

# LIGHTness: Interactive Luminous Ballet Outfit

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**Abstract.** The priorities of dressing have broadened and become more complex over the years, creating challenges in developing new products. The technological evolution allied with its democratization has provided new possibilities for experimentation in the area of fashion and clothing in order to meet the current complex expectations. The article presents the experimental development of a transdisciplinary fashion product, which proposes the expansion of the communicability of dance through technological stage design. According to the metalinguistic concept allied to the computational logic pre-established in a project plan, the proposed product has, attached to a ballet costume, sensors to capture movements and transform them into light and colors with different intensities, through direct interaction with the movement direction and intensity. As a result, the LIGHTness project explores the forms, interactivity and light effects of ballet, emphasizing the dichotomy between strength and lightness in this type of dance.

**Keywords:** Ballet, Technological Stage Design, Fashion Product, Interactive Textile, Smart Wearable.

## 1 Introduction

In the field of fashion design, several professionals use clothing and its ability to express and communicate as an object of study. From gala dresses to jeans, all clothes have the potential to communicate an idea and assist in projecting the image of the wearer.

In arts, as well as in fashion, the communication of subjective aspects is, in many cases, non-verbal. For example, the prevalence of cold colours in horror movies, the accelerated rhythm of cheerful music, the fluidity and slowed velocity of the ballerina in a romanticized spectacle, are part of the characteristics of this interlocution. However, these elements do not constitute a dialogue in an autonomous way, but rather they constitute a set of elements that, when combined favourably, allow creating a desired climate.

This article presents the experimental development of a transdisciplinary fashion product that proposes to unite art and technology. The project results from a challenge posed to students of the MSc course in Design and Marketing at University of Minho, Portugal. The task sought to approach design students to the possibilities of technology

by designing an interactive textile product. Specifically, the assignment was to create an interactive textile product using sensors and light. The authors focused on producing an interactive ballet dress.

Costumes and clothes are considered one of the most important elements of success in a spectacle [1]. Besides the skills of the dance professionals, the costumes and the scenarios build the atmosphere of the show, helping to construct and enhance the emotion and beauty presented by the dance.

In the universe of dance, the dancers' movements and their dramatization are the key factors to construct the information that will be communicated within the plot. The viewer should perceive a natural ease of the dancer in performing the moves, which is achieved by expressing softness and lightness in executing the movements in a choreography. However, it is known that muscular strength is fundamental for the dancer to develop a good movement execution [2]. Citing [3]: "The performance of the movements supposes technical perfection and, despite the harsh characteristics, the ballet tries to exalt lightness, delicacy and beauty, which are attributes associated with the feminine gender."

Focusing on exploring the dichotomy between the light and fluid beauty presented by the ballerinas and their strength and commitment used during the execution of ballet steps, the concept was developed as "lightness and strength", later renamed as "LIGHTness, wearing dance". This concept, applied to clothes, has the objective of materializing through lighting the moments in which strength and intensity are present in the performance.

## **2 Background and state-of-the art**

### **2.1 Smart wearables**

Wearable technologies, e-textiles, electronic textiles and smart fabrics are terms that indicate the application of electronic and other technologies, aiming to offer additional functions to worn objects, e.g. clothing and accessories [4]. The advance of researches in this area is growing and has close relationship with the wide development of computing, its miniaturization, democratization and multiple applications at individual and customized levels.

Among the research topics in this area it is possible to notice the wide range of applications, from medical, rehabilitation, enhancement of military articles, traffic safety, pure technology experiments, such as experimental laboratories [5] and projects of an artistic-conceptual objective in the area of fashion. Previous projects resulting from work in the MSc in Design and Marketing at University of Minho approach the interactivity between wearables and environment in daily life and in arts [6][7].

### **2.2 Interactive art projects in ballet and dance**

Several commercial products exist in luminous dresses for dance and ballet. The company Etereshop proposes "interactive tutus" and "wing dresses" [8]. Whilst some of

these products display a static LED light pattern, others can be pre-programmed or controlled remotely. A direct interaction between the dance movements and the dress is not present. Still, beautiful spectacles can be observed [9].

