Advances in Intelligent Systems and Computing 794

Tareq Z. Ahram · Christianne Falcão
Editors

Advances in Usability, User Experience and Assistive Technology

Proceedings of the AHFE 2018 International Conferences on Usability & User Experience and Human Factors and Assistive Technology, Held on July 21–25, 2018, in Loews Sapphire Falls Resort at Universal Studios, Orlando, Florida, USA

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Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, Poland
e-mail: kacprzyk@ibspan.waw.pl

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Editors
Tareq Z. Ahram
University of Central Florida
Orlando, FL, USA

Christianne Falcão
Catholic University of Pernambuco
Boa Viagem, Pernambuco, Brazil

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Advances in Human Factors and Ergonomics 2018

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9th International Conference on Applied Human Factors and Ergonomics and the Affiliated Conferences

Proceedings of the AHFE 2018 International Conference on Usability & User Experience and Human Factors and Assistive Technology, Held on July 21–25, 2018, in Loews Sapphire Falls Resort at Universal Studios, Orlando, Florida, USA

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Preface

Successful interaction with products, tools, and technologies depends on usable designs and accommodating the needs of potential users without requiring costly training. In this context, this book is concerned with emerging ergonomics in design concepts, theories, and applications of human factors' knowledge focusing on the discovery, design, and understanding of human interaction and usability issues with products and systems for their improvement.

The Human Factors and Assistive Technology promotes the exchange of ideas and techniques which enable humans to communicate and interact with each other in almost every aspect. The new relationship between humans and technology added convenience for many, and for those with impairments, modern-day technology has transformed their daily living into a journey toward capability instead of disability. Assistive technology assessment focuses on the examination of problems in designing and providing assistive devices and services to individuals with disabilities or impairment, to assist mobility, communication, positioning, environmental control, and daily living. The conference addresses a wide spectrum of theoretical and practical topics related to assistive technologies. It provides an excellent forum for combining real experience and academic research, while examining how we can adapt to machinery and increase the technology acceptance, effectiveness, and efficiency. The conference aims at investigating how psychological factors can affect the efficiency and acceptability of assistive technology.

This book will be of special value to a large variety of professionals, researchers, and students in the broad field of human modeling and performance, who are interested in feedback of devices' interfaces (visual and haptic), user-centered design, and design for special populations, particularly the elderly. We hope this book is informative, but even more that it is thought-provoking. We hope it inspires, leading the reader to contemplate other questions, applications, and

potential solutions in creating good designs for all. The book is organized into nine sections that focus on the following subject matters:

Section 1: UX Evaluation and Design Thinking
Section 2: Human Machine Interfaces
Section 3: Usability Evaluation and User-Centered Design
Section 4: Virtual Reality and Interaction Design
Section 5: User Experience in Healthcare and Learning
Section 6: User Experience and Visualization in Automotive Industry
Section 7: Eye Tracking and Visualization
Section 8: Assistive Technology and Design Solutions
Section 9: Assistive Design Solutions and Prosthetic Environments

This book will be of special value to a large variety of professionals, researchers, and students in the broad field of human–computer interaction, usability engineering, and user experience research, who are interested in feedback of devices' interfaces (visual and haptic), user-centered design, and design for special populations, particularly the elderly.

Each section contains research papers that have been reviewed by members of the International Editorial Board. Our sincere thanks and appreciation to the board members as listed below:

Usability & User Experience

Assistive Technology

Hanan A. Alnizami, USA
Wolfgang Friesdorf, Germany
S. Fukuzumi, Japan
Sue Hignett, UK
Matteo Zallio, Ireland

We hope this book is informative, but even more thought provoking to inspire the reader to contemplate other questions, applications, and potential solutions in creating good designs for all.

