Mapping User Journeys in Occupational Exoskeleton Adoption: the Adoption UX Curve (AUXC)

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ABSTRACT

Occupational exoskeletons represent a promising innovation to mitigate biomechanical risk factors leading to musculoskeletal disorders. However, their full potential will only be realized if operators sustain their use over time. Thus, there is a need to understand the trajectories inducing operators to maintain prolonged use. To address this need, longitudinal studies are sometimes conducted in the field. However, they are costly, and it is common for participants to discontinue their participation. In this work-in-progress paper, we introduce a retrospective method founded on the Adoption UX Curve (AUXC). The AUXC aims to retrace usage patterns that have led operators to continue using exoskeletons. We expect the results to enhance our understanding of the adoption process of occupational exoskeletons and to potentially serve as an effective alternative to longitudinal studies.

CCS CONCEPTS

• **Exoskeletons**; • **Acceptance**; • **Users Study**;

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1 INTRODUCTION

Recently, different user typologies have been proposed for occupational exoskeletons [1]. The authors distinguished "Non-Users" from "Users", who have fully integrated the exoskeleton into their activities. The Non-User group includes individuals who either lack the opportunity or willingness to use an exoskeleton (referred to as Excluded and Resisters, respectively), those who reject the device after a short trial (Rejecters), those who reject it after prolonged use (Discontinuers), and those for whom use of the device is involuntarily terminated (Expelled). Since exoskeletons can only prevent musculoskeletal disorders (MSDs) when use is sustained over time, it is crucial to understand the trajectories leading operators to become Users. For this purpose, longitudinal field studies are sometimes conducted [2], [3], [4]. However, these studies are costly to set up and limited in duration; rarely exceeding five weeks. In addition, participants frequently drop out of these studies, further limiting access to Users trajectories. To elucidate the adoption dynamics of these devices, another possible approach is to conduct retrospective studies. This study design allows technology usage trajectories to be reviewed, overcoming the constraints of longitudinal studies. To date, no field study has specifically targeted exoskeleton Users using retrospective design. Therefore, this article proposes a methodology to trace the paths enabling exoskeleton users to maintain their use over time. As part of this methodology, we present a perspective on technology adoption. The adoption of new technology can be described as a dynamic process articulated around several phases based on the accumulation of usage experiences. Authors generally agree on the existence of a phase preceding the first use, a "pre-adoption phase", during which the user forms expectations and attitudes with respect to the technology [5]. After the first use, a "familiarization phase" begins, during which the user learns to control the technology [6]. This phase predominates in the adoption process. For example, Karapanos et al. [7] found that 75% of all smartphone usage experience narratives were related to the first month of use. Meneweger et al. [8] explained the importance of familiarization by changes in the ordinariness of experience, especially at work, where interactions with technology are often shaped by routines and repeated activities. According to these authors, when a new system is deployed, previous routines are disrupted, resulting in a sharp rise in novel experiences. Over time, users become accustomed to the new system, leading to a slow return to a routine experience. In this sense, we can legitimately consider that the familiarization phase and the quality of user experience during this period have a critical impact on the sustained use of an occupational exoskeleton. Once the technology has been adopted as part of the user's daily life, a "routinization phase" starts [5]. This phase is characterized by stable usage patterns, and the user may develop a functional dependency on the technology. For occupational exoskeletons, the pre-adoption phase is the most widely documented. Thus, the expectations of future users and the factors determining engagement in a first use have recently been the subject of a review [9]. However, from a user experience perspective, the familiarization phase, and even more so the routinization phase, remain poorly understood. We therefore chose to use a retrospective method with exoskeleton Users to shed