Another example of a ballet show using a pre-programmed LED ballet tutu was choreographed by Nicolai Kabaniaev. In this case, a synchrony between dance, music and light effects exists, achieved through careful preparation and rehearsal [10].

The project "E-Traces" by Lesia Trubat uses ballet pointe shoes with sensorized tips that allow dancers to translate their movements into digital images in a mobile application [11]. In this case, true interaction between dance and effect exists.

In the project herein described, the intention was to transform the dance movements into light effects that emphasize the dancer's strength and elegance in real-time, in a truly interactive effect that adds beauty and complexity to the spectacle.

### **3 Objectives**

As pointed out before, the authors intended to explore the dichotomy between lightness and fluidity presented during ballet performance and the strength, the effort required to produce this perception.

To implement this concept it was proposed that the movements should be materialized through light emitting devices embedded discretely in the ballet dress or accessories.

Fundamental requirements for the final product are a non-intrusive integration of the electronic components and light emitting devices in the ballet dress, sufficient autonomy for the performances and an attractive and innovative aesthetical design.

### **4 Methodology**

The work was divided into three main stages. The first one was exploratory, researching academic, commercial and other sources for previous projects that could be inspiring and guiding to the current implementation, or other that could be translated to the ballet universe. In this phase, also an extensive search for materials, technologies and products enabling the development of the desired product was carried out.

In the second phase, the work focused on the thematic selection for the product to be addressed. Starting from the potential of the textile base material of the project, the possible application to the scenic dance spectacles was considered. A data search and analysis in the contexts of show business, productive partnerships and ballet professionals was carried out.

Finally, a design methodology was applied for product development. At this point, the concept and morphological orientations of the product were elaborated, as well as the generation of alternatives, analysis of the technical feasibility, selection and development of the project. The result was a construction of the concept project and finally the implementation and testing of the prototype.

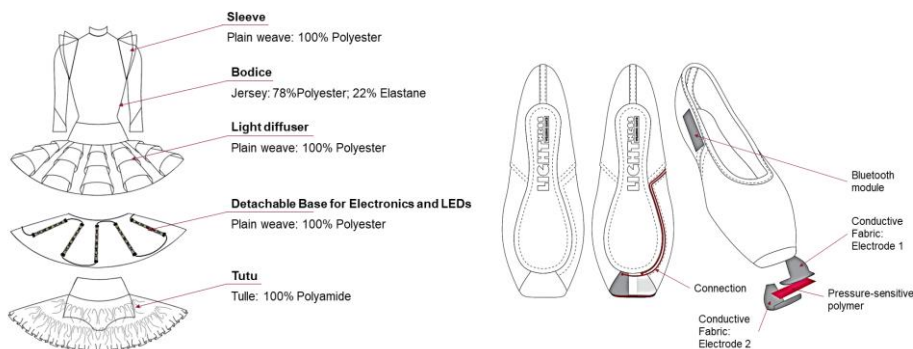
## 5 Results and discussion

The final concept of the project was to test the aesthetic and communicative possibilities of apparel by interpreting and displaying effort of the dancer during the performance. For this purpose, the interactive product should represent the dancer's movement direction and intensity using light movement, intensity and colours. A second feature defined for the product was to detect force applied on the ballet shoes, when the dancer is in the difficult "en pointe" position. This effort should be emphasized and rewarded by additional light effects.

The developed product is divided into three fundamental parts: the **costume**, the central **electronic platform** and the **sensing pointe shoes**.

### 5.1 The costume

At a conceptual-aesthetic level, the ballet costume construction was based on structures that offer a sense of strength, such as combat armour, and were built with fluid materials that show lightness, such as tulle fabric and a light plain weave, in white colour. Another element used were fabrics capable of assigning a diffusion effect to the light from the LEDs. Fig.1 shows the schematic design of the developed concept, its hierarchy and the material selection.



**Fig. 1.** Ballet costume and shoes, schematic drawings and details.

### 5.2 Electronic platform

To implement the electronic platform, independent devices were developed to gather most of the electronic elements. This optimises fundamental factors such as portability; stability; safety and easy removal were observed to assist in the outfit's maintenance and storage.

