as "The art of designing and arranging the steps and movements in dances..." (Oxford University Press, 2020, para. 1). However, Mackrell (2019) states that today, choreography only follows two absolute rules: it should structure dance "beyond the level of pure improvisation" (para. 10) and propel the human body's potential by shaping dance in accordance with space and time.

As bodies move in space engaging with textiles and technology, the sound, melody, or music becomes a crucial element of attention. Music is an artistic medium that is created by a composer. Traditionally, composers collaborated with performing artists, choreographers, theatre-set directors, and scenographers: four seemingly separate disciplines with specialized skills, aims, and contexts for working. These joint projects create the framework and form the composers' practice where all parties contribute in their way.

These four disciplines have a long history of collaboration. While the intersection between the fields of composition, choreography, and textiles is longstanding, technology has also been increasingly integrated as a crucial element in performative projects during the last century. This project presents insight on the collaboration between the fields not only in the sense that each part holds specialized responsibility towards the outcome but also on the dynamics of creative participatory exchange through the embodied integration of all the members in all the layers of the project.

The paper explores creative exchange through joint responsibility as an intrinsic consequence of multidisciplinary projects while exploring the role of embodied learning within the

context of multidisciplinary education. By analyzing the structure and team set-up of the current project in an educational context, we find relations of interdependence that allow the expansion of borders in different fields and students' future prospects. Taking into account the unexpected impact the COVID-19 pandemic brought to the project's final outcomes, in this paper we reflect upon the process and relations between disciplines and students, as well as the importance of collaboration and co-creation in times such as these.

Background

The specialties of Textile Design, HCI, Choreography, and Composing have evolved from their initial and traditional purpose towards more multidisciplinary and collaborative practices. Many projects combine textiles with technology and / or movement and / or sound. The disciplines hold numerous focuses and connect in various depths.

The connection between textile, technology and performance reaches as far as to 1880s with the Electric girls bringing illumination to the ballet stage (*Electric girls*, 1884). Around turn of the 19th century, Loïe Fuller introduced color choreography to dance using light-emitting wearables (Lamontagne, 2017). In the 1920's Oskar Schlemmer explored "technological mechanisms" (Lamontagne, 2017, p. 107) through kinetic costumes with the Triadic Ballet. However, it was in the 1950s when the first wearable computers as we know them today were developed by Thorpe and Shannon (Thorp, 1998). The end of the 20th century brought upon the further development of wearable technology in performative contexts. Pioneers such as Laurie Anderson in 1986 using her body as a percussion instrument (Anderson, 1986), Mark Coniglio from Troika Ranch in 1989 presenting dancers generating audio through wearable sensors (Stewart, 2019), and Benoit Maubrey in 1998 working on audio ballerinas (Maubrey, 2021) developed further the material-human connections as well as dreamt up scenarios for its use.

Figure 1. From left: Magic Lining sensorial clothing developed by Kuusk, Tajadura-Jiménez, Väljamäe. AURA woven interactive spatial element developed by Demir.

The concept of e-textiles or interactive textiles was first introduced by Post & Orth in 1997, showcasing musical conductivity as a possible implementation (Stewart, 2019). More recent examples show that e-textiles combine textiles with technology in various contexts. Persson's (2013) conductive knitted heating wall panel and thermochemically printed garments, for example, create a spatial interaction where the pattern on the costume changes when getting in contact with the wall panels. Cute Circuit's Sound Shirt (2016) converts sound into vibration on the wearer's body for people with hearing impairment to experience music. In the spatial context, Demir (2020) explores self-perception via light-emitting woven interactive spatial elements that react to a person's proximity (Figure 1). Involving the body, Kuusk et al. (2019, 2020) look into changing the wearer's body-perception through vibrotactile clothing Magic Lining (Figure 1).

Many projects combine three of these specialties. Textile artist and musician Pigao (2018) created a woven spatial element as the musical instrument theremin; dancers placed in between play music by controlling the woven theremin with their movements. Akin to this, Yamaha Corporation (2018) converts body movements into sound by utilizing Artificial Intelligence

(AI) technology, turning the dancer into a pianist. Ruth (2018) transforms the weaving loom into a musical instrument, and Castán et al. (2017) look at movement as material expression. Several projects explore the utilization of textiles in combination with technology and dance (Liang et al., 2019; Honauer, 2018); furthermore, various performative projects integrate music, movement, and technology (Murray-Browne et al., 2014; TeamLab, 2018).

Some existing projects converge the fields of textile, sound, movement, and technology. Donneaud et al. (2017) explore the interactivity of textiles as musical multi-touch devices for performances. SITISIZER (2017) experiments with the pneumatic material as a seat that generates sound with the close interaction of body movements. Gurbuz and Fatato (2018) creates scenographic textile tools for participatory performances, and Wilde (2007) makes hipDisk, a wearable device to be used around the waist, which generates sound with the wearer's movement.

Multidisciplinary approaches can vary in shared responsibility and authorship. For example, what is primarily a dance performance can be led by the dance partner(s) and supported by the other disciplines. In contrast, textile designers usually ask for advice and consultations from technology, movement, or sound experts when developing a material or costume with those elements. Multidisciplinary collaboration gains more ground in research and academic contexts in recent years, and the resulting projects are increasingly more co-owned. Ten Bhömer et al. (2012) look into shared ownership in the process of developing smart textiles. Magic Lining (Tajadura-Jiménez et al., 2020) combines knowledge from neuroscience, HCI, and smart-textile spheres when looking into body-perception through e-textiles and tactile metaphors. Each project partner uses the haptic dress to tap deeper into their field while simultaneously creating new shared interests.

