

# Usability Heuristics for Costume Design and Quality Ergonomics in the Entertainment Industry

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## ABSTRACT

The entertainment business continues to push the limits for human performance and technologies by augmenting performances with costume technologies. A major challenge in the design and applications of costumes is the lack of ergonomic standards to ensure successful performance while minimizing injuries. This paper will present an application of Nielsen's usability heuristics to create heuristics for costume design with the usability principles for user interface design reimagined and applied to costume design. Fourteen usability heuristics make up the framework for the Costume-Apparatus Usability Heuristics (CAUH), with two strategies for applying the CAUH. One strategy evaluates the usability of each costume element separately, which is useful because the costume-apparatus elements are frequently designed and produced by different people. The second strategy is a more holistic evaluation of the configuration of costume elements and their impact across the full lifecycle of the performance. The implications for the adoption of the CAUH within the entertainment industries can produce multiple benefits, from reducing injuries to enabling visionary performances.

**Keywords:** Costume design, Costume-apparatus usability heuristics, Human performance, User interface heuristics, Human performance, Usability evaluation

## INTRODUCTION

Human performance is an interdisciplinary focus that includes human and environmental factors to accomplish goals or meet task requirements (Beneke & Böning, 2008; Stanton & Barnes-Farrell, 1996). The testing and evaluation of human performance has been an area of interest in several industries, including military personnel training, virtual reality simulators, and surgeons (Casali et al., 2019; Cadeddu & Kondraske, 2007; Hennessy, 1990). According to the International Ergonomics & Human Factors Association (IEA) in 2000, a specific domain of human factors/ergonomics (HFE) is physical ergonomics which encompasses anatomical, anthropometric, and biomechanical characteristics related to physical activity. Physical ergonomics focuses on preventing injuries in the workplace caused by performance of work or the conditions of the work environment, and in turn can lead to work-related musculoskeletal disorders (WMSDs) and vary in severity from mild to intense (Odebiyi & Okafor, 2023). The National

Institute for Occupational Safety and Health defines WMSDs as injuries that affect the musculoskeletal, nervous, and neurovascular systems and are caused by workplace hazards (NIOSH, 1997). There is a multitude of HFE analytical methods that are utilized to objectively measure and evaluate ergonomics. From hand tools to laparoscopic surgery and muscle strain to work conditions, ergonomic assessments and standards have been developed to target specific issues addressed throughout various industries (Das, 2007; Matern et al., 2005). The goal of ergonomics is to create a work environment that reduces the rate of WMSDs by creating a set of guidelines and principles to follow to decrease ergonomic hazards. These ergonomic hazards include repetitiveness and pace of work, forceful motions, extreme temperatures, compromised work-posture and movement, and work equipment or inadequate work methods (Odebiyi & Okafor, 2023). There are research gaps to establish ergonomic requirements that would safeguard the well-being and work performance of entertainment performers. However, the entertainment industry does not have standardization or properly tailored ergonomic assessments for costume design and human performance interactions. The application of Dr. Nielsen’s usability heuristics as a blueprint to develop specific usability heuristics for costume design will yield positive results. Therefore, the creation of usability heuristic guidelines for the entertainment industry to follow with HFE standards would lower injury rate, improve performance and productivity, and support good musculoskeletal health.

**Nielsen’s Usability Heuristics**

Dr. Jakob Nielsen developed a set of usability heuristics specifically for the design of computer interface usability. These heuristics were utilized in their own evaluation to supplement user testing because that is the prioritized usability method for developing user experience projects (Nielsen, 1994). From Nielsen’s list, there are ten foundational usability heuristics to identify each usability problem on a computer user interface and to determine the severity of the usability issue when a heuristic evaluation is conducted. In Table 1, each of Nielsen’s heuristics is listed with a description to provide guidance on creating interfaces with minimal usability problems.