July 2018

Tareq Z. Ahram
Christianne Soares Falcão

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UX Evaluation of a New Rowing Ergometer: The Case Study of the Technogym "SkillRow"

Alessia Brischetto[1(✉)], Mattia Pistolesi[1], Giuseppe Fedele[2], and Francesca Tosi[1]

[1] Laboratory of Ergonomics and Design, Department of Architecture, University of Florence, Via Sandro Pertini 93, 50041 Florence, Calenzano, Italy
{alessia.brischetto, mattia.pistolesi, francesca.tosi}@unifi.it
[2] Scientific Research Department, Technogym S.P.A, Via Calcinaro, 2861, 47521 Cesena, Italy

Abstract. This paper demonstrates the results of workshop "UX Skillrow Evaluation" workshop, promoted by the Laboratory of Ergonomics and Design (LED) of the University of Florence in collaboration with Technogym, a leading-edge company that develops fitness equipment for any physical activity. The workshop aimed to define the current levels of usability and experience of use of rowing "Skillrow", through method of investigation and practice of Human-Centered Design and User Experience approaches. The predominant aim of work was to identify usability and user experience of rowing Skillrow and its user interfaces. Following this, to identify the potential, project proposals were conducted, brainstorming and focus group activities. During testing twenty-one users participated, aged between 22 and 30. The research goals were: measurements of current usability level and user experience of product-system interfaces, and definition of critical issues and implementation of the current user interfaces. Finally, the results from the evaluation phases allowed to get qualitative data on the levels of effective usability of the product, the components and its graphic interface. In the form of scenario-based design, solutions to improve the current high levels of usability of the user interface were also developed.

Keywords: Wellness · Human-Centered Design · User Experience
User Observation · Focus group

1 Introduction

Human beings were not born for inactivity. Physical inactivity is nowadays identified as the fourth leading risk factor for global mortality and its levels are rising in many countries. This phenomenon has major implications for the prevalence of no communicable disease (NCDs) and the general health of the population worldwide [1]. On the contrary, movement and physical activity contribute to improving all aspects of quality of life, representing a strategic tool for healthy aging [2].

It is therefore necessary to educate as many people as possible to an active lifestyle even at an advanced age. In order to do so, it is important to develop high added-value

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products for the wellbeing and health of people, and this goal can be achieved through an interdisciplinary approach between Design and Ergonomics [3].

Within the fitness industry one of the most complete UX markets in emerging, in the form of a gym or personal fitness environment. A new paradigm known as "smart gyms" are aimed at providing support for both the trainers and users, keeping track of all activity and later tailoring the experience to the direct specifications of the individual. The growth and development in digital technology has been expansive, assisting all individuals throughout a training session in addition to providing a more engaging and interactive experience. The advances of touch screen display not only offer information (requiring input) specific to the exercise however have additional features to allow a more connected experience with the digital ecosystem such a social networking and personalized multimedia content, making these tools particularly more interesting to the HF/E community. Unfortunately however, although there is a great increased interest in mobile technologies within fitness a cursory literature search identifies that the interest of technology within the fitness environment is directed towards the hardware components demonstrating a greater significance on biomechanics and ergonomics with reference to comfort and safety [4–6].

Additional contributions, commonly targeting the design of tools for a specific population, are rare (e.g. elderly, people with disabilities), in addition to the promotion and monitoring of physical activity.

This was the case with the "SkillRow UX evaluation" workshop, conducted and developed in collaboration with Technogym S.p.A. at the Laboratory of Ergonomics and Design (LED) of Florence University. Aim of the study was the evaluation of the overall user experience (UX) with the rowing ergometer SkillRow and the willingness to promote it.

2 Background: Usability and User Experience

To design an industrial product, it is fundamental knowing the specific needs of the addressed users.

The Italian standard UNI 11377-1:2010 [7] and international standard ISO 9241-210:2010 [8] define usability as: "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". Nielsen defines usability as the sum of 5 attributes [9]: learnability; efficiency; memorability; errors; satisfaction. Usability is not an absolute characteristic of the object, but it is always relative to the task, the user and the environment [10].