It is less common to urge four different disciplines to collaborate in an educational context. Pennington (2008) highlights that it is vital to provide an environment for collective thinking in

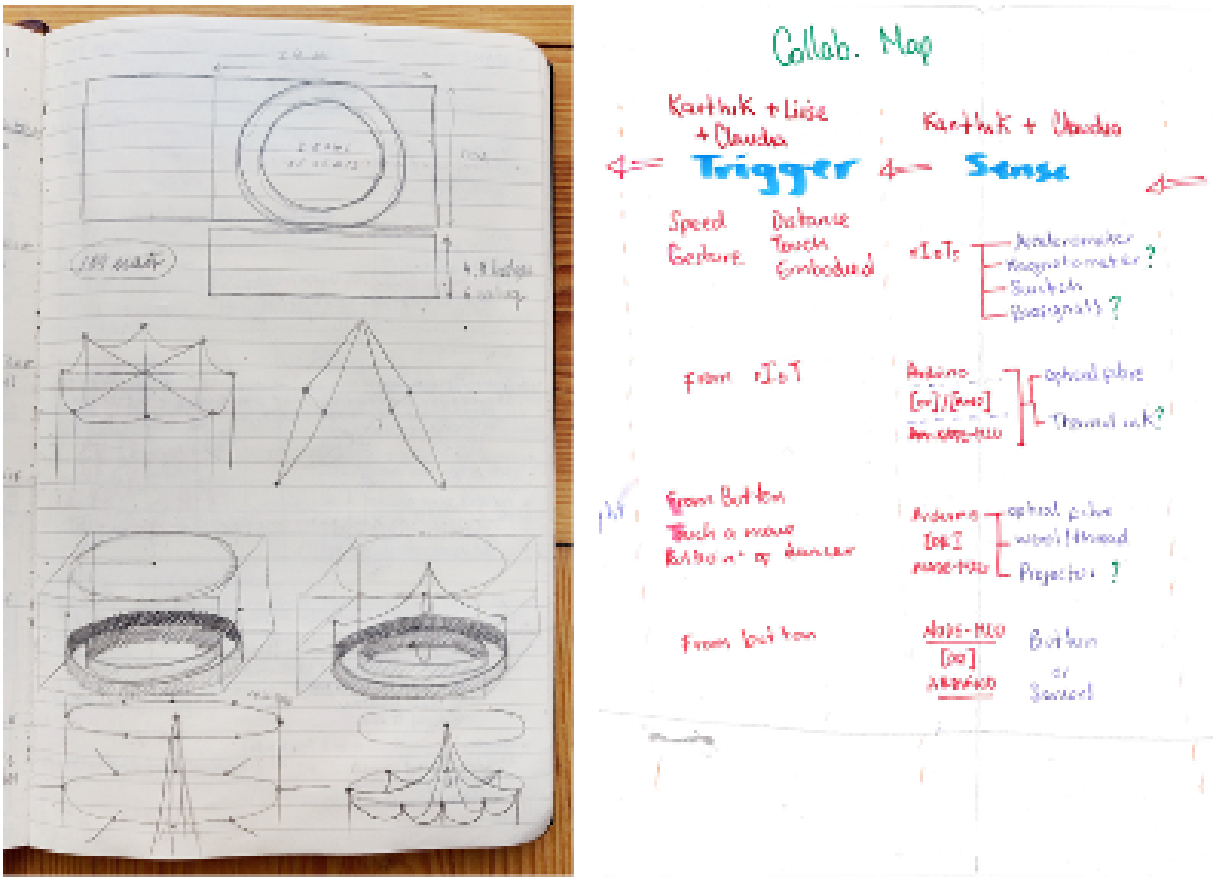

Figure 2. From the left: journal notes from the projects Rings and In-Between.

collaborative research, which can be achieved by all collaborators' learning and understanding of each other's perspectives. Therefore, this paper taps into such experience through reflections of participating students, tutors, and course organizers.

Methodology

This project involves four academic partners in Estonia: Estonian Academy of Arts (EKA) Textile Design department, Tallinn University (TLU) HCI program, Baltic Film and Media School (BFM) Choreography department, and Estonian Academy of Music and Theatre (EMTA) Audiovisual Composition studies. It ran as a one year project. Each discipline planned em-

bodied actions for the first (autumn) semester to create a deeper engagement for the students of different specialized fields. Throughout the semester, the students participated in various hands-on workshops introducing the four specialities. Afterward, they generated initial ideas for the performances and started to prototype those in groups. They had the second (spring) semester to continue working on their projects. A total of 16 local and international master students (four from each speciality) formed four multidisciplinary teams. Two students could not continue with the course for the spring semester, therefore two new students joined the project. Tutors from each institution provided courses and coaching throughout the project for the mixed groups. In the following section, the workshops and other course activities are described in detail. Additionally, to the organized sessions, the students worked in a self-initiated group setting.

Students documented their work throughout the year by taking notes into research journals or similar (Figure 2), videos, and photographs. The organizing team of tutors communicated using online shared documents, e-mails, video calls, and in-person meetings. The course schedule and meetings were communicated in a shared table between the tutors and the student teams.

Process

Even though some of the institutions involved had previously collaborated on a smaller scale or professional projects with each other, having all four directions engaged in one common educational context was new to everyone involved. The project's goal was to provide a collaborative environment where students may gain deeper insight into each other's disciplines while co-creating. Entering the realm of other disciplines, students were hoped to gain a new perspective on their fields. This could potentially extend their vision and open up opportunities for future collaborations and alternative unique career paths. To provide a common language and knowledge space for the multidisciplinary project, the course started with one workshop

