Investigating the Effect of Automation on User Experience: Enriching a Task-Modeling Notation

Regina Bernhaupt
Department of Industrial Design
Eindhoven University of Technology
Eindhoven, The Netherlands
r.bernhaupt@tue.nl

Elodie Bouzekri
Célia Martinie
ICS-IRIT, University of Toulouse
Toulouse, France
elodie.bouzekri@irit.fr
martinie@irit.fr

Philippe Palanque
ICS-IRIT, University of Toulouse
Toulouse, France
Department of Industrial Design
Eindhoven University of Technology
Eindhoven, The Netherlands
palanque@irit.fr

Günter Wallner
Department of Industrial Design
Eindhoven University of Technology
Eindhoven, The Netherlands
g.wallner@tue.nl

ABSTRACT

This position papers presents a solution to allow to analyze the impact of automation on user experience by extending a task notation with the representation of concepts of function allocation, responsibility, authority and the ability to represent data from user experience evaluations.

Workshop proceedings *Everyday Automation Experience'19*
In conjunction with CHI'19, May 5th, 2019, Glasgow, UK
Website: http://everyday-automation.tech-experience.at

KEYWORDS

Task model, user experience, evaluation

ACM Reference Format:
Regina Bernhaupt, Elodie Bouzekri, Célia Martinie, Philippe Palanque, and Günter Wallner. 2019. Investigating the Effect of Automation on User Experience: Enriching a Task-Modeling Notation. In *Proceedings of Everyday Automation Experience (EAA '19).* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

INTRODUCTION

Recent attempts in automation are based on the promise to make the life of a user easier, for example by removing tiring and repetitive tasks. If such an automated system really enhances the usability can be measured, for instance, by comparing efficiency (e.g. time to perform a task) and effectiveness (e.g. number of successful task completions). The relationship of automation and usability has been well explored and understood in the past, and there is a variety of approaches and processes that allow for the design of automation with a focus on usability.

A second promise of automation is that it enhances the overall user experience [7]. For user experience (UX) such measurements are more complicated, as user experience has various dimensions and is changing over time. Key for a successful automation of a system is thus the ability to already understand in the design phase which functions should be performed by the user and which functions shall be performed by the system. This includes changes in authority – who is allowed to do what and if the user or the system is responsible if the desired outcome is delivered or not.

To be able to understand how automation is impacting UX we propose the following solution: a combination of task models with the ability to describe autonomous behaviour of systems and the ability to integrate evaluation data from user experience evaluations in such a task model in order to support analysis and understand of the impact of automation on different UX dimensions.

STATE OF THE ART

When designing a system including automation the following aspects have to be taken into account [4]: The allocation of function, authority, and responsibility (abbreviated AFAR, see sidebar).

The integration of user study evaluation results in task models requires the task notation to be able to integrate a variety of data from the evaluation. The PRENTAM process [3] as well as the extensions in the software called HAMSTERS [8] show a possible solution, giving the ability to (1) compare a traditional system with the more automated version of the system; (2) the ability to describe the users tasks, including the representation of errors; (3) the ability to represent the key principles of automation in the task model; and (4) the ability to represent UX evaluation data (in different dimensions and over time).

Allocation of Functions: Wright et al. [9] defines the Allocation of Functions as *"determining the distribution of work between humans and machines [early in the design process]"*. Thus, key is to be able to describe if a task is performed by the user or by the system.

Authority: According to Flemish et al. [5], authority refers to *"what the actor is allowed to do or not to do"*. Similarly to their work, we refine this definition by splitting authority in two concepts. First, the authority refers to the initiative of the user or system to execute a task or a function on its own. Second, the authority refers to the ability to define the next tasks (or functions) of the user (or the system). The task or function itself (how), data or objects manipulated (what) and the temporal aspects (when and scheduling) can be defined. For example, the authority (for episode selection) lays in the system in case of automatic playback of episodes while binge-watching a TV series.

Responsibility: When users perform an activity, they expect a particular result. For example, in the case of binge-watching a series, the user would expect to have an enjoyable watching experience. If the episode does not start, the responsibility lays with the system that the expected result was not achieved.

To be able to understand the impact of automation design on user experience a notation must be able to represent explicitly each of the AFAR principles.

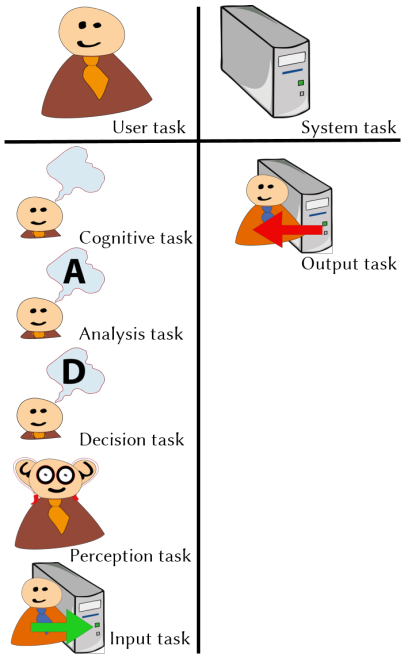

Figure 1: The first column presents tasks allocated to the user. The second column represents functions allocated to the system.