The process of identification and needs analysis on which the Human-centered Design is based, is carried out through the realization of usability tests that may be conducted by specialist and/or the direct involvement of a segment of users representing the targeted consumers [11]. The methods of usability verifications and safe check are based on the collection of information related to the modality with which the user interact with the product within a given context of use. By doing so it is possible to identify and analyze the behavior of users, their needs and finally the type and frequency of errors performed during the execution of the required tasks.

This information can be used to define the characteristics of the new product, to test prototypes, and/or to evaluate the existing products [11].

In regards to the User Experience, the international standard ISO 9241-210:2010 defines it as: "person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service".

Whilst the usability focus on the degree to which a product can be used by specific users to achieve specific tasks with effectiveness, efficiency and satisfaction [8], the user-experience focuses on human factors such as emotional, affective and contextual aspects [12]. The evolution of this concept, as defined by ISO 9241-210:2010, takes into account that feeling positive or negative about a task can transform the user experience with the product/system [13].

3 Workshop SkillRow UX Evaluation

The "SkillRow UX Evaluation" workshop, organized by the University of Firenze's Ergonomic and Design Lab (LED) in partnership with Technogym SPA, had the purpose of evaluating the usability and User Experience (UX) of the "SkillRow" rowing machine. The test involved 21 subjects from various part of the World. The workshop was divided into 2 phases (phase 1 consisted of the measurement of the current usability and User Experience (UX) level of the product-interface system, while in phase 2 the criticality and margins of implementation of the current user interfaces were defined), organized in 4 days as followed:

- During the first day usability and thinking aloud tests were carried out. At the end of the session each subject submitted a user experience evaluation questionnaire;
- In regards to the second day, a brainstorming session was run, followed by a collective focus group one aimed at bringing out doubts, considerations, thoughts and difficulties encountered while interacting with the product and its components;
- During the third and fourth day, the Task Analysis, Personas and Scenario-based design methods were used in order to identify possible areas of intervention and future scenarios of use for the SkillRow.

For the evaluation of the usability level and the UX (step 1), referring to the norm ISO 9241-210:2010 [8], the following methods were selected: Questionnaire [14], Task Analysis – TA [15], User Observation [16] and Thinking aloud [17]. In regards to the to the user test sessions, a hybrid survey methodology was tested, which applied simultaneously the User Observation and the Thinking Aloud, following a heuristic approach. This approach allowed us to gather opinions, thoughts, expectations, critical points and intuitions useful for defining the requirements of the design concept. Step 2 focused on the definition of the possible areas of implementation in relation to the critical issues and needs that emerged in step 1. In this regard, the following methods were selected: Brainstorming [18] and Focus group [19], Personas [20] and Scenario-based design [21].

4 Methods

The workshop consisted of a preliminary phase which involved the analysis of the product and its components (phase 1). The results were useful for selecting the two most critical tasks that a user can face while using the rowing machine (phase 2). Once the tasks were defined, users run the test sessions. In order to increase the level of effectiveness of the analysis phase, using the tools of Thinking Aloud, each user was asked to talk loudly about the activities he was performing and the difficulties he was experiencing (phase 3). At the end of the test sessions a thematic questionnaire was submitted to each individual user (phase 4).

Once the test sessions were over, step 2 aimed to bring out needs and critical issues experienced during the tests with the rowing machine (phase 5) through brainstorming and focus groups. The last 3 phases of the workshop involved defining some possible areas of implementation and new usage scenarios in relation to the findings of phase 5; performing the Task analysis (phase 6); and using the Personas and Scenario-based design (phase 7).

4.1 Phase 1 and 2: Preliminary Analysis and Requirements Definition

A preliminary analysis of the product SkillRow (a) and its components SkillRow interface (b) and SkillRow app (c), was carried out by the Ergonomics and Design laboratory (LED) before proceeding to the test sessions (Fig. 1).