Week	Title	Content	Leading Organization / Location	Person Responsible
Week 1	Kick-off	Introduction to the course and different disciplines.	EMTA auditorium	All tutors
Week 2	Workshop (mending futures)	During two intensive evenings, the students ment a wounded garment that was somehow meaningful to them using the different e-textile techniques and soft-electronic materials that were introduced. This process was accompanied by several performed exercises exploring body-garment interaction and reflective writing. In parallel, the students made other spontaneous performative exercises researching movement exploration and bodily interactions with each other.	EKA classroom	Anna Arov & Anja Hertenberger
Week 3	Portfolio exchange + discussion	Presentation and discussion of students individual practice and ideas in the context of the course.	EMTA auditorium	All tutors
Week 4	Crash-course (movement-based practices)	Movement exploration exercises researching the connection between body, materials, movement and sound. The workshop started off with basic movement exploration exercise. For the second part of the meeting, the students were paired in groups and were given a roll of paper, plastic bags and tape. The exercise consisted of applying these materials to the bodies in a way that would allow the students to take advantage of their sonoric and physical properties when moving.	Sakala 3, theatre, rehearsal room	Renee Nõmmik
Week 5	Crash-course (e-textiles)	Introduction to e-textiles. The course was a hands-on creation of buttons using soft-electronics.	EKA e-textiles studio	Dila Demir
Week 6	Crash-course (into to RioT)	Introduction to RioT using BITALINO and its implementation with the sound software Max. The workshop started with a theoretic presentation followed by an explanatory demonstration on the performance and possibilities of the technology.	TLU, HCI classroom	Taavet Jansen
Week 7	Crash-course (movement and sound)	Exploration of the relations between music and dance by framing it with a debate on biological symbiotic relationships and their parallelism with poly-disciplinary collaboration. In this course the students were also introduced to the softwares Ableton Live and Max.	EMTA black box	Manoli Moriaty
Week 8	Forming the groups and presenting ideas	Meeting to formally organize the students in teams and presentation of first ideas.	EMTA black box	All tutors
Week 9-10	Group work / Open studios	Rooms booked for free use and tutors available for consultation.	EKA, TLU BFM, TLU HCI, EMTA	All tutors
Week 11	Crash-course (RioT/BITalino)	This crash-course provided the students with the opportunity to present their work-in-progress and receive feedback from the creator of BITalino (the RioT platform that students were using for their projects), as well as learn more about him and the platform through a keynote presentation.	TLU, HCI classroom	Hugo Silva
Week 12	Group work / Open studios	Rooms booked for free use and tutors available for consultation.	EKA, TLU BFM, TLU HCI, EMTA	All tutors
Week 13	Visiting the venue	The students visited the theatre Vaba Lava - venue for their final performance (to happen originally in April 2020) - by attending the event The psychedelia of science and art by Anna Cinnamon, hosted under the concert series Curioosum (Eesti Kontserdimajad, 2020) which was also meant to integrate the student's final performance.	Vaba Lava, Theatre, main stage	All tutors
Week 14	Final Rehearsals	The students rehearsed their final presentations on the stage (the choice of venue for this presentation resulted from it offering similar characteristics to the final stage in Vaba Lava).	Sakala 3 theatre, black box	All tutors
Week 15	Final Presentations	The students presented their performance and a demo of 15 minutes.	Sakala 3 theatre, black box	All tutors

Figure 3. the course structure for the first (autumn) semester.

on e-textiles and storytelling and five crash courses from all disciplines included (Figure 3). The crash-courses were structured as embodied learning actions. Within that process, thinking, being, doing, and interacting intermingle with each other.

Embodied learning played an essential role in this multidisciplinary collaborative course to help overcome the challenges usually faced by students coming from specialized disciplines in the multidisciplinary collaboration. Theories of embodied cognition suggest that mind and body continuously influence each other and that cognition is shaped by both perception and action (e.g., Wilson, 2002; Fugate et al., 2019). Additionally, Kontra et al. (2015) elucidate the importance of embodied cognition in learning. One of the purposes of this course is to propel each student's active engagement with each other's disciplines. Therefore, the course structure aimed to create an environment where the students could have an embodied experience of all the implicated fields, hopefully gaining more profound insight into each other's disciplines.

The first meeting in the autumn semester was introductory, as the tutors from all institutions involved in the course presented their interest in the project. Two days later, the first workshop by Anna Arov and Anja Hertenberger took place at EKA. The workshop focused on a speculative exploration of technology as a tool to mend internal and external tears through the use of body movement, storytelling, stitching, and soft-electronics. During the next meeting, the students presented their individual work and discussed their expectations towards the creative practice in the context of the course.

Five crash-courses provided by each institutional partner followed. During these activities, the students learned about different fields and built a deeper understanding of their disciplines, which later benefited their group works.

BFM delved into the discipline of dance while integrating material and sound (Figure 4). Rodrigues Neves, one of the textile design students and first author of this paper, finds that the course propelled the merging of the different fields. She further exemplifies that this first crash

Figure 4. Week 4's BFM-led workshop about material, sound and movement interaction. Image credit: Renee Nõmmik.

course made her realize how strongly materials could influence a performative context. This contributed to the conceptualization of the project Rings and provided her insight into her own artistic practice.

EKA introduced e-textiles with a hands-on workshop (Figure 5), and TLU provided a workshop introducing BITalino R-ioT (2020), a commercial version of R-ioT technology: a module which enables "sensing movement, processing and wireless transmission through WiFi" (Sound Music Movement Interaction—ISMM, 2017). EMTA's crash-course focused on the relations between music and dance. These courses provided a deeper understanding of each discipline for the students and the space to get to know each other before forming the groups. Regarding this, Diaz Reyes, the second author of this paper and co-author of the project In-Between states that, in this way, when the groups were formed, all the members knew where the project was

Figure 5. Week 5's EKA-led workshop about e-textiles. Image credit: Vladimir Tomberg.

going to focus. During the groups' brainstorming sessions, they reached very prompt agreements on the topics they wished to explore and the roles each discipline would portray in the developing performance.

After the first four crash courses, the workflow was loosened as the teams could organize their own meetings and workspaces individually. Each institution provided a room at a specific time of the week where the teams could consult each tutor. The flexible meeting structure made the process highly productive for the students as some of the teams split into two sub-groups to increase efficiency. The students were aware of the value of each student's specialized input on their field, which made the individuals take initiative for the sake of their projects. Rodrigues

Week	Title	Content	Leading Organization / Location	Person Responsible
Week 16	General meeting for updates	Individual meeting within each institution between the respective students and their tutors to discuss further plans and expectations regarding the project. After that there was a second meeting with all the institutions.	EKA, TLU BFM, TLU HCI, EMTA	All tutors
Week 17	General meeting for updates	Group meeting with all institutions in which the students were updated on the plans for the final performance and the needs of the teams for executing their projects were discussed.	TLU BFM	All tutors
Week 18-19	Group work	Groups organized their meetings individually.	EKA, TLU BFM, TLU HCI, EMTA	All tutors
Week 20	Crash-Course (movement/ sound with MiniBee and SuperCollider)	Exploring movement and sound technology by using MiniBee and SuperCollider as tools to generate interactive sound with movement.	TLU BFM	Külli Roosna & Kenneth Flak
Week 21	Group work	Groups organized their meetings individually.	EKA, TLU BFM, TLU HCI, EMTA	All tutors

Figure 6. Course structure for the second (spring) semester

Neves mentioned that even though the ideas stemmed from a group discussion, the students who were experts in a particular field were in charge of deciding the most suitable specialized solution for the project. As Pennington (2008) elucidates, self-actualization in collaborative projects leads to team actualization. In other words, individual progress inherently influences the group. This also indicates how strongly students valued co-authorship and co-responsibility in their working process, notions which were core to this collaborative project.

