# ERGONOMÍA OCUPACIONAL

## INVESTIGACIONES Y APLICACIONES

VOL. 17

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## VOL. 17


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# Prefacio

Para la Sociedad de Ergonomistas de México A.C. (SEMAC); la ergonomía se ha distinguido por ser una ciencia cada vez más comprometida con el bienestar humano, ampliando sus intereses y alcances en el estudio de las capacidades y limitaciones del hombre. Las reglamentaciones y normativas existentes en torno a la Ergonomía y Salud Ocupacional existentes en México y que se fraguan en Latinoamérica deben cubrirse por las organizaciones al desarrollar ambientes y espacios laborales confortables y saludables. Pero la Ergonomía debería incluirse en la búsqueda de la mejora en la productividad donde la inversión realizada es retornada para empresas con ergónomos comprometidos.

La Ergonomía también debe aplicarse en la informalidad laboral, donde también se tienen condiciones riesgosas y peligros laborales que vulneran la calidad de vida de quienes los realizan. Así, en México uno de cada dos trabajadores subsiste en la informalidad laboral y esta proporción parece estar aumentando en los últimos años, por lo que representa un desafío complejo con diversas perspectivas, económicas, sociales, ambientales, tecnológicas y de sostenibilidad que amerita un esfuerzo multidisciplinario para atender, reducir y mitigar sus efectos en la población laboral.

Los editores, árbitros y comité académico, a nombre de la Sociedad de Ergonomistas de México, A.C., agradecemos a los autores de los trabajos por compartir investigación en este libro que busca recapitular nuevos conocimientos y aplicaciones creativas. Reconociendo a los autores en su esfuerzo, compromiso y sacrificio al impulsar la ergonomía en su propio entorno social y sector de trabajo específico. Donde su valiosa aportación estamos seguros impulsa y contribuye en el avance de la ergonomía a nivel nacional y mundial en la mejora de entornos de trabajo, el aumento de la productividad organizacional y hacia el interior de las Instituciones de Educación Superior.

Considero que este nuevo libro editado por la SEMAC ha conseguido la meta de difundir y dar acceso libre a estos trabajos que buscan el bienestar de los miembros de empresas y organizaciones. Los invito a leerlos, compartirlos y difundirlos para que sean de utilidad a aquellos estudiosos y practicantes de la ergonomía en México y el mundo y así se consiga el objetivo y lema de SEMAC "TRABAJO PARA OPTIMIZAR EL TRABAJO"

Dr. Carlos Raúl Navarro González
Presidente SEMAC 2024-2026

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# USABILITY ANALYSIS FOR THE DESIGN OF A GLOVE FOR MEASURING FORCES IN THE PALM REGION AND FINGERS

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**Resumen:** Este estudio evalúa la usabilidad del guante Evo Pinch, un dispositivo inalámbrico con sensores de detección de fuerza (FSR) diseñado para medir la fuerza de los dedos, comparándolo con un prototipo rediseñado. Los dinamómetros tradicionales, aunque efectivos, son a menudo voluminosos y difíciles de usar. El guante Evo Pinch ofrece una alternativa más compacta, pero su usabilidad no había sido evaluada sistemáticamente. Cinco participantes de la Universidad Autónoma de Ciudad Juárez probaron ambos guantes a través de una serie de tareas. El guante Evo Pinch original obtuvo un 55% en usabilidad, indicando un nivel "regular". En contraste, el prototipo rediseñado alcanzó un 76%, clasificado como "muy bueno". El rediseño redujo significativamente el tiempo necesario para colocar el guante, de 2 minutos a 43 segundos, y mejoró la satisfacción del usuario. Estos resultados destacan la importancia del diseño iterativo y las pruebas centradas en el usuario en el desarrollo de dispositivos ergonómicos, demostrando que las pruebas de usabilidad pueden llevar a mejoras sustanciales en la eficiencia y la experiencia del usuario. Esta investigación subraya la necesidad de evaluaciones continuas de usabilidad para optimizar el diseño y la funcionalidad de dispositivos utilizados en la investigación ergonómica y de factores humanos.