**Table 1:** Nielsen’s 10 usability heuristics (Nielsen, 1994).

| Heuristic                               | Description                                                                                          |
|-----------------------------------------|------------------------------------------------------------------------------------------------------|
| Visibility of system status             | Keeps users informed with timely and relevant feedback.                                              |
| Match between system and the real world | Language usage aligns with the everyday speech and experiences of what people already know.          |
| User control and freedom                | Users control the system and can exit the system if a mistake is made (i.e., undo and redo actions). |
| Consistency and standards               | Words, concepts, and situations refer to the same thing and follow common platform standards.        |

Continued

**Table 1:** Continued

| Heuristic                                               | Description                                                                                                                                          |
|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Error prevention                                        | Prevents high-cost errors from occurring and eliminate error-prone conditions by adding a confirmation option before committing to the action.       |
| Recognition rather than recall                          | Minimize the user's memory load with visible elements and actions. Should not put user in a state to remember information from a previous interface. |
| Flexibility and efficiency of use                       | Caters to different users ranging from inexperienced to experienced and allows users to tailor frequently used actions.                              |
| Aesthetic and minimalist design                         | Do not include irrelevant or rarely needed information that could cause distraction and keep displays simple.                                        |
| Help users recognize, diagnose, and recover from errors | Error messages should be expressed in plain language, precisely indicate the problem and suggest a solution.                                         |
| Help and documentation                                  | Site contains a help facility and other documentation to support users' needs; easy to search and focused on the user's task.                        |

Nielsen's usability heuristics have been utilized outside of being applied to user interfaces. In a study conducted by Zhang et al. (2003), Nielsen's traditional heuristic evaluation was modified to assess and identify usability problems on medical devices and patient safety when using these devices. This study developed its own set of usability heuristics for medical devices by combining Nielsen's ten heuristics for good user interface design and Shneiderman's (1998) eight golden rules that good interfaces should follow for the best design. For this paper, the Nielsen-Shneiderman list that was used in the Zhang et al. (2003) study will be reimagined and utilized toward costume design to enable usability testing in this line of business for the safety of entertainment performers.

### **Ergonomic Costume Design**

When costume designs are made, ergonomics is considered because both fashion and ergonomics hold a direct relationship to the human body as it is their common denominator (Cabral & Manuel Figueiredo, 2022). Clothing ergonomics is a human-centered subject of fashion design that focuses on the materials, uses, and needs of all people where designers create products that meet the harmony of human to clothing to environment (Yang, 2016). The goal of this subject is to create clothing designs to make wearable art for people with the best matching provision to be more comfortable, sanitary, functional, and appeal in appearance. Some researchers have explored the combination of ergonomics with the principles of universal design to fashion

products/clothing to develop strategies for market expansion and increase volume of production while reducing prices (Martins & Martins, 2012). This concept of ergonomic costume design in fashion can reform the change from people adapting to clothing to instead be the clothing adapts to the people. However, costume design in the entertainment industry expands beyond everyday fashion because there are demands/requirements related to aesthetics, material, and functionality that must fit the artistic vision of the production. In the area of performing arts, a performance is an event that requires the physical presence of trained or skilled humans who demonstrate their skillset through choreographic movement and staging (Bial, 2006). These skilled individuals are referred to as performers and wear costume pieces that align with the creative vision of the performance. These costume pieces can take form as pedestrian clothing, apparatuses such as harnesses that are weight-bearing, or fully cover the performer, but they all serve as a visual medium to convey their character portrayal, mood, or the setting based on the decisions of creative directors. The entertainment industry presents different types of performances (film, dance, theater) beyond an indoor venue. The environment for performances can vary from being on an outdoor stage to a parade in the streets or even be interactive with the audience. Therefore, these differences in comparison to everyday fashion pose variables that are not targeted by current research in clothing ergonomics and universal design in fashion. Consequently, the development of usability heuristics for costume design are proposed to detect and assess the severity of usability issues within performers' costumes.

## **METHODOLOGY**

### **Heuristic Evaluation**

Heuristic evaluation is a cost-effective usability inspection method that reveals usability problems of a product. This type of evaluation is conducted by multiple evaluators to apply the list of usability heuristics to the product and identify which violations of the heuristics are present and then rate the severity of each one if applicable. This usability evaluation is classified as more informal due to the assistance of the heuristics list and the knowledge of the evaluators (Nielsen, 1994b). In this paper, the usability heuristics established by Nielsen and the adjustments made by Zhang et al. (2003) are altered for criteria that best fit for the evaluation of costume design usability.