The last of the five crash-courses happened three weeks later at TLU. It was built on the experience gained from working with R-IOT and focused on BITalino open-source hardware for education, rapid prototyping, and exploratory research in biomedical engineering (BITalino, 2020). By the end of the first semester, each team presented a 15-minute live demo and a presentation of the concept, technical solutions, dramaturgy, and general plan for the final performance.

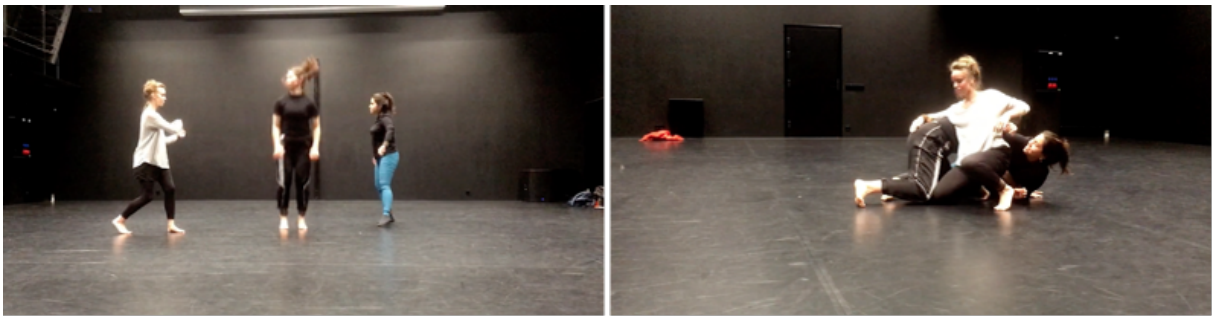

Figure 7. Week 20's TLU-led workshop about movement and sound technology. Image credit: Vladimir Tomberg.

The second semester started with meetings in each institution and after altogether to discuss the plans for materializing the projects (Figure 6). The students continued to meet in teams to work on their projects and had one more crash course that explored movement and sound technology (Figure 7). The students from all disciplines explored movement while wearing sensors that create sound based on their motion. After that, during the thirteenth week of the course, the state of emergency was declared in Estonia due to the global COVID-19 pandemic, resulting in the temporary closing of Universities and prohibition of social gatherings. As a result, the groups stopped meeting in person, and the practical work was suspended.

The final performances meant to happen five weeks later, on the 30th of April, were initially intended to be shown at a theatre, within a concert series, as a showcase between research fields. Due to the prohibition of social events and the temporary closing of theatres, this event was cancelled. The students continued meeting by video calls and redirected their focus towards investigating the necessary adjustments their projects needed to undergo to fit the new reality enforced by the pandemic. At the same time, a draft for this paper was started to capture the learning and potential aspects of such collaboration, communicating it even if the physical performances had to be delayed indefinitely. On the 20th of September, the project Rings was re-invented to adapt to the necessities and restrictions regarding public events in COVID-19

times and was presented to the public in the event "Interdistsiplinaar" at MiniCOMMUTE#2, an audiovisual festival organized by EMTA (Eesti Muusika- ja Teatriakadeemia esitleb, 2020).

Projects Rings and In-Between

The two projects out of four in which the members stayed the same throughout the one year period were Rings and In-Between. We focus on those two as they best illustrate the described process, allowing us to regard their uniqueness and reflect on their approach to collaboration and emerging shared ownership.

Project 1: Rings

Rings (Figure 8) is a holistic exploration of life. The project scrutinizes the dance of energy and matter in space and time, the rhythm of it. It manifests itself from the idea of connection. The very nature of life suggests that all beings are connected: from the smallest part of the body to the whole existence, or the universe itself. Rings interprets these ideas by suggesting that we are all part of a dance of tension and release, distance and closeness, compression, and expansion. It aims to remove the hierarchies between audience and performer, creating unity between all animated and non-animated elements of the performance.

In this project, stage elements generate unity between the audience and the performer. A translucent textile akin to a curtain is attached to rails on the ceiling in a circular structure positioned at the center of the stage. The textile has two essential roles: 1) bringing the audience physically closer to the performer by moving towards the center with the help of motors, 2) reflecting the physical manifestation of the performer by vibrating according to their breathing tempo. To reflect the performer's breathing tempo on the curtain, a Respiration Sensor (PZT) would be used, which would also be influencing the music. Additionally, an accelerometer (IMU) would be used to control the sound signals. EMG is used to track the performer's muscle