Fig. 1. The SkillRow Technogym machine and the related components

Afterwards, in collaborations with Technogym S.p.A. researchers, a recurrent task and a less recurrent one, representatives of the user experience, were identified:

- Task 1: distance training (700 m);
- Task 2: sending feedbacks to Technogym through the app.

4.2 Participants

The workshop involved 21 students from the University of Firenze (13 females and 8 males) aged between 22 and 30 years. 15 from Italy, 4 from Iran, 1 from Albany, and 1 from China. In order to avoid misunderstandings, non Italian subjects had to prove to be proficient in the Italian language.

4.3 Phase 3: Usability Test (User Observation and Thinking Aloud)

In this phase each subject had 15 min to complete the two task mentioned above. The test was run at the Ergonomics and Design Laboratory and was mediated by two researchers from the same lab. Each session had the following rules:

- set the target to 700 m (task 1);
- starting and ending the exercise (task 1);
- sending feedback to Technogym (task 2).

During the test sessions, a hybrid survey methodology was experimented. Following a heuristic approach, the User Observation and the Thinking aloud methods were simultaneously applied. This approach made it possible to gather opinions, thoughts, expectations, critical points and intuitions useful for defining the requirements of the design concept. The User Observation allowed us to observe how users were interacting with the rowing machine. [16–22] without interfering with the normal running of the test session. To increase the level of effectiveness of the analysis phase, the Thinking Aloud method was used simultaneously with the User Observation [17]. With this method the users were invited to express loudly their thoughts, feelings and frustrations, while interacting with the machine, the problems of usability of the product were identified, and we were able to observe at the same time these interactions. The role of the researchers was to stimulate each individual to express verbally his/her thoughts [22]. After the test session, a questionnaire was submitted to each user.

4.4 Phase 4: Questionnaire

Once the test sessions on the SkillRow ended, each user submitted a thematic questionnaire which included biographical data, user experience (UX) and comprehension questions. The questionnaire section related to personal data and understanding included both open and closed answers [22], while the UX section was developed following the NASA TLX evaluation method. It is a multidimensional assessment tool for the subjective workload [23, 24], which allows to evaluate the users' workload while interacting with the SkillRow integrated interface, the user-SkillRow app and with the SkillRow itself. The workload, defined as the effort sustained by the user to achieve a specific level of performance [23, 24], was calculated from the result of subjective responses weighted on the following five values: (1) mental request; (2) physical request; (3) global effort; (4) performance; (5) frustration.

4.5 Phase 5: Brainstorming e Focus Group

In order to highlight criticalities and needs emerged during the usability test, the participants, divided into 2 groups, were involved in the brainstorming and focus group activities, for a total duration of 4 h. One group dealt with the SkillRow and its app for IOS, while the other group dealt with the same rower and its application for Android.

4.6 Phase 6: Task Analysis

The next step consisted of performing 2 Task Analysis, one for the IOS group and one for the Android group. This method allowed each group to map the possible interactions of each user with the SkillRow app interface. The Task Analysis, additionally it was necessary to identify the critical issues and consequently the possible areas of implementation.

4.7 Phase 7: Personas and Scenario-Based Design

The Personas and Scenario-based design techniques are fundamental tools in the design process of a product/service. The personas represent fictitious profiles created to better represent needs, aspirations and behaviors of a particular segment of users, emerged in step 5. Four Personas were defined for the Android group and four for the IOS group, for a total of eight people and eight Scenario-based design. Thanks to this technique it is possible to describe in a realistic way the actions, or the sequence of actions, that a user makes while using a specific product/service (in this case SkillRow and SkillRow app), and therefore define how they should work in order to guarantee a satisfying user experience.

5 Results

5.1 Questionnaire

The questionnaire submitted to the users was of a thematic nature, divided into three parts, and aimed at incorporating personal data, user experience (UX), and comprehension information.

