Mermaids do not exist? Interactive Costumes do!

Figure 1. The Jellyfish costume.

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MUM 2017, November 26–29, 2017, Stuttgart, Germany

ACM ISBN 978-1-4503-5378-6/17/11.
https://doi.org/10.1145/3152832.3156609

Abstract
We here present two interactive costumes deployed for a fairy tale performance of a children and youth ballet. These are the costumes of two underwater world characters, a Jellyfish and a Seahorse. Both costumes sense the performers' motion and decode them to an individual on-body light concept, underlining the role's expressivity while respecting the overall appearance of the show. A major prospect was to develop the interaction concept according to the choreographic work that evolved simultaneously. Finally, the artistic statement of the costume creators and the choreography are integrated concurrently, and resulted in a harmonious and aesthetically pleasant performance.

Author Keywords
Interactive Costumes, E-Textiles, Ballet Performance.

ACM Classification Keywords
J.5. Computer Applications: ARTS AND HUMANITIES: Performing arts (e.g. dance, music).

Introduction
Wearable costumes [6] are now seen fairly frequently in the performing arts, but project examples of interactive costumes at traditional theatre stages are still rare [4]. The children and youth ballet of a local

The Little Mermaid

A Fairy tale by Hans Christian Andersen, 1837:
The Little Mermaid is the daughter of the sea king. She is half human (upper body) and half fish (lower body). After celebrating her 15th birthday, she is allowed to swim to the upper world of humans. Rising to the surface, she observes a handsome prince on his ship and immediately falls in love. A huge storm destroys the ship and the Little Mermaid saves the prince's life while remaining unknown to him. The Little Mermaid wishes to have legs and makes a contract with the sea witch who promises her to become human, but will never be able to return to the underwater world. The Little Mermaid agrees, from now on is a human and starts to live at court, close to the prince. However, he is going to marry another princess who, as he believes, rescued him. The Little Mermaid feels desperate and commits suicide.

theatre house took a chance, and, for the very first time, staged interactive dance costumes for a fairy tale ballet performance. The HCI Group of Bauhaus-Universität Weimar developed the costumes for two supporting dancers in the scene of the Little Mermaid's birthday party – The Jellyfish and the Seahorse. They are the assistants of the sea king who is the Little Mermaid's father and has, together with his court society, a large entry at the beginning of the performance (figure 8). The show lasts about 90 minutes, whereof Seahorse and Jellyfish were onstage for 17 around minutes.

The two interactive costumes have been developed by an interdisciplinary student team, consisting of students from *Computer Science and Media*, *Human-Computer Interaction*, *Media Art and Design*, and *Product Design*. This project is subordinate to a larger-scale research interest on interactive costumes within traditional theatre production processes. Our goal was to develop the interactive costumes within the artistic space given by the ballet production while executing a lab-based costume creation process in close collaboration with the choreographer and the performers, and with a team that combines design and engineering competencies.

Related Work

Free performance groups and artists have demonstrated for years how wearable and e-textile costumes can drive a performance show. Famous stars like U2 [2] or Rhianna [8] have shown customized lighting costume solutions, sometimes produced just for a single event. In contrast, performances with a more traditional theatre production process, less often stage interactive costumes. For instance, the Brooklyn Ballet presents their interpretation of *The Nutcracker* to the public for a few years now. That includes a dozen snowfall tutus and the so-called Pexel shirt [1], sensing performers' motions and turning it into light inside the costume. Further, the *Finish National Ballet* and the *Finish National Opera Orchestra* presented another Little Mermaid production in 2016, where they also made use of light elements for their jellyfish costumes. We found no detail information, neither on the technology used, nor if these jellyfish costumes function interactively.

Artistic Statement

The overall artistic intention of the choreographer who was at the same time the director, wanted to present a colorful and fantastic picture of the underwater world to the public. In particular, the birthday party as opening part of the performance was meant to create a glamorous, shiny, and celebratory atmosphere. Seahorse and Jellyfish are part of this glamourous event, they are the helping hands of the host and spend quite a long time onstage (see figure 8). Hence, we carefully considered what fabrics, materials, and colors to use for the interactive costume, always in coordination with the entire production. Our artistic goal further was to create two interactive costumes that are sensitive to dance movements and using interactive technologies as extension for communication through dance [5]. Moreover, the costumes are to resemble a jellyfish or seahorse, and nevertheless, look aesthetically pleasant as dance costumes.

The Seahorse

The Seahorse costume (see figures 2-4) basically consists of a black leotard. On top, the dancer wears a bodysuit with hood which contains all electronics and is covered by the bright exoskeleton. In sum, we

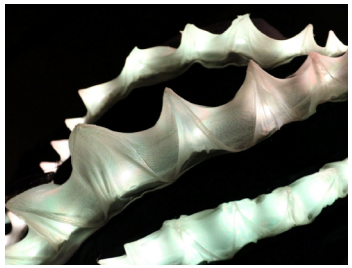

Figure 3. Close-up of the exoskeleton, a combination of 3D printing with fabric.