**Palabras clave**: Usabilidad, Análisis, Evaluación, Diseño

**Relevancia para la ergonomía**: Relevancia para la ergonomía: este estudio enfatiza la importancia de utilizar herramientas de análisis de usabilidad en el diseño de equipos de medición, destacando la necesidad de mejorar la facilidad de uso y la eficiencia en la captura de datos. El rediseño del guante Evo Pinch muestra cómo los comentarios de los usuarios pueden mejorar significativamente la funcionalidad y la experiencia del usuario, que son fundamentales para el éxito en aplicaciones del mundo real.

**Abstract:** This study evaluates the usability of the Evo Pinch glove, a wireless device equipped with Force-Sensing Resistors (FSRs) designed to measure finger strength. Its performance was compared to that of a redesigned prototype. Although traditional dynamometers are effective, they tend to be bulky and difficult to handle. In contrast, the Evo Pinch glove offers a more compact alternative, but its usability had not been systematically evaluated until now. Five students from the Autonomous University of Ciudad Juárez tested both gloves in a series of tasks. The original Evo Pinch glove received a usability score of 55%, indicating a "fair" level. On the other hand, the redesigned prototype achieved a score of 76%, classified as "very good." The redesign significantly reduced the time required to put on the glove, from 2 minutes to 43 seconds, and improved user satisfaction. These results highlight the importance of iterative design and user-centered testing in the development of ergonomic devices, demonstrating that usability testing can lead to substantial improvements in both efficiency and user experience. This research underscores the need for continuous usability assessments to optimize the design and functionality of devices used in ergonomic and human factors research.

**Keywords:** Usability, Analysis, Evaluation, Design.

**Relevance to Ergonomics**: This study emphasizes the importance of using usability analysis tools in the design of measurement equipment, highlighting the need to enhance ease of use and efficiency in data capture. The redesign of the Evo Pinch glove shows how user feedback can significantly improve functionality and user experience, which are critical for success in real-world applications.

## 1. INTRODUTION

Usability is defined as the degree of effectiveness, efficiency, and satisfaction with which a product meets user needs in a specific environment, enabling them to achieve their objectives (Huelves Zarco, Aguayo González, Lama Ruiz, & Soltero Sánchez, 2009). Its specific goal is to identify the key functions and features that allow the product to satisfy user needs. Usability analysis is a method that provides information about the interaction between the user and the product through the observation of activities.

The measurement of hand and finger strength is typically carried out using dynamometers, which occupy a considerable portion of the hand's size. In recent years, more streamlined dynamometers in the form of gloves have been developed, allowing

for the measurement of finger strength. The introduction of these new measurement tools enables ergonomic evaluations. However, their efficiency has not been systematically tested or analyzed, offering a significant opportunity to improve the design of these devices through usability analysis.

One of the available devices is the wireless Evo Pinch glove, an essential tool for collecting and analyzing data under real working conditions in research and human factors applications, as well as in industrial, engineering, and ergonomic studies. The Evo Pinch system includes force-sensing resistors that allow for the measurement of force in the phalanges.

Before conducting the usability analysis, it is necessary to determine the interaction between the user and the product by selecting the tasks to be observed. Therefore, the objective of this study is to perform a usability analysis of the Evo Pinch glove, determine its usability level, and compare it with a prototype glove, meeting the following specific objectives: a. Determine the usability level of the Evo Pinch glove. b. Design the glove. c. Perform a usability analysis of the new device and compare it with the current one.

This study consists of three stages. First, a usability analysis of the current glove is conducted to identify areas for improvement. Second, the glove is redesigned, proposing improvements to increase its usability and measurement capacity. Finally, the usability levels of the current glove and the new device are compared (see Figure 1).


Figure 1. Diagram of the stages of usability analysis.

## 2. MATERIALS

A usability analysis was conducted based on the selection of activities and tasks with which the user would interact with the product. In this study, the wireless Evo Pinch glove was used, an essential device for collecting and analyzing data under real working conditions, applicable to research tests, human factors studies, as well as industrial, engineering, and ergonomic applications. The Evo Pinch system includes Force Sensing Resistors (FSRs), which, although not load cells or strain measurement devices, have similar properties and provide a reliable alternative. The FSR sensors

included in the kit are thin, flexible, discreet, and cause minimal interference with the action and performance of the device and the task.