The platform consists of a central controller module, two peripheral modules at the pointe shoes and LED strips. All of the modules are based on the Arduino Nano proto-

typing platform. The central controller includes a three-axis MMA7361L analogue accelerometer module and uses the nRF24L01+ communication module to receive force information from the shoe modules. WS2813 programmable LED strips are distributed evenly over its textile support. Segments of 6 LEDs are placed vertically on the support and linked by specific connectors. The circuit is fed by a 3.7V LiPo battery combined with a DC-DC converter to boost voltage to 5V.

### 5.3 Pointe shoes

The classic ballet pointe shoes are fundamental to execute a good performance, since they add beauty to the dance and their physical construction provides support for the execution of the techniques, especially for the “en pointe” position.

The pressure sensors used are piezoresistive sensors based on Velostat. Velostat is a flexible piezoresistive polymer film. To incorporate the sensors in the shoes, it was necessary to make small modifications to the traditional ballet shoes. This was made at the external part of the shoe, in order not to interfere at the functional level and comfort, Fig.1 shows the schematic representation of the shoe. The sensor was added to the pointe and was then covered with fabric similar to the one of the shoe by gluing. Two wires connect the sensor to a small box containing an Arduino Nano with the nRF24L01+ communication module, 3.7V LiPo battery and DC-DC converter.

### 5.4 Interactivity

In order to materialize the objectives, a chromatic variation linked to luminous effects representing the physical effort and force was proposed. The chromatic variation ranging from cold colours, at moments where less movement is present, to warmer colours at moments of greater effort was implemented using the signals of the accelerometer. Moreover, the spatial information provided by the combination of the signals in the three axes of the accelerometer was used to light the LEDs in a way that can represent a sense of directionality of the movement (jumps, left and right rotations and combinations). Finally, the “en pointe” position is detected by the pressure sensor in the shoes and produces an intense glitter effect. Although it was intended to quantify the pressure and make the glitter’s intensity proportional to it, in a first version of the dress the same glitter effect is produced whenever the dancer is in the position.

### 5.5 Presentation

The proposed costume has an experimental, objective, poetic and metalinguistic character. In addition, it is intended to express the dichotomy between the force employed by the ballerina and the visual result of the ballet steps during the act of dancing (Fig.2).

As an experimental project, the product was developed using electronic components available on the market. Therefore, the result is a functional prototype that can be significantly enhanced regarding miniaturization and integration of the material.



**Fig. 2.** Visual effects

In a first test by a professional ballerina, the glitter effect associated to the “en pointe” position resulted as a pleasant surprise in what concerns an actual reward and enhancement of this noble and difficult technique. The display of movement was poor due to a lack of sensitivity to the movement. This was not due to the accelerometer, but to the thresholds and levels defined in the controller’s firmware.

In a second moment, after adjustment of these values, a true sense of directionality and intensity could be observed in the light effects produced. A problem was observed with the connectors used to link the individual LED strip segments, at which bad contacts generated by movement would sporadically generate pixel display errors. This was later solved by applying tin solder to the contacts at the connectors.

## 6 Conclusion

In the art scene, the aesthetic increase as a conceptual reinforcement is constantly used. The development of the costume presented, even with an experimental character, highlights the importance of the spectacle, emphasizing the search for new platforms that could communicate and connect with the public by showing, for instance, the dancers’ feelings. With this proposal, we believe that the body language and power of dance communication are increased, because it surpasses the communication of a traditional costume, presenting a luminous interactive aesthetics resulting from choreography. Beyond the sheer representation of force during the dance, the luminous answers may allow people to implement different concepts, being able to collaborate aesthetically and conceptually in different spectacles.

In the universe of smart wearables, the project shows itself to be innovative and with potential for commercial relevance. The devices that capture the interaction, especially the pressure sensors, are perfectly integrated into the costume without interfering with the primary performance.

In addition to the construction of an interactive ballet outfit, the project presents new possibilities for research and development of interactive electronic products in the ballet area. For example, pointe shoes with a pedagogical character that help trainees by

indicating the correct position of the feet using their ability to perceive shoe position and pressure distribution of the tip in contact with the floor. Besides incremental improvements to the current prototype (especially regarding miniaturization and weight reduction), the use of the shoe sensor for assessment of correct positions in dance training is a subject with potential for future work.

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