### **Costume-Apparatus Usability Heuristics**

Costume-Apparatus Usability Heuristics (CAUH) is the derivative list of fourteen heuristics that share the same names as the list presented by Zhang et al. (2003) that merged the heuristics of Nielsen (1994) and the usability ruled by Shneiderman (1998). In Table 2 below, the title names of the heuristics are referred to as the User Interface Heuristics (UIH) in the first column with a description of the proposed CAUH for costume-prop applications.

**Table 2:** Nielsen-Shneiderman user interface heuristics (UIH, Nielsen, 1994; Shneiderman, 1998; Zhang et al., 2003) vs. Costume-apparatus usability heuristics (CAUH).

| User Interface Heuristics      | Costume-Apparatus Usability Heuristics                                                                                                            |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Consistency and standards      | Instructions for wearing the costume-apparatus must be used consistently and develop standards that are easily understood by the users.           |
| Visibility of system state     | The performer must be able to see the audience view which informs the user with feedback to adjust the display of the costume-apparatus properly. |
| Match between system and world | Costume-apparatuses should only contain elements familiar to users based on what is worn in their everyday life.                                  |
| Minimalist                     | Too many fastening parts to the costume-apparatus increases the time to apply and remove wearable pieces in case of emergency.                    |
| Minimize memory load           | Too much complexity to the costume can create confusion and frustration.                                                                          |
| Informative feedback           | Training in using the costume-apparatus is required and performer-instructor feedback is essential for successful onboarding.                     |
| Flexibility and efficiency     | Customization options should be available to meet the needs and preferences of performer.                                                         |
| Good error messages            | There should be indicators for the costume shifting from the current safety standard.                                                             |
| Prevent errors                 | Reinforcements and redundancy in attachments and adjustments to ensure costume-apparatus is properly secured.                                     |
| Clear closure                  | The costume-apparatus should have a definitive starting point and endpoint from when a user first puts on the pieces of it to the completion.     |
| Reversible actions             | Every aspect of the costume-apparatus should contain a reversible action to undo the initial action.                                              |
| Use users' language            | Language used to describe the aspects of the costume-apparatus should align with the mental models and expectations of the user.                  |
| Users in control               | Performers should be able to adjust the costume-apparatus to minimize discomfort.                                                                 |
| Help and documentation         | Documentation that provides visuals and written instructions on how to construct/wear the costume pieces.                                         |

### Severity Rating Scale

If a heuristic above is violated, the evaluator will classify the severity of the usability issue based on the following scale (Nielsen, 1994b):

- 0: not a usability problem
- 1: cosmetic problem only; needs to be fixed if allotted time
- 2: minor usability problem; fixing this is assigned low priority
- 3: major usability problem; important to fix and should be assigned a high priority
- 4: usability catastrophe; imperative to fix before the product (e.g. costume) can go into production.

When the evaluator is rating the usability problem, there are certain considerations to assign the proper level of severity. Such considerations include the persistence of impact that the problem will have on the costume and performer. If the usability issues is a problem only once or will it be a recurring issue that interferes with the users' performance and comfort is a critical consideration. A one-time minor problem becomes a major problem when it presents itself 30 times during a 45-minute performance. Usability problems that become persistent will be given a higher severity rating.

### Procedure

The costume displayed in Figure 1 was evaluated using the following strategies. Two usability experts independently evaluated the costume and produced a separate list of heuristic violations according to the CAUH described in Table 2. The evaluators identified the heuristic violations, provided a description of the problem, and rated the severity as shown in Table 3 below.



**Figure 1:** Entertainment performer wearing the costume-apparatus evaluated using the reporting strategies.

## Reporting Strategies

**Strategy #1:** A single costume element can have multiple heuristic violations and evaluators can target their usability assessments for a single costume element. This strategy's strength is its targeting to specific sources of usability problems that would get assigned to specific staff responsible for improving that costume element. Once the evaluators have completed their independent heuristic evaluation, their results are combined to create a mean severity rating so that the costume designers can prioritize the usability problems for resolution.