## 3. Methodology

According to Steanton and Baber (2006), it is recommended to conduct a usability test at the end of the design process, that is, when the product is fully completed and ready to be evaluated. This is because, to obtain valuable and accurate information about the product's usability, it is essential for users to interact with the product in its final form. This interaction allows for the identification of issues and areas for improvement that may not have been apparent in earlier stages of design. Additionally, another significant proposal, published by Hassan *and Ortega* (2009) in the "APEI Usability Report," introduces the concept of a "user test," which consists of the following: a general diagram of the usability methodology is presented to guide the process.

### 3.1 Product Description

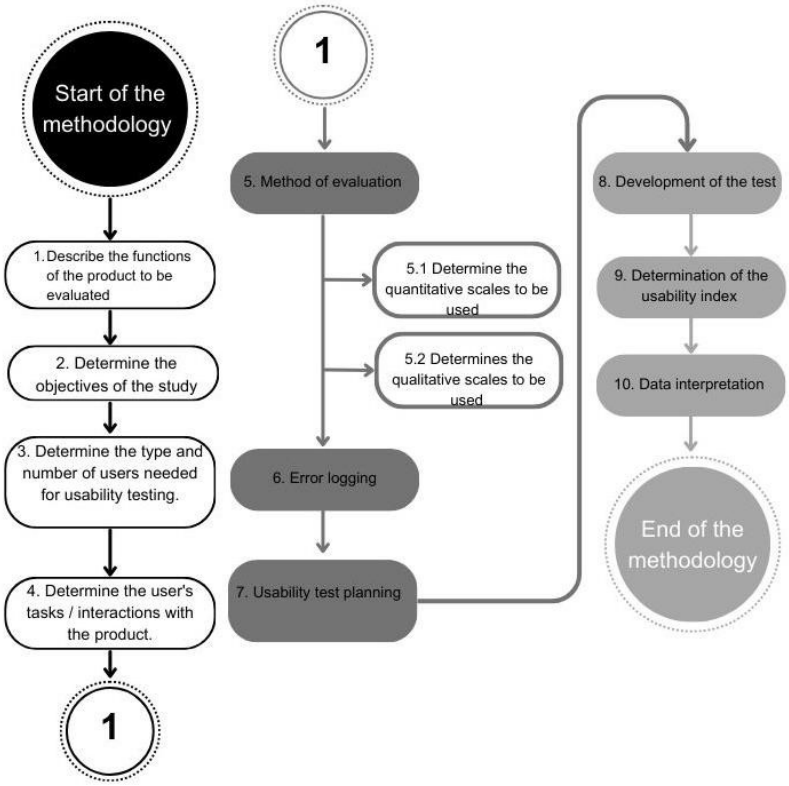


Figure 2. Methodology diagram (Hernandez & Hernandez, 2013)

The wireless EVO Pinch is an essential device for collecting and analyzing data under real working conditions, intended for applications in research testing, human factors, as well as industrial, engineering, and ergonomic contexts. The EVO Pinch

system includes Force Sensing Resistors (FSRs), which, while not load cells or strain measurement devices, possess similar properties and provide a reliable alternative. The FSR sensors included in the kit are thin, flexible, discreet, and cause minimal interference with the device's action and performance during tasks.
The FSR sensors offer the following features:

- They provide accurate measurements for a variety of testing applications.
- They allow for the combination of instrumentation devices to measure force, angle, and acceleration.
- Each sensor is independently calibrated to facilitate easy updates or replacements (except for accelerometers and FSR sensors, which are not calibrated).

### 3.2 Determination of study Objectives

**General Objective:** Identify areas of opportunity for improving the glove.

**Specific Objectives:**
a) Determine the application capacity of the glove.
b) Analyze the disadvantages in the glove's application.
c) Identify specific areas for improvement.