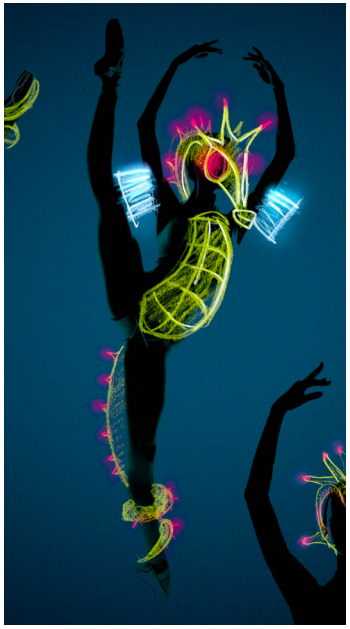

Figure 4. Seahorse design sketch, by Christian Wiegert.

Figure 2. The Seahorse costume in action, changing colors according to sensed motion (velocity, arm movements, and twists).

integrated over 180 addressable LEDs. The idea is to visually let the human body disappear and to have the lighted exoskeleton of a seahorse come to focus. We integrated two accelerometers on the upper arms to sense quick and large dance movements, which again changed the light pattern from yellowish-red to bluish-green and speeded up visual oscillation of light. How to create the exoskeleton (figure 3) was a bit challenging, and after trying out different 3D-manipulation techniques for fabrics, we ended up stretching the net fabric, then 3D-printing a cross-like pattern on it. After releasing from stretch, a flexible and light-weight 3D exoskeleton was ready.

The Jellyfish

The Jellyfish (figures 1, 5-7) is also conceptualized in layers (figure 6): first rosy tights and bodysuit, then a technology layer with more than 110 addressable LEDs, and two cover layers of tulle and organza to diffuse the light. The light is white and slowly pulsates, comparable to a jellyfish's swim movements. The balloon dress stands for the typical umbrella jellyfishes have, and the head band reminds of the gonads. Similar as for the Seahorse, we hid an accelerometer on each upper arm to detect arm up- and down movement. These then trigger a red pixel moving up and down the oral arms underneath the dress respectively. A third accelerometer on the dancer's lower back senses twists, and the light of the dress turns red during spinning moments.

Figure 5. Material inspiration for the Jellyfish costume.

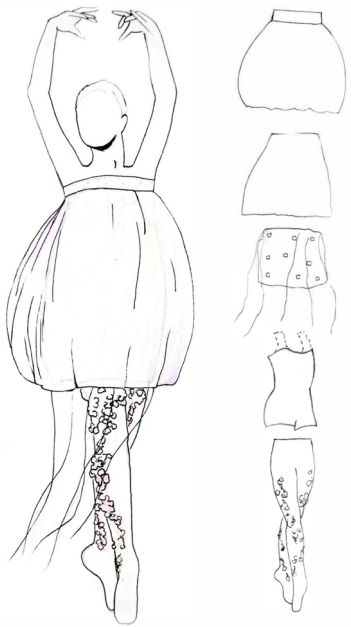

Figure 6. Jellyfish design in layers, by Maike Alisha Effenberg.

Practice-oriented Collaboration

We developed the two wearable costumes in an integrated process that combines the usual *stage costume design process* with the *wearable computer design process*, as suggested by [3]. The costumes are the result of an interdisciplinary approach, forcing fashion design, interaction design, and technical development to work concurrently, and in close collaboration with the performance. Around seven months before the premiere, the pre-production period of the performance started in terms of general choreographic work. In parallel, we started the interactive costume design for Jellyfish and Seahorse, attended rehearsals regularly (every second to fourth week), and tested ideas as well as progress with the dancers and the choreographer. As a result, both costume prototypes were ready when the official production period took place two month before premiere. Then, more costume rehearsals with the performers led to a customized wearable solution for this ballet piece and enabled us to make small improvements on hardware, software, and costume design.

However, our artistic work is at the same time framed by the ballet production. Given constraints informed the interactive costume design over the entire process, such as actuating on-body light, designing for female adolescent dancers, or the need to harmonize with stage aesthetics. We thus have chosen addressable LEDs that can be integrated for dynamic light patterns. We further fitted the costumes a few times for the still growing bodies of our teenager performers. Finally, we made sure that the costumes go well together with other costumes, stage design, and light (compare figure 8).

Figure 7. The Jellyfish, pulsating in white when standing still. The balloon dress turns red for a moment if the dancer is twisting, the tentacles underneath turn red in response to up-down arm movements.

Figure 8. The Seahorse (right front) and Jellyfish (left, behind the sea king) costumes appearing during the Little Mermaid's birthday ceremony in the public performance. Image courtesy of Sabina Sabovic (copyright).

Conclusion

We here presented an artwork that bridges between research on interactive costumes and the real-world production of a traditional theatre house. The costumes for Jellyfish and Seahorse were created by an interdisciplinary team, in close collaboration with the choreographic development, and with full attention to the overall aesthetics of the fairy tale ballet performance. Our experiences feed a mutual understanding across disciplines (choreography, design, and engineering) and purposes (research and cultural event). We further hope to encourage more researchers, designers, technologist, and theatre producers to explore similar project ideas.

Acknowledgements

Many thanks to Claudia Kupsch, the Kinder- und Jugendballet and the theatre staff of Gera/ Altenburg. We further thank Annika T. Meinecke, C. Pauline Bimberg, and Eva Kratz helping to stage the costumes.

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