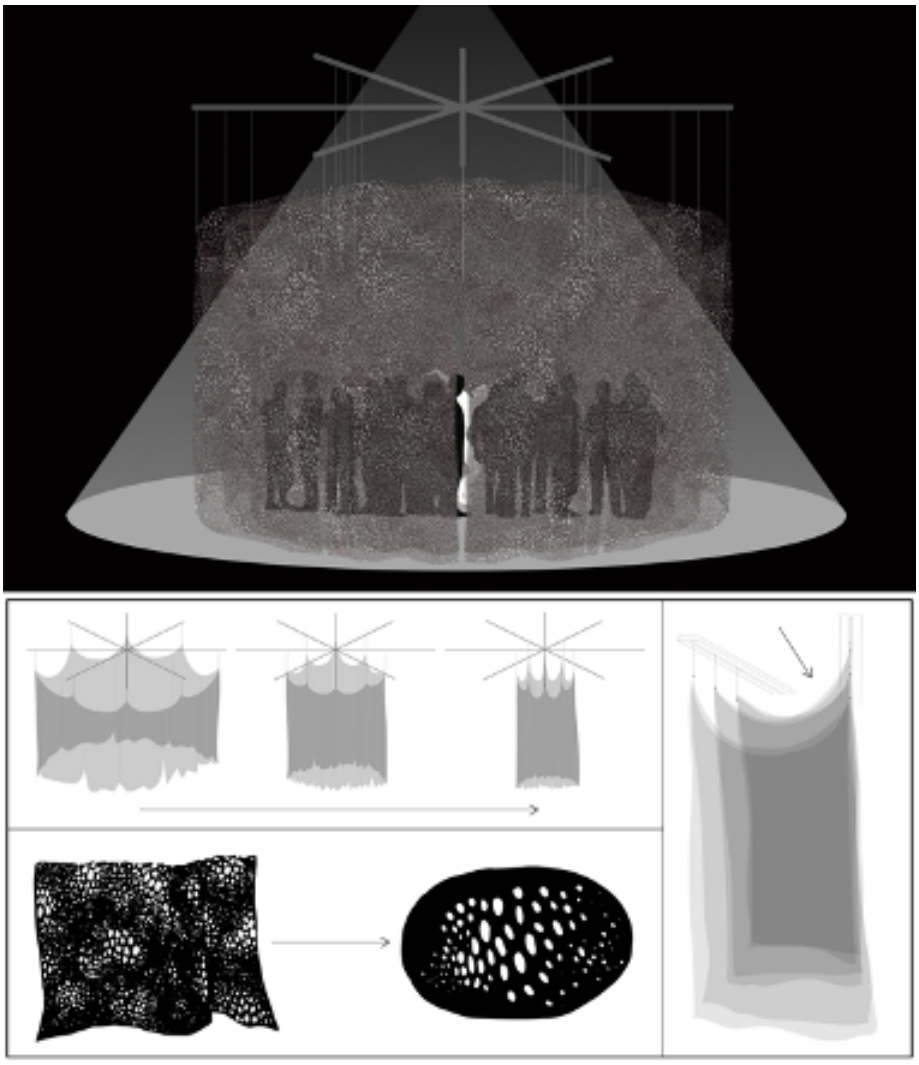

Figure 8. The textile scenography for the project Rings by Inês Rodrigues Neves, Daniel Irabien Peniche, Simo Kruusement and Natalia Wójcik. A rail mechanism would move the curtain inwards, which would be made of a translucent fabric with an organic pattern printed with light-reflective pigment.

activities, influencing the music as a secondary element. The choreography would be improvised to explore the performer's inner feelings, leveling them with the audience who would also improvise their participation. As stated by the project's choreographer, 'Formally it's a piece where we all together make these rings that interweave revealing a Mandala...' (Kruusement, 2019).

Rodrigues Neves reflects that there was a very particular feeling of mutual understanding and transparent communication that allowed the process to be fluid. She highlights that every group member committed equally to the project, devoting themselves to the ultimate collective result. The notion of an ultimate shared goal naturally invited a sense of co-responsibility. Unconditional support towards each group member's ideas was essential for this group, which, when necessary, invited the responsibility of individuals towards benefiting a collective target.

For instance, Rodrigues Neves reveals that her initial idea for the curtain's mobility was to use muscle wires, which require high temperature to operate. Applying such material on a larger scale would require even higher voltage, which would provoke discomfort and a potential safety threat for the performer and the audience. After being warned of these problems by the tutors, she gave up this idea, and the group decided to utilize motion motors instead. The important aspect of this example is that Rodrigues Neves's initial idea was supported by their peers, but she took the individual responsibility to let go of an idea that would not benefit the ultimate collective goal. When building an environment for co-creation, support and respect for all ideas are vital. They contribute to individual responsibility towards a collective aim, ultimately leading to the enhancement of co-responsibility.

Project 2: In-Between

In-Between (Figure 9) is a performance that tells a story from Estonian Mythology. This story is about a girl, representing dusk, and a boy, representing dawn, who are assigned with the responsibility to sustain the daily cycle by an old man, the God. One day, dawn and dusk meet, fall in love and kiss. The old man sees this, but because of the hard cooperative work, he rewards them by allowing them to meet once a year: in the summer solstice. Nowadays, the boundaries between both have faded; the day can work through the night and vice versa. The collaborative project In-Between takes inspiration from the cycle of day and the summer solstice and reflects

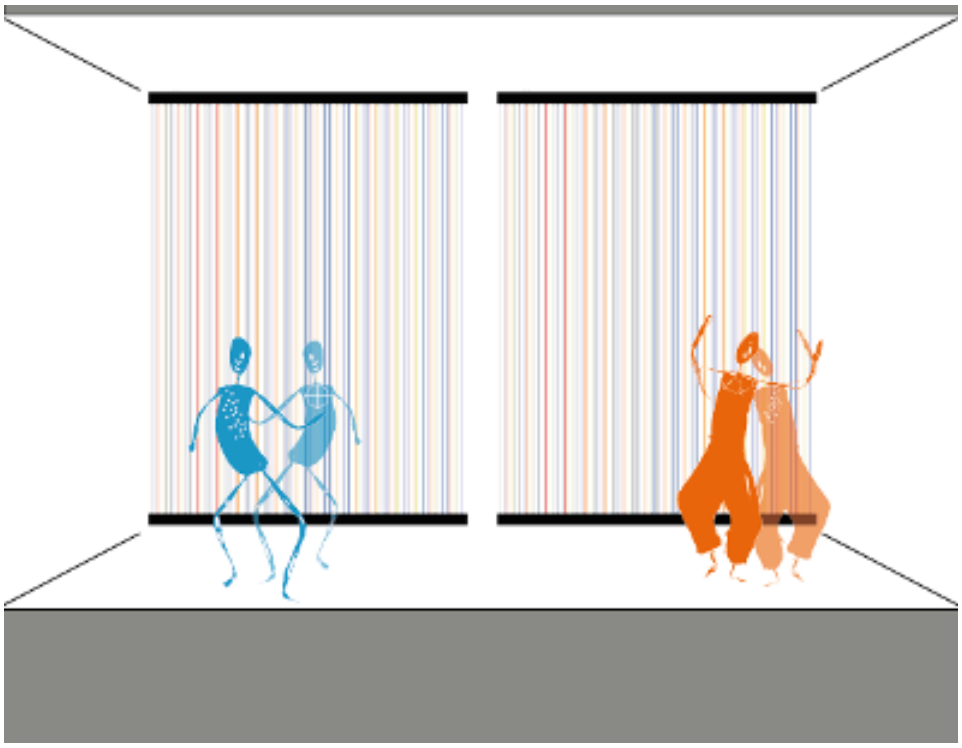

Figure 9. The textile scenography for the project In-Between by Claudia Diaz Reyes, Karthik Adisin, Liise-Marie Roosaar and Marcelo Chacur. There would be three panels of nylon threads and two panels of nylon threads and fiber optic. The fiber optic would change colors with the choreography, emitting hues of orange or blue depending on which performer is closer to the panel.

on the current city lifestyle, metaphorically exploring concepts of cooperation, collaboration, and unity.