5.1.1 Personal Data

At the time the questionnaire was submitted 29% of the users trained between 2 and 6 h a week, while only 14% of them engaged into physical activity for more than 6 h a week. These activities took mainly place outdoor, followed by gyms and homes. 71% of the subjects were used to monitor their physical activity through apps or other devices, while the remaining 29% preferred not to use any monitoring devices and virtual trainers. Twenty users out of 21 were considered “novices” (as they had never used a rowing machine to perform physical activity), while one user was considered “competent”.

5.1.2 User Experience

The 24% of users perceived a mental request of 5 (on a scale of 1 to 10 where 1 is the lowest level and 10 the highest level) while interacting with the integrated interface during training. Only 10% sensed a mental request of 10.

Data are similar in regards to physical request: 24% of users detected an request of 5 during the interaction with the machine and only a 5% has detected a level of 10.

Regarding the physical and mental requested to reach the personal level of performance during the interaction with the rower, 29% of the users recorded a level equal to 6 and only 5% a level equal to 10 (Fig. 2).

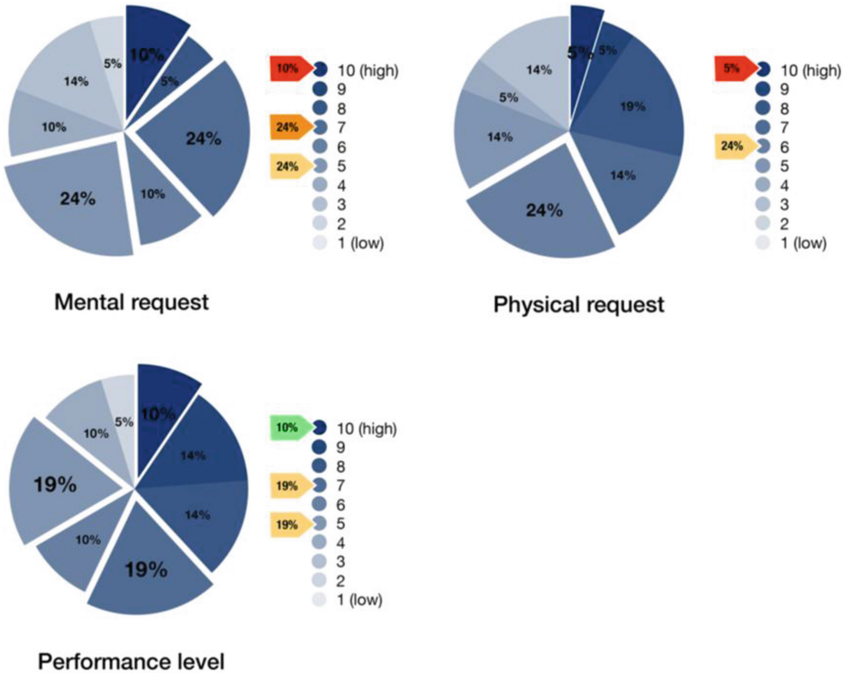

Fig. 2. Rower User Experience. Mental request, physical request and performance level charts.

Regarding the "performance level", which express how much each user believes to have been successful in completing the assigned task, 19% of users recorded a level of 5 and 7 while 10% had difficulty in bringing the task to completion. Most users have not experienced high levels of frustration while interacting with the product. With regard to the SkillRow app user experience, most users found the application easy to use, as the application itself guided users to achieve their goals. 5% of the users perceived a mental request of 1, 24% a level of 5 and 10% equal to 10. Only 19% recorded a level of physical exertion of 5 and 9. As shown in the chart, majority of the users did not register high levels of frustration (Fig. 3).