### 3.3 Determination of Users

The sample will be incidental and composed of volunteer participants from the student community of the Autonomous University of Ciudad Juárez. Each candidate will be informed about the study's process to ensure they understand the importance of their participation in the project, as well as the implications and benefits involved.

### 3.4 Number of Users

Usability tests must be conducted with volunteer users; otherwise, these tests cannot be carried out. Therefore, it is important to determine the appropriate number of participants (sample size). According to the usability methodology (2014), a maximum of 15 participants is suggested to detect 100% of usability issues.

### 3.5 Determine user/product tasks/interactions

The tasks and activities that the user will perform with the product are defined as follows:
a) Putting on the glove and its components.
b) Time spent on placing the components.
c) Adjustment of the FSR sensors.

### 3.6 Evaluation Method

The Likert scale is one of the most commonly used methods, as it allows for the rating of items or variables by linking a number to a linguistic expression. Typically, scales with 3, 5, or 7 divisions are used, as shown in Table 1.

Table 1. Likert Scale.

| Rating | Expression |
|---|---|
| 1 | Good |
| 2 | Fair |
| 3 | Poor |

### 3.6 Selection of tasks to be evaluated

Table 2. Tasks to be evaluate

| Rating | Expression |
|---|---|
| 1 | Never |
| 2 | Only once in a while |
| 3 | Sometimes |
| 4 | Often |
| 5 | Always |

| Tasks to be evaluated | |
|---|---|
| **Quantitative** | Qualitative |
| 1. Placing a screw | 1. Task accessibility |
| 2. Using a mouse | 2. Glove comfort |
| 3. Using cutting pliers | 3. General satisfaction |

### 3.6 Data Capture Format

Table 3. Tasks to be evaluated

| Data Capture Format | | | |
|---|---|---|---|
| Qualitative Variables | | | |
| Column 9 | Column 10 | Column 11 | Column 12 |
| Error Type | Rating / Unit of Measurement | Interval | Score |
| 1. Glove placement | | 0 = Critical 5 = Major \|10 = Minor | |
| 2. Number of errors during the test | | < 1 Good = 10 2 Fair = 5 > 3 Poor = 0 | |
| Sum of error scores (SES) | | | |

To calculate, the following formula was used:

$$UI\left(\frac{\overline{15+10+5}}{(3+3+2).10}\right).100 = UI \quad (1)$$

### 3.8 Usability level

Table 4. Usability level

| Value obtained | Usability Level |
|---|---|
| 76% to 100% | Very Good |
| 51% to 75% | Good |
| 26% to 50% | Fair |
| 0% to 25% | Poor |

## 4. RESULTS

The study involved 10 students, with an average age of 21.5 years. The results showed that, according to the calculated percentages, the average usability of the EVO Pinch

glove among the 10 participants was 59% (see Table 5), which indicates a usability level classified as "fair" according to Table 4. Additionally, the results for the redesigned glove, with an average usability of 77% among the same 10 participants (see Table 6), indicate that the redesigned glove exhibits a usability level classified as "very good." These findings highlight the significant improvements in user experience achieved through the redesign.

Table 5. Results obtained for the usability level for both current and new glove design

| Participant | Current design | New design |
|---|---|---|
| 1 | 38% | 75% |
| 2 | 63% | 75% |
| 3 | 69% | 75% |
| 4 | 69% | 81% |
| 5 | 56% | 81% |
| 6 | 38% | 81% |
| 7 | 69% | 69% |
| 8 | 38% | 75% |
| 9 | 50% | 69% |
| 10 | 50% | 75% |
| Average | 55% | 76% |

## 5. CONCLUSION

In this research, quantitative and qualitative data were collected to determine the usability level, evaluating various tasks and obtaining both individual sample percentages and overall averages. The tests were conducted in two stages: first, a usability analysis of the current glove was performed, which showed a usability level of 55%, classifying it as "fair." Subsequently, the new glove design was evaluated, achieving a usability level of 76%, considered "very good". A significant optimization in the application of the glove was observed, as well as a reduction in the time required to put it on, which decreased from an average of 2 minutes with the original glove to 43 seconds with the redesigned glove.

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