In reference to the cooperative tale of day and night, this project presents the choreography of two performers representing the boy and the girl from the story. The project aims to create a soft panel hanging from the ceiling made of fiber optic light cables as a stage element that would reflect the day and night colors. Hues of blue would be emitted as night and shades of orange for the day. This poetic play between colors would be changing in response to the dancers' proximity to each other within the choreography. This would be achieved by integrating proximity sensors into the costumes of the dancers.

The Arduino system working via Wi-Fi would be connected to the optic fiber lighting piece in the background, emitting light in response to the choreography. The light would also be influenced by the speed of the dancers. An accelerometer (R-IoTs) would be attached to the costumes to collect the movement data. Costumes would have a textural sound coded with Arduino. In other words, they would generate a smooth soundscape which is not necessarily thematic or motivic, but a homogenous sound to which the audience can relate to from each side: a sonority juxtaposed to the other ones already flowing.

Diaz Reyes reflects that when ideas and knowledge are shared, they gain a lot of value. She highlights the importance of sharing experiences and acknowledging one's study area. By exchanging knowledge, one can acquire significant insight through alternative perspectives. As Diaz Reyes states, what is most important is to be aware of one's role and acknowledge that someone's actions affect others and *vice versa*.

The academic course and both performative projects got disrupted by the social distancing measures brought up by the COVID-19 pandemic. Nevertheless, it provided the teams with the opportunity to re-think and envision collaborative performances in entirely new situations. The highlight of the project Rings was to bring people physically together, connecting them to create unity. Yet, in light of the outbreak, the group adapted their initial idea for the performance. The final piece (Figure 10) sought to explore the same essence of connectivity by reflecting on their state and place in the age of social distancing and virtual interactions. Rings materialized the immaterial performer onto the stage using three projectors to display in 180º the pre-recorded and pre-edited performance.

The scenography (Figure 11) consisted of twelve silver organza panels hanging over the stage. The purpose of these transparent panels was to simultaneously deconstruct and multiply the performer's image, thus generating a three-dimensional and ethereal presence. Through

Figure 10. Moments of the final performance for the project Rings in the context of the Mini-COMMUTE#2 festival at the Estonian Academy of Music and Theatre. Image credit: Estonian Academy of Music and Theatre.

this effect, the performance delved into the experience of the immaterial, what is between the physical dimension of the performance and the audience's perception.

Figure 11. The scenography for Rings' final performance. Image credit: Estonian Academy of Music and Theatre.

The In-Between project group continued to meet for a while online but decided to review the project's status once the health situation has stabilized, hence not directly changing their idea based on the newly emerged social circumstance. By the end of June, when time, space, and dates for the possible performance were confirmed, TLU and EKA's members could no longer participate. For this reason, the proposal remained in a conceptual dimension.

Discussion

The presented creative exchange was realized through joint responsibility, designing performances in multidisciplinary teams in the educational context. The experience being novel to all parties provided a lot of insight to the initiators, tutors, and students participating in the project. The importance of integrating multidisciplinary projects in educational contexts arises from its outstanding contribution to the innovation of the respective fields and the skillset of the future designer. By working in multidisciplinary teams, the students broadened their spectrum of hard and soft skills—acquiring basic knowledge in new disciplines as well as in communication, col-

laboration, and co-responsibility. Thus, by providing them with embodied knowledge in these fields, the institutions broadened their creative horizons, allowing the students to see beyond the boundaries of their disciplines. Regarding what was learned throughout this process, Diaz Reyes mentions that besides acquiring a new interest in Arduino technology, which she aims to integrate into her future textile practice, the project also represented an opportunity to have more ideas for other collaborative projects with her teammates.

In this paper, two textile design students shared their experience working in a multidisciplinary group in an educational context. Both students highlighted co-responsibility as one of the main challenges they faced throughout the project. Being the only textile designers in their groups, they carried all the weight of single-handedly designing and producing an ambitious large-scale textile project with high-quality. This allowed them to develop their skills much further than if they had shared the responsibility with other textile designers. By extending the students' comfort zones, such collaboration can propel their creative process and contribute to the ultimate innovation within the individual fields.

One of this project's goals was to support embodied learning to overcome the challenges regarding the engagement of students who have one-discipline-oriented backgrounds in a multidisciplinary environment. Thus, workshops and crash-courses organized with a hands-on approach were essential for the process. The hands-on workshop and crash courses organized in the Textile Department generated an embodied learning environment where all students could incorporate the specific knowledge from their disciplines with the hybrid knowledge given by the courses. Akin to these courses, the choreography crash-course supported all students' engagement through embodied actions; by embodying body movements with sound and materials. These three workshops were the ones where all the students got the chance to embody the presented disciplines' practices.

On the other hand, as educators, we also realize that not all the crash-courses provided active interaction for all students. For example, HCI's crash-course was restricted in supporting participation and hands-on interaction of all students; the apparent reason was due to its technical requirements that were absent in students from other backgrounds. Additionally, the music crash-course worked as a binding element between dance and HCI, which unfortunately lacked to support textile design students' engagement. Despite these difficulties, this course concerned a first attempt to create such a multidisciplinary educational environment within four different institutions in Estonia. Therefore, without a doubt, we, as educators, learned from this journey in order to better support the multidisciplinary educational environment. On the other hand, regarding the students' feedback and the presented works, it can be said that the course was successful in the way that it supported multidisciplinary creative exchange by embodied learning actions.

Another goal of the project was to propose new possible identities and purposes for the disciplines involved. In the face of the fast-evolving creative context of the last decades, there have been great advancements in all these fields. However, questions on how to continue innovating persist. Multidisciplinarity and collaboration are increasingly common proposals. By engaging in collaborative projects, we contribute to the evolution of the separate fields and generate more opportunities for shared knowledge and spaces to work together.