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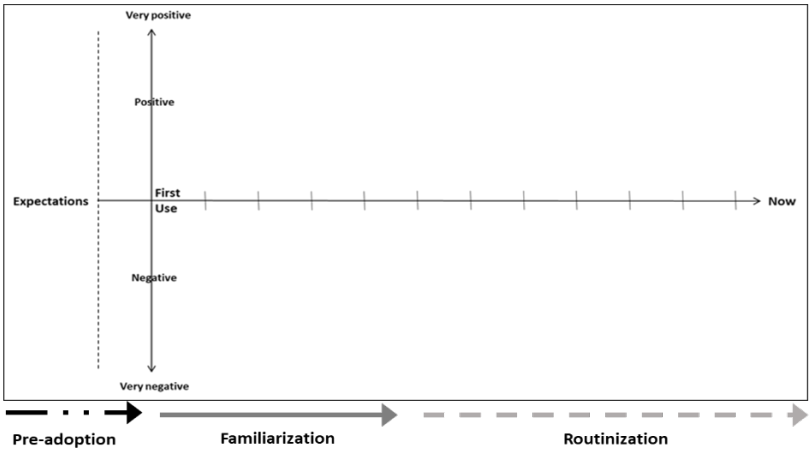

Figure 1: Template used to map the adoption of occupational exoskeleton (Adoption UX Curve)

light on the dynamic process of occupational exoskeleton adoption, from pre-adoption to routinization.

2 METHODOLOGY

We developed a methodology based on interviews with Users of occupational exoskeletons. This qualitative approach allows an in-depth exploration of users' perceptions and feelings toward their exoskeleton, and how these perceptions evolve over time. According to literature focusing on long-term user experience (UX), stable usage patterns are observed at one or two months of use, depending on the technology [10], [5]. Therefore, we considered that selecting participants who had been using an occupational exoskeleton for a minimum of 3 months was reasonable. We designed an interview guide to acquire a retrospective view of the adoption process, from pre-adoption to routinization. The early questions are devoted to the pre-adoption phase, aiming to explore the expectations, apprehensions, and representations that the User had before first using the exoskeleton. Subsequently, in line with the view that familiarization is a critical step, the interview focuses on early uses of the exoskeleton, aiming to identify ways in which wearing the exoskeleton disrupted the operator's activity, the various explorations of usage, and any adaptations that they implemented. Finally, the interview focuses on current use and how the operator now feels about their exoskeleton. In this part of the interview, the operator is asked to complete a modified UX Curve [11]; the Adoption UX Curve (AUXC). The AUXC is a retrospective tool to assess long-term user experience, including the pre-adoption phase. The AUXC deployed is an adaptation of the original template (see Figure 1), where the y-axis represents experience, ranging from very positive at the top to very negative at the bottom; and the x-axis represents time, from pre-adoption, through first use, and on until the day of the interview. Participants are invited to draw a curve reflecting the quality of their overall interaction with the exoskeleton over time. Then, they are asked to explain why they drew the curve in that way, to obtain qualitative data related to any improvements or deteriorations in their experience. Although the data collected may not be as detailed as those collected in the field during technology use, the results provide a robust summary of the most relevant user experiences. The duration of the familiarization phase is unknown a priori. Consequently, whether the participant is already in a routinization phase can only be determined at the end of the interview. Indeed, to determine the phase, information on the operator's daily use of the device is required, indicating whether they have developed stable usage patterns and functional dependency on the technology. This explains why there is no clear separation of the familiarization and routinization phases in Figure 1. According to typical guidelines for UX Curve analysis [12], the curves will be analyzed to identify improvements, stagnations, or decreases. Qualitative data will be used to enhance the understanding of the trends observed in the curves.