**Table 3:** CAUH for strategy #1.

| Place of Occurrence       | Usability Problem Description                                                                                                         | Heuristics Violated            | Severity Rating |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-----------------|
| The bodice of the costume | The zipper of the bodice is oriented to zip close in a downward motion rather than upward.                                            | Match between system and world | 2               |
|                           | There are eight snap buttons that are randomly placed with no apparent pattern to follow for additional layering on the bodice piece. | Minimalist                     | 2.75            |
|                           | User (performer) cannot adjust the bodice themselves and require assistance to put it together on their body.                         | Users in Control               | 3.5             |

**Strategy #2:** The usability evaluation is conducted on the complete configuration of costume elements. The benefit of this strategy is that it identifies the interactions between different costume elements during a complete performance which the designers of the costume elements may not have considered.

**Table 4:** CAUH evaluation using strategy #2.

| User Interface Heuristics | Costume-Apparatus Usability Heuristics                                                                                                  | Butterfly Costume                                          | Severity Rating |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------|
| Consistency and standards | Instructions for wearing the costume-apparatus must be used consistently and develop standards that are easily understood by the users. | Verbal instructions by different costumers not consistent. | 2               |

Continued

**Table 4:** Continued

| User Interface Heuristics      | Costume-Apparatus Usability Heuristics                                                                                                            | Butterfly Costume                                                                                                                                                                                                 | Severity Rating |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Visibility of system state     | The performer must be able to see the audience view which informs the user with feedback to adjust the display of the costume-apparatus properly. | The orientation and fit of the harnessed wings and antennae head piece maintain position from getting dressed to performance completion. Audience & performers know this is intended to be a butterfly.           | 1               |
| Match between system and world | Costume-apparatuses should only contain elements familiar to users based on what is worn in their everyday life.                                  | Shoes (character heels) are the same brand and style that is used across different roles and familiar across multiple entertainment venues.                                                                       | 2               |
| Minimalist                     | Too many fastening parts to the costume-apparatus increases the time to get dressed/remove wearable pieces in case of emergency.                  | Bodices have multiple zippers and Velcro to attach the wings.                                                                                                                                                     | 3               |
| Flexibility and efficiency     | Customization options should be available to meet the needs and preferences of performer.                                                         | Elaborate costumes are “one size fits most” – so performers are selected by their size to fit the costumes.                                                                                                       | 4               |
| Good error messages            | There should be indicators for the costume shifting from the current safety standard.                                                             | No early warning about costume malfunctions; Costume shifting occurs but the performance does not enable adjustment in the situation.                                                                             | 4               |
| Users in control               | Performers should be able to adjust the costume-apparatus to minimize discomfort.                                                                 | Once performance starts, performers cannot adjust costumes easily; they must leave the parade route if necessary. Some fastening components are not accessible to the performer and require assistance to adjust. | 5               |



## CONCLUSION

The application of a usability heuristic to costume-apparatus design in the entertainment industry can systematically produce outcomes that reliably improve the safety, cost-effectiveness, and entertainment value of the costumes. Incorporating a usability inspection throughout the design process of costumes allows traceability of usability problems that could culminate a major usability catastrophe. The Costume-Apparatus Usability Heuristic (CAUH) evaluations can become another checklist in the design-to-production cycle, creating a usability feedback loop that identifies problems to fix early in the design cycle in a more timely and cost-effective manner. The adoption of CAUH in industry practices can also result in standardizations for the performance costume industry and optimize ergonomic designs that adhere the costume to the human and not vice versa. When human performance is not hindered by improperly designed costumes, especially with repetitious actions, it will reduce workplace ergonomic hazards and WMSDs in performers. Integrating usability evaluations into the entertainment industry can revolutionize both the design process of costumes and benefit the health, safety, and success of the performers to capture the vision of the entertainment production.

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