The project Rings exemplifies how the interactive space that engages the audience can bring a new dimension to textiles. The performance needs the collaboration of many interactive pairs to get completed: body-movement, body-technology, body-textile, textile-space, audience-space, dancer-audience, sound-space. These areas are delved upon not only in collaboration with each other and used to serve the purpose of generating an experience for the public, but they also depend on each other in order to create. When integrating these fields,

they are expanded because there is a network of interdependence that goes beyond traditional collaboration.

Conclusions

When designing for a performative context, a new view on materiality and sensoriality is enabled as the designer must consider not only the typical passive visual and tactile qualities of textiles but also their active qualities (movement and sound). Additionally, they must also account for other more complex sensorial properties related to the non-experienced sense, which requires the design of all of these sensory properties together with other atmospheric characteristics (light design, staging, etc.) to create curated energies that render a higher experience for the audience.

As creators, we are always seeking to create something meaningful, yet in collaborative projects, the mere exchange of ideas and experiences is already in itself meaningful. While individual creative work often stems from the inevitable drive to fulfill oneself's expectations, philosophies, and identities, projects which result from the dialogue and intersection of different minds comprise a bit of many individual egos in a single common entity. They emerge from a group of thinkers and makers who put their minds and resources together not only to create something meaningful for their individual selves but also everyone else involved. By needing to adapt, merge, and intersect different ideas and goals into one, there is a democratization of the artwork and an approximation to the spectator. By reaching a compromise and focusing on serving the collective idea, a greater opportunity is generated to detach the created object's drive from the needs of the individual ego towards feeding the collective experience. The potentiality in collaborative creations is expanded because there are many hands, minds, eyes, and ears working on the same outcome. As such, the different elements that comprise the collective artifact are constantly questioned and discussed. The number of ideas and different points of

view that are brought to the table naturally tend to be more extensive than that of a single mind at work. In conclusion, whilst individual creation's value sets on the exploration of the self, in collaborative projects of co-creation and joint-responsibility, the limits of the individual and collective self are more diffuse. Every decision is made towards serving something transcendent to the individual selves, which is common to everyone, thus becoming universal.

We are now not only in the midst of a health crisis but also of a crisis of human relationships. If before artists and designers fought to physically approximate people and push against the distancing consequences of living in an ever more digital era, the attempt for physical proximity could be considered unethical in these pandemic times. The role of art and design today has completely inverted, making the call for social distancing urgent and necessary. So what is our role as creatives in times such as these? The world and the way we view human contact might never be the same. It is necessary to think about how, as creatives, we can maintain a sense of community even when this community does not physically exist anymore. We must ponder the consequences of digitizing human connections and encounters and how amid this digital era (which has only been fast-tracked by the pandemic), we can still preserve one of our most primal human needs: to connect. Since the beginning of the pandemic, creatives of all sorts have come together to maintain a sense of community and simple human connection when we must physically disconnect from the public sphere. Collaborative projects and embodied learning practices are now more pertinent and necessary than ever. They yield a sense of community and help to preserve our social ways amid this crisis of isolation by generating creative exchange and producing an approximation to the spectator, other disciplines, and creators.

Collaboration and multidisciplinarity in educational contexts have significant potential in expanding the horizons of students' future working places, areas, and fields and determining with whom the students consider collaborating in the professional sphere after graduation. By presenting two performative multidisciplinary collaborative projects involving design, HCI,

sound, and movement students, this paper invites reflection on the importance of multidisciplinary collaborative projects supported by embodied learning as creators and promoters of new knowledge.

References

Anderson, L. (1986). *Home of the brave (video).* United States: Warner Bros.

Berzowska, J. (2005). Electronic textiles: Wearable computers, reactive fashion, and soft computation. *TEXTILE*, *3*(1), 58–75. doi: 10.2752/147597505778052639

Betzenbichler, F., Eymannsberger, C., Glück, F., Kirmaier, C., & Schneider, M. (2017). *Sitisizer - interactive sound installation.* Vimeo. Retrieved June 8, 2020, from https://vimeo.com/197682935

BITalino. (2020). *Hardware.* Retrieved June 4, 2020, from https://bitalino.com/en/hardware

BITalino R-ioT. (2020). *Bitalino r-iot kit full-featured 9dof wireless imu in a stamp- sized package with direct osc streaming over WiFi.* Retrieved June 4, 2020, from https://bitalino.com/en/r-iot-kit

Castán, M., & Suarez, D. (2017). Textile choreographies: Bridging physical and digital domains in the context of architectural design. In *Proceedings from EKSIG2017: Alive. Active. Adaptive. Experiential knowledge and emerging materials.* Rotterdam, Netherlands: Delft University of Technology Het Nieuwe Instituut.

Choreography. (2020). In *Oxford advanced learner's dictionary online.* Oxford University Press. Retrieved May 14, 2020, from https://www.oxfordlearnersdictionaries.com/definition/english/choreography?q=choreography

Composer. (2020). In *Cambridge english dictionary.* Cambridge University Press. Retrieved from https://dictionary.cambridge.org/dictionary/english/composer?q=composers

Cutecircuit. (2020). *The sound shirt | Junge symphoniker hamburg.* Retrieved from https://www.youtube.com/watch?v=8V3XQZZCED4

Da Silva, H. P., Guerreiro, J., Lourenço, A., Fred, A. L., & Martins, R. (2014). BITalino: A novel hardware framework for physiological computin. *PhyCS*, 246–253.

Demir, A. D. (2020). AURA: Altering self-perception through interactive light emitting textiles. In *Proceedings of the 11th Nordic conference on human-computer interaction: Shaping experiences, shaping society* (pp. 1–3). New York, NY, USA: Association for Computing Machinery. doi: 10.1145/3419249.3421234

Donneaud, M., Honnet, H., & Strohmeier, P. (2017). *Designing a multi-touch e-textile for music performances*. Copenhagen, Denmark: Aalborg University.

Eesti kontserdimajad. (n.d.). In *Concert series 'Curioosum' between fields of research.* Retrieved from https://concert.ee/en/kontsert/kontserdisari-curioosum-uurimisvaljade-vahel-festival-commute/

Eesti muusika- ja teatriakadeemia esitleb. (n.d.). In *Commute.* Retrieved from https://commute.art/

Electric girls. (1884, April 26). New York Times. Retrieved February 2, 2020, from https://www.nytimes.com/1884/04/26/archives/electric-girls.html

Fleischmann, K., & Hutchison, C. (2012). Creative exchange: An evolving model of multidisciplinary collaboration. *Journal of Learning Design*, *5*(1), 23–31.