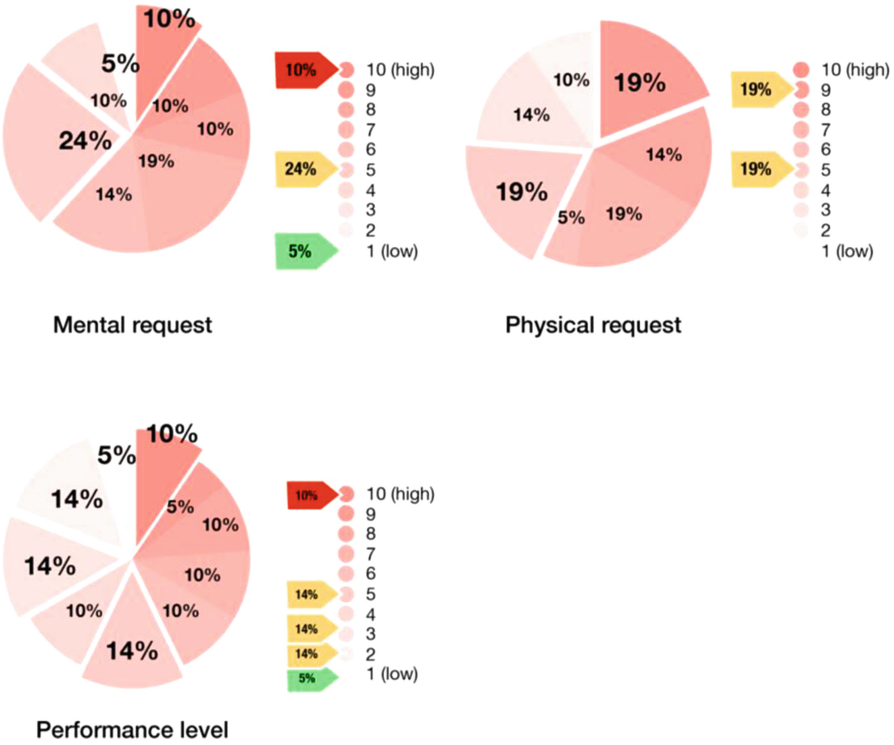

Fig. 3. App *Skillrow* User Experience. Mental request, physical request and performance level charts

The physical request to interact with the application means aspects like visibility and reachability of the smartphone during the rowing exercise.

5.1.3 Comprehension

A significant portion of users did not experience difficulties in understanding how to use the rowing machine, how to turn it on and off, and how to regulate the physical activity intensity. As for the parameters displayed on the rowing machine's screen, almost all users recognize and understood the meaning of the icon and the numerical parameter of the time, distance and Kcal consumed. The majority of users also recognized the icon and understood the numeric parameter relative to both the 500 m split time and the W (power) generated.

On the other hand, 57% of users did not understand the numerical parameter, nor they recognized the icon, relative to the strokes per minute (spm). Majority of the users also had trouble understanding and/or recognizing the information relative to resistance level, AVG, DRAG, REPS.

The last section of the questionnaire covered the understanding of the Skillrow application. 76% of users recognized the icons and their meaning, but 62% of the

interviewed users declared overall difficulties in using of the app. Finally, 38% of users consider the skillrow application to be fairly comprehensible.

5.1.4 Overall UX Evaluation and Net Promoter Score

As showed in *Overall User Experience* chart, 81% of users assessed the overall product user experience positively (5% a level of 10, 24% a level of 9, 38% a level of 8, 14% a level of 7), while 19% of users assessed it as sufficient (14% a level of 6 and 5% a level of 5). In the other chart, Net promote score, is clear how the 53% of users highly recommend the use of Skillrow to other people, while the rest of users suggest the use of the product with a varying level from 7 to 5 (Fig. 4).