Figure 2: From left to right: symbols for responsibility and authority

PROBLEM DESCRIPTION

Key question for this research is how we can assess the effects of automating tasks and activities and understand their impact on user experience. To be able to figure out how design choices in automation lead to different user experiences and changes in UX dimensions like aesthetics perception, users emotions, meaning and value of a product etc, we need (1) to be able to model different systems, and to be able to compare the automated system with the non-automated system [1] and (2) to relate users and system activities to results from user experience evaluations in order to investigate the impact. This paper deals with the second need: to relate user and system activities to results from user experience evaluation.

When automating a system or a function it is difficult to understand how the introduction of automation is changing the user experience. Let us consider as an example the very simple automation in a television or video-on-demand user interface: you are watching an episode of your favourite show. At the end of an episode the system either allows the user to manually control the selection of the next episode, or automates this function by proposing the episode on screen (including a count-down of 15 seconds until the next episode is played) to support, for instance, binge-watching.

The following section exemplifies how we can evaluate the effect of automation on the overall user experience of such an automated function in a video-on-demand user interface.

EXTENDING A TASK NOTATION TO REPRESENT AUTOMATION

HAMSTERS (Human-centered Assessment and Modeling to Support Task Engineering for Resilient Systems) [8] is a task modeling language with the corresponding editing and simulation environment. To address the problem, HAMSTERS was extended to describe the three key aspects of automation at a low level of detail, namely (1) allocation of function, (2) authority, and (3) responsibility. For (1) the notation was extended by an orchestration model that allows to describe which actor (system or user) performs the function (which is described by a model). The symbols in Figure 1 are used to represent this allocation of function to system (left) or human (right). Graphically, each tasks can be annotated with (2) authority and (3) responsibility symbols presented in Figure 2. The models presented in Figure 3 and Figure 4 exhibit these symbols (making comparison easy). For our ongoing example of how to watch the next episode of the users most favorite current TV series, the task model would consist of two parts, either having the user doing the selection of the next episode manually or having the system automatically proposing the next episode. If both models are valid on the system, it would mean that both designs are made available to the user (who can chose which one to use).

Figure 3 shows the task description for the simplistic example of an automated function in a TV user interface with the authority belonging to the system. The user desires to watch a series, plays an episode, and the system plays the next series episodes. The system selects the next episode that

Figure 5: Proposition of representation of UX dimensions on a user task.

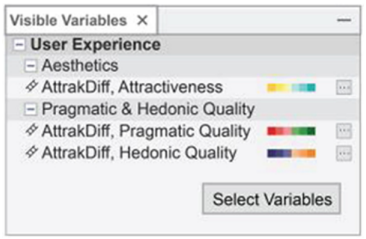

Figure 6: Proposition of the representation of UX dimensions using a color panel in the task modeling notation.

should be played, shows a snippet of the show on the screen for 15 seconds, and then automatically starts to play the next episode. The authority can be taken back by the user within the 15 second time-frame highlighted by the authority symbol (the crown). This is different from the case when an episode is manually selected (cf. Figure 4), where the authority lays with the user. After playing the first episode, the system displays the list of available episodes and the user has to manually choose one among them. The user can decide to stop watching an episode and to take back the authority in both cases.

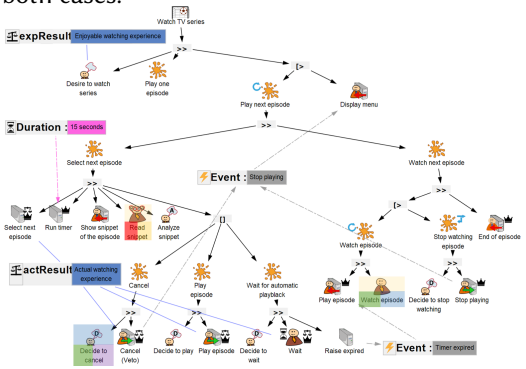

Figure 3: Automation of episodes selection task with authority belonging to the system (♛).

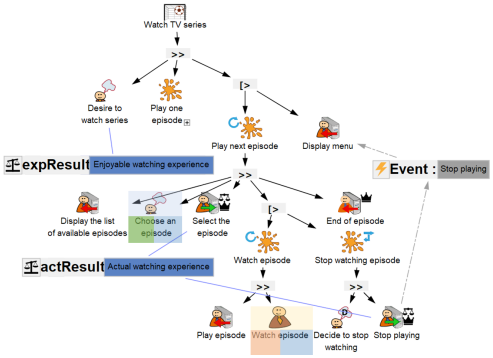

Figure 4: Manual selection of an episode with authority of the user (♛).

Responsibility refers to the fact that the outcome of an action might not fit the expected result of the user. In the current notation this is typically the case for all instances when the system is producing an object or modifying an object related to the expected result of the users. Such a situation is highlighted with a 'weighing scale' symbol for responsibility (Figure 2, left).