3 PRELIMINARY RESULTS

We are at the beginning of this study, and so far, we have interviewed one User. The operator works at a "filter-press unloading" workstation. This task requires the operator to hold a pressure washer above shoulder height, pointing downward. The task is physically demanding, and before testing the exoskeleton, the operator had experienced shoulder issues. We recorded the entire interview, which lasted approximately 55 minutes. On the day of the interview, the operator had been using upper-limb exoskeletons for 11 months. He used a first upper-limb exoskeleton for 6 months, and switched to a second one for the last 5 months. From notes taken on the AUXC during the interview, we have produced a digital reproduction of the curve he drew (see Figure 2). The first thing to observe is that the experience of wearing the exoskeleton was not immediately positive for the operator. It took him over 6 months and a change of exoskeleton to achieve complete satisfaction. However, he never reported a negative experience with the exoskeleton. At worst, initially, he noted an absence of benefits.

3.1 *Pre-adoption*

Before interacting with any exoskeleton, due to recurrent shoulder pain, the operator had been in a process of developing methods to protect against shoulder pain. For example, he and his colleagues

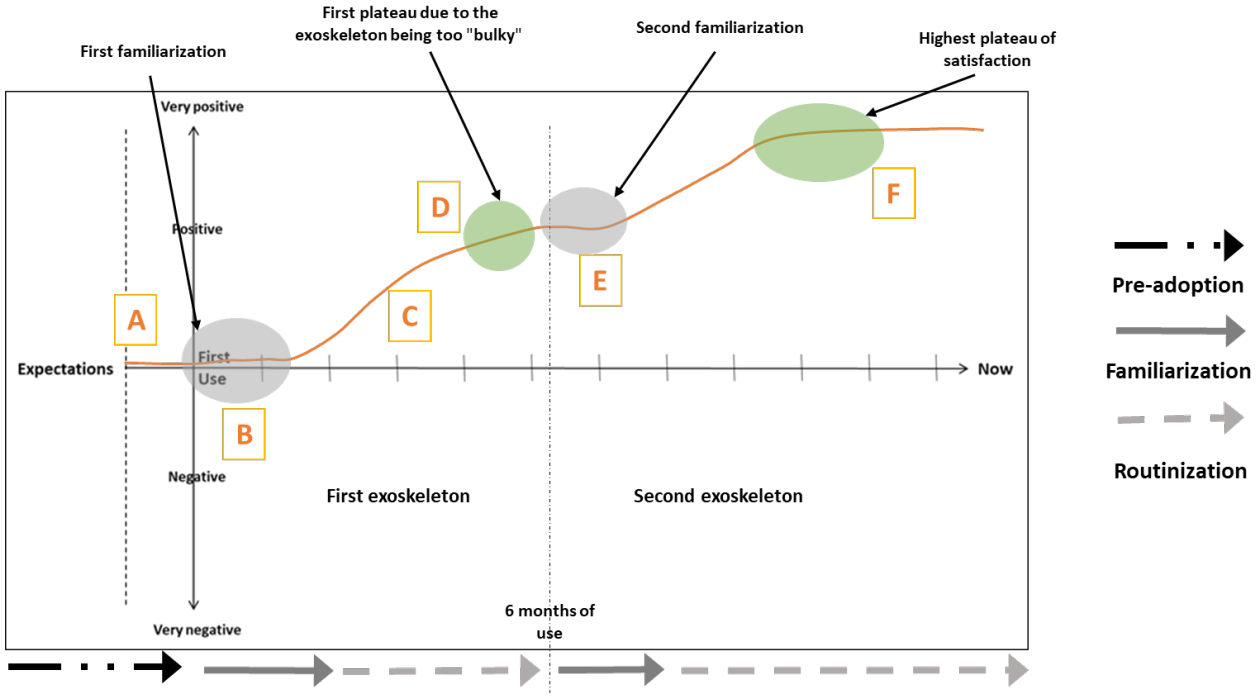

Figure 2: Digital reproduction of the operator's AUXC (orange). The annotations correspond to the mapping between the verbatim and the curve drawn. Analysis of the verbatim suggests that the operator underwent two phases of familiarization, leading him to routinization of usage on both occasions. At the time of the interview, he indicated having reached a maximum level of satisfaction and uses his exoskeleton daily.