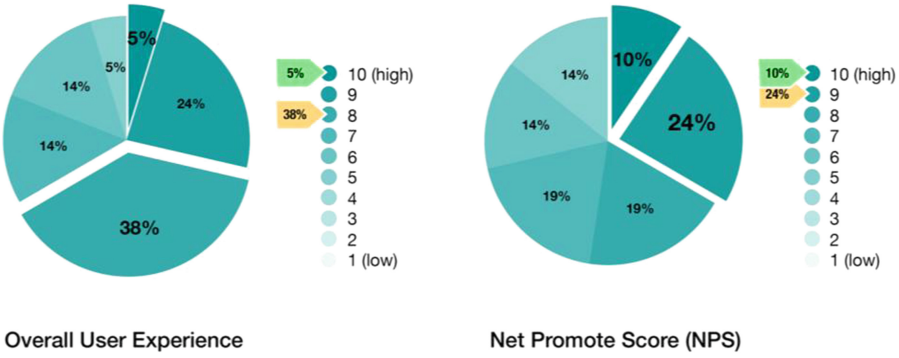

Fig. 4. Overall User Experience and Net Promoter Score (NPS) charts

5.2 Brainstorming and Focus Group

This section highlighted that the problems experienced by the users were mainly due to the limited usability of the SkillRow application interface. In fact, most information could be understood only by advanced users. Some issues also arose with the SkillRow itself and with its interface. In fact, some users did not consider some of the information displayed on the screen or they misinterpreted them, some had trouble with the regulation of fundamentals components such as the pedals or the dumper settings (users tried to push or press the wheel instead of rotating it).

5.3 Task Analysis

What emerged from the two Task Analysis relative to the interaction with the SkillRow application interface, is that the application itself offers two types of interaction: press and scroll. The issues while using it were due to:

- Difficulty in visualizing the available exercises and in understanding them;
- Poor access intuitiveness to sub-menus;
- Difficulty in setting some parameters before physical activity;
- Difficulty in understanding certain specific acronyms and graphs relative to physical activity results.

5.4 Personas and Scenario-Based Design

In light of the critical issues emerged from the questionnaires, the Brainstorming and Focus Group, and the Task Analysis, the Personas and the Scenarios were designed. Thanks to this technique it was possible to define possible implementations for the rowing machine, the rower interface and the app so that they can be easy to use also for those with limited or little experience with this type of products and activities. Figure 5 represents only some of the Personas and the new Scenarios designed during the workshop.

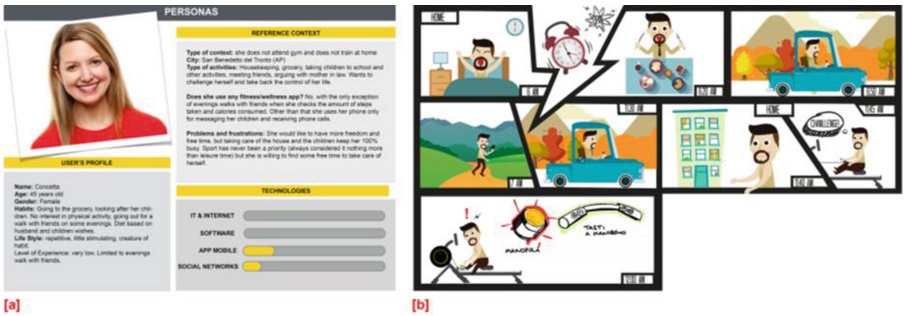

Fig. 5. Personas (a) and Scenario-based design (b)

6 Conclusions

The paper proposes some methodological implications in the evaluation of usability and User Experience (UX) with the new SkillRow rowing machine. The empirical approach allowed us to determine criticalities and difficulties in addition to gather thoughts and suggestions from a segment of users representative of the target. These methodologies are also useful for improving the product usability, which enhances pleasure, satisfaction and user experience. In order to do that, it was necessary to adopt a Human-centered approach, aimed at indirectly or directly involving the user, as a partner of inestimable value, during all phases of the project. Furthermore, the Ergonomics for design and its methods offer many opportunities for intervention, thus allowing to outline new usage scenarios and new services-products.

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