What is interesting to note is the difference between the automated version and the standard version of playing the next episode: not only authority and responsibility shift in the two versions, but also the cognitive effort is very different for the user. While in the case of manual selection, the user has to remember the number of the next episode or has to identify the next episode to be played, the cognitive load in the automated version is different, requiring the user to react within the limited time frame of 15 seconds.

ENABLING THE REPRESENTATION OF USER EXPERIENCE EVALUATION DATA

To be able to understand the impact of automation on the overall user experience, Bernhaupt et al. [2] proposed to extend the task notation with the ability to represent data from UX evaluation in

REFERENCES

[1] Regina Bernhaupt, Martin Cronel, François Manciet, Celia Martinie, and Philippe Palanque. 2015. Transparent Automation for Assessing and Designing better Interactions between Operators and Partly-Autonomous Interactive Systems. In *Int. Conf. on Application and Theory of Automation in Command and Control Systems*. 129–139.

[2] Regina Bernhaupt, Philippe Palanque, Dimitri Drouet, and Celia Martinie. 2019. Enriching Task Models with Usability and User Experience Evaluation Data. In *Human-Centered Software Engineering*. Springer, 146–163.

[3] Regina Bernhaupt, Philippe Palanque, François Manciet, and Célia Martinie. 2016. User-Test Results Injection into Task-Based Design Process for the Assessment and Improvement of Both Usability and User Experience. In *Human-Centered and Error-Resilient Systems Development*. Springer, 56–72.

[4] Elodie Bouzekri, Alexandre Canny, Célia Martinie, Philippe Palanque, and Christine Gris. 2019. Using Task Descriptions with Explicit Representation of Allocation of Functions, Authority and Responsibility to Design and Assess Automation. In *Human Work Interaction Design. Designing Engaging Automation*. Springer, 36–56.

[5] Frank Flemisch, Matthias Heesen, Tobias Hesse, Johann Kelsch, Anna Schieben, and Johannes Beller. 2012. Towards a dynamic balance between humans and automation: authority, ability, responsibility and control in shared and cooperative control situations. *Cognition, Technology & Work* 14, 1 (2012), 3–18.

[6] Marc Hassenzahl, Michael Burmester, and Franz Koller. 2003. *AttrakDiff: Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Qualität*. Vieweg+Teubner Verlag, Wiesbaden, 187–196.

[7] Marc Hassenzahl and Noam Tractinsky. 2006. User experience - a research agenda. *Behaviour & Information Technology* 25, 2 (2006), 91–97.

[8] ICS Group. 2019. HAMSTERS. https://www.irit.fr/recherches/ICS/softwares/hamsters/

[9] Peter Wright, Andy Dearden, and Bob Fields. 2000. Function allocation: a perspective from studies of work practice. *International Journal of Human-Computer Studies* 52, 2 (2000), 335–355.

a flexible form, allowing to define different variables and showing the results of the UX evaluation within the task model by assigning colors (Figure 5). Figure 6 shows the definition of UX values based on Hassenzahl's *AttrakDiff* [6].

Once an evaluation is performed, the evaluation data for user experience can be visually represented within the task model. For example, Figure 3 shows superimposed over the "Watch episode" user task yellow, green and blue colors representing average attractiveness, pragmatic and hedonic qualities. The software HAMSTERS additionally allows analysis of UX evaluation results in a variety of ways including views on data not only on the task level but also having the ability to show scenarios of usage [2].

SUMMARY AND DISCUSSION

To enable a better understanding of how automation is affecting user experience this position paper introduces a series of extensions to an existing task notation that is implemented in the HAMSTERS tool, enabling the three key principles for automation (AFAR) as well as the representation of different UX dimensions. The notation allows to describe how tasks are allocated to either the system or the user (function allocation) and the representation of responsibility (who is responsible if the desired outcome for a task is not achieved) as well as the authority (who has the initiative or the control). HAMSTERS also supports the comparison of different systems as well as the representation of data.

A limitation in the example given above is that the user experience depends on the automatic starting of the next episode (which is a simple function). Nevertheless, the notation is able to represent, for example, how the user is interacting with a system (e.g. the input device of the TV can be a simple remote control or a mobile phone app with a variety of automated functions for control) and thus enables to analyze the impact of larger scale automation. Especially the criteria for talking about responsibility is only related to playing the next episode and not to the quality of the interaction technique that is used (see [2]).

NEXT STEPS

Currently, the design and the implementation of the proposed extensions is still ongoing. This includes developing suitable visualization and representation methods to facilitate the analysis of the collected data and the assessment of the impact of automation on user behaviour. This is, however, not a straightforward endeavour because – as mentioned earlier – UX and behaviour changes over time. In addition to the task model and the UX dimensions, visualizations thus need to take time into account to properly convey the evolution of experience and enable comparison. These comparisons may focus on changes over time, individual versus collective experience, and intended versus actual experience.