adjusted their work organization by dividing the time spent on physically-demanding tasks. The operator was introduced to exoskeletons by the health and safety department in his company. Initially, he mentioned that he "*had no specific expectations because [he] didn't know what benefit it was going to bring [him]*". However, later in the interview, he said: "*the first thing I wanted was for myself, to recover... I still have years to go* (until retirement)*, and what state will I be in then?*". As a result, the operator drew a neutral curve to represent the pre-adoption phase, indicating that he had no prior positive or negative bias toward exoskeletons (see Figure 2, part A). However, his statements indicated that he had strong expectations that use of an exoskeleton would benefit him in terms of health matters.

3.2 *Familiarization*

The operator initially described experiences that were neither positive nor negative. He expressed surprise during the initial interactions as well as an absence of benefits: "*I was surprised because the natural movements we have... they're not necessarily the same. It is a bit uncomfortable at first [...], there were... big things behind... it wasn't easy. It was heavy*". According to him, during this initial period, he had to keep in mind the benefits he could experience once the interaction became smoother: "*At the beginning for sure, getting used to the system is not easy. That is when you have to keep telling yourself: "it's going to do me good*". During this familiarization period, the operator indicated that he explored various settings on the exoskeleton, which allowed him to adapt its use to perfectly match his activity. Indeed, to align with his very specific professional gesture, he adjusted the assistance differently on the right arm and on the left arm. According to him, the adjustment period lasted 2 weeks (see Figure 2, part B). Only after the familiarization period did he indicate that he felt the benefits of the exoskeleton, with the curve trajectory shifting toward a positive experience (see Figure 2, part C). However, due to the first exoskeleton's design, which he considered too "bulky", his overall experience reached a plateau (see Figure 2, part D). The operator indicated the change of exoskeleton by drawing a vertical line after 6 months of use. This change required him to repeat a familiarization period, although his statements indicated that it was shorter: *"after about a week, you get used to the new system and then everything goes smoothly. It's natural*" (see Figure 2, part E). He also highlighted having transferred the knowledge gained during his familiarization with the first device to the use of the second exoskeleton; for instance, he directly replicated the asymmetric adjustment of assistance on both arms during his initial usage of the second exoskeleton. After this adaptation, he resumed a trajectory toward maximum satisfaction (see Figure 2, part F).

3.3 *Routinization*

The operator likely entered a phase of routinization following his initial familiarization despite the disadvantages of the first exoskeleton. Indeed, he indicated that the switch to a new exoskeleton make

him ”feel weird”, as he had ”become used to working with the first exoskeleton”. However, the second familiarization phase enabled him to reach a phase of routinization in the use of the second exoskeleton. Today, according to his statement, he could not do his work without the exoskeleton. He mentioned that if he did not have it, he would not perform his activity. This indicates the development of a functional dependency on the exoskeleton. The operator mentioned that, unlike during his initial interactions, he now completely forgets that he is wearing an exoskeleton, not because he no longer feels its benefits, but because the exoskeleton has become transparent to him. This allows him to fully focus on his work while wearing the exoskeleton. In addition, he appears enthusiastic about his role as an ”early adopter”, as he regularly invites his colleagues to try out the exoskeleton or recommends its use to younger team-members. Through these activities, he has become a crucial link in the integration of exoskeletons within his company, and is relied upon by the health and safety department to conduct demonstrations or initiate potential future Users.

4 CONCLUSION AND ONGOING WORK

This work-in-progress paper presents an innovative methodological proposal to study the adoption of exoskeletons in occupational settings, the Adoption UX Curve (AUXC). So far, we have interviewed one operator, but the preliminary results are encouraging, highlighting the importance and components of the familiarization phase from a user experience perspective. Future interviews will allow us to refine the results and to conduct a comparative analysis of the curves. Overall, this methodology can provide in-depth insights into usage trajectories with occupational exoskeletons, enhancing our understanding of the conditions required for their sustained use.

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