Fugate, J. M. B., Macrine, S. L., & Cipriano, C. (2019). The role of embodied cognition for transforming, learning. *National Journal of School & Educational Psychology*, *7*(4), 274–288. doi: 10.1080/21683603.2018.1443856

Gurbuz, B., & Fatato, M. (2018). *Skene.* Retrieved from http://www.interactivearchitecture.org/lab-projects/skene

Hertenberger, A., Scholz, B., Contrechoc, B. S., Kurbak, E., Perner-Wilson, H., Posch, I., ... Nachtigall, T. R. (2014). 2013 E-Textile swatchbook exchange. In *Proceedings from the 2014 acm international symposium on wearable computers: adjunct program* (pp. 77–81). New York, NY: Association for Computing Machinery. doi: 10.1145/2641248.2641276

Honauer, M. (2018). Designing a remote-controlled interactive dance costume. In *Proceedings from the 5th international conference on movement computing (MOCO'18).* Genoa, Italy.

Human-computer interaction (HCI). (2020). Interaction Design Foundation. Retrieved from https://www.interaction-design.org/literature/topics/human-computer-interaction

Kontra, C., Lyons, D. J., Fischer, S. M., & Beilock, S. L. (2015). Physical experience enhance science learning. *Psychological Science*, *26*(6), 737–749. doi: 10.1177/0956797615569355

Kruusement, S., Neves, I., Peniche, D., & Wójcik, N. (2019). *Rings. Report No. 1.* [Unpublished online document for personal communication].

Kuusk, K., Tajadura-Jiménez, A., & Väljamäe, A. (2020). A transdisciplinary collaborative journey leading to sensorial clothing. *CoDesign*, *16*(4), 311–327. doi: 10.1080/15710882.2020.1833934

Kuusk, K., Tajadura-Jiménez, A., & Väljamäe, A. (2019). Magic lining: Crafting multidisciplinary experiential knowledge by changing wearer's body-perception through vibrotactile clothing. In *Proceedings of the international conference 2019 of the drs special interest group on experiential knowledge* (pp. 186–200). Tallinn, Estonia: Estonian Academy of Arts.

Lamontagne, V. (2017). *Performative wearables: Bodies, fashion and technology* (PhD thesis). Concordia University.

Liang, A., Stewart, R., & Kinns-Bryan, N. (2019). Design of textile knitted stretch sensors for dance movement sensing. In *Proceedings from the international conference on the challenges, opportunities, innovations and applications in electronic textiles.* London, England.

Lurie, A. (1981). *The language of clothes.* New York, NY: Random House.

Mackrell, J. R. (2019). Dance. In *Encyclopædia britannica.* Retrieved May 14, 2020, from https://www.britannica.com/art/dance

Maubrey, B. (2021). *The line.* Retrieved March 2, 2021, from https://benoitmaubrey.com/the-line/

Multidisciplinary. (2020). In *Oxford advanced learner's dictionary online.* Oxford University Press. Retrieved June 11, 2020, from https://www.oxfordlearnersdictionaries.com/definition/english/multidisciplinary?q=multidisciplinary

Murray-Browne, T., Aversano, D., Garcia, S., Hobbes, W., Lopez, D., Sendon, T., ... Chapman, D. (2014). The cave of sounds: An interactive installation exploring how we create music together. In *Proceedings from the international conference on new interfaces for musical expression.* London, England: Goldsmiths, University of London.

Pennington, D. D. (2008). Cross-disciplinary collaboration and learning. *Ecology and society*, *13*(2). Retrieved from https://www.jstor.org/stable/26267958

Persson, A. (2013). Exploring textiles as materials for interaction design. In H. L. (Ed.), *Proceedings from the 3rd service design and service innovation conference* (pp. 53–63). Retrieved May 25, 2020, from https://www.diva-portal.org/smash/get/diva2:877042/FULLTEXT01.pdf

Pigao, P. (2018). *Pearla pigao - playing patterns.* Retrieved September 15, 2019, from https://www.norwegiancrafts.no/articles/pearla-pigao-playing-patterns

Ruth, K. (2018). *The warp and weft of kelly ruth.* Retrieved May 10, 2020, from https://www.musicworks.ca/warp-and-weft-kelly-rut

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign*, *4*(1), 5–18. doi: 10.1080/15710880701875068

Sound Music Movement Interaction – ISMM. (2017). *R-IoT.* Retrieved June 4, 2020, from http://ismm.ircam.fr/riot/

Stewart, R. (2019). Cords and chords: Exploring the role of e-textiles in computational audio. *Frontiers in ICT*, *6*, 2. doi: 10.3389/fict.2019.00002

Tajadura-Jiménez, A., Väljamäe, A., & Kuusk, K. (2020). Altering one's body-perception through e-textiles and haptic metaphors. *Frontiers in Robotics and AI*, *7*, 7. doi: 10.3389/frobt.2020.00007

TeamLab. (2018). *Resisting and resonating ovoids: Lost, immersed and continuous.* Retrieved May 10, 2020, from https://www.teamlab.art/w/Ovoids-Lost-Immersed-Continuous/

Ten Bhömer, M., Tomico, O., Kleinsmann, M. S., Kuusk, K., & Wensveen, S. A. G. (2012). Designing smart textile services through value networks, team mental models and shared ownership. In *Proceedings from the servdes '12 third nordic conference on service design and service innovation conference.* Espoo, Finland.

Thorp, E. (1998). The invention of the first wearable computer. In *Digest of papers. second international symposium on wearable computers (cat. no.98ex215)* (p. 4-8). doi: 10.1109/ISWC.1998.729523

Wilde, D. (2007). *hipDisk- augmenting the moving body with sound.* Retrieved June 2, 2020, from http://www.daniellewilde.com/swing-that-thing/hipdisk/#:~:text=hipDisk%20is%20designed%20to%20inspire,full%2Dbody%20movement%20for%20actuation

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, *9*(4), 625–636. doi: 10.3758/BF03196322

Yamaha Corporation. (2019). *Yamaha artificial intelligence (AI) transforms a dancer into a pianist.* Retrieved September 15, 2019, from https://www.yamaha.com/en/news_release/2018/1801310