

Using Personas for Supporting User Modeling on Scheduling Systems

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Abstract — User modeling and user adaptive interaction has become a central research issue to understand users as they interact with technology. The importance of the development of well adapted interfaces to several kinds of users and the differences that characterize them is the basis of the successful interaction. User Personas is a technique that allows the discovery and definition of the archetype users of a system. With that knowledge, the system should shape itself, inferring the user expertise to provide its users with the best possible experience. In this paper, an architecture that combines User Personas and a dynamic, evolving system is proposed, along with an evaluation by its target users. The proposed system is able to infer the user and its matching Persona, and keeps shaping itself in parallel with the user's discovery of the system.

Keywords — *User Modeling, Human Computer Interaction, User Centered Design, Usability Analysis, Machine Learning.*

I. INTRODUCTION

The development of intelligent systems that learn with experience is a challenging domain considering that current systems are becoming more and more complex and subject to rapid changes requiring fast adaptation.

Current financial/economical context and global competitiveness requires that organizations adopt agile strategies for planning, scheduling, and strategic decision making fields. Modeling the decisions to be taken and the constraints placed by the market in a way to address the needs of all stakeholders has been an important area of academic and industrial research. Analysts, developers, and business people involved in all stages of the business organizations value chain have a need for applied business insight through modeling.

Human-Computer Interaction (HCI) arises in literature as a research area that studies interactions and relationships between humans and computers. HCI is a multidisciplinary and an evolving field covering different research areas [1].

User modeling and user adaptive interaction has become a central applied issue to understand users as they interact with technology [1]. As the user modeling field has been evolving, so the methodologies have also evolved from the area of knowledge representation, to techniques from Artificial Intelligence, Computer Science, and even Social Sciences. User Centered design takes time, effort, and expertise.

Producing effective user interaction requires focusing on what is best for the user, rather than what is quick and easiest to the design and implementation process [1]. The importance of the development of well adapted interfaces to several kinds of users and the differences that characterize them is the basis of the interaction system success.

Various studies referred on literature [2] have shown that user differences account for much more variability in task performance than either system design or training procedures. Much of this variability comes from making and recovering from errors. Factors that predict differences in computer-based skills include user experience, particular technical aptitudes, age, domain specific skills and knowledge. Technical aptitudes that are good predictors of user performance include spatial visualization ability, vocabulary, and logical reasoning ability [1].

Developing a system to face any complex subject and, simultaneously, with a high usability is a very hard and challenging problem. Dense topics usually require high amounts of information and input from users, hence when developing this particular type of systems, the process focus primarily in performance and results, and not on other user needs.

In order to increase the usability of a system, the type of users that operate it must be known. Therefore, most computer systems have to accommodate different classes of users.

User Personas, one of the most applied user-centered design techniques, offers the possibility of creating standard system users, discovering the disparity in their experience. This eases the difficulty decreasing during the system development, allows the discovery of the user base that potentially will work with the system, and brings forward their specific needs and requirements.

In this paper, a Personas based approach on the ADSyS system is proposed. We start by understanding the system current and potential users, and with the gathered information, four Personas (three primary Personas + one secondary Persona) were developed. For each primary Persona is then given a proper interaction with the system (different Personas have unique interfaces or messages/dialogs). The connection to the real user is performed as follows: working with the

remaining parts of the User Module in which the Personas are incorporated, a real user will be matched by the system to one of them, according to its level of knowledge and methods of working within the system.

This work is expected to benefit multiple developers across different areas, from information rich systems, to intelligent agents and user-Centered design, being taken as a successful example and guide to improve their systems usability and Personalization.

The remaining sections are organized as follows: Section II summarizes a literature review on Real World Scheduling, User-Centered Design and User Modelling. In Section III, the Personas technique and its applications in the prototype are presented. Section IV puts forward the usability evaluation of the prototype. Finally, the paper presents some conclusions and puts forward ideas for future work.

II. LITERATURE REVIEW

In this section, a literature review on User-Centered Design, User Modeling lifecycle and a Personas approach in computer-based interactive systems is presented.

A. User-Centered Design and User Modeling

User-Centered Design, also known as Human-Centered Design, is a methodology for the development of user-friendly systems whose main goal is to ensure the necessities of users and the requirements of the organization business goals [1].

ISO 13407:1999 (later revised by ISO 9241-210:2010) standard describes a set of best practices in user centered design. It provides guidance on design activities that take place throughout the life cycle of interactive systems. This standard states "Human-centered design is an approach to interactive system development that focuses specifically on making systems usable. It is a multi-disciplinary activity."

The concepts of functionality (set of actions or services available to users) and usability (efficiency degree and appropriateness in achieving certain goals for specific users) should be considered in the development process of interactive computing systems [2-3]. There are two concepts to have in mind when designing interfaces: usability and user experience. Although they are related, each concept has a different meaning and focus regarding a specific product or service. Standard ISO 9241-11(1998) defines usability as "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use", while ISO 9241-210 (1999) defines user experience as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service", being influenced by three factors: the system, the user and the context of use.

According to ISO definition, usability is concerned with the "effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments" [4]. Thereby, usability can be described as the qualitative attribute that verifies and measures how easy-to-use and easy-to-learn some objects are. Although these objects – software, websites, tools, machines, books, or anything that involves human interaction - are made by humans, most times they are not

designed with the human interaction in mind, which leads to problems and doubts during its use. Applying usability criteria during the design process leads to better interfaces by making them more intuitive, efficient, memorable, effective and enjoyable to use. These characteristics are referred by Nielsen [5] as a way to achieve system's acceptability by users, among other factors like cost, reliability and social acceptability.

There are several methods to evaluate interfaces accordingly to its usability. A usability study can be conducted during different stages of a system development, in order to satisfy different purposes like requirements gathering and product validation. Several usability methods can be applied in different stages of the User Centered Design process depending on the purposes, such as: Card Sorting, Contextual Interviews, Focus Groups, Heuristic Evaluation, Individual Interviews, Parallel Design, Personas, Prototyping, Surveys, Task Analysis and Usability Testing [6].

User modeling and user adaptive interaction has evolved as a research area and as an applied issue to understand users as they interact with technology and improve the collaborative nature of human-computer systems [5]. Kay and Calla [7] compiled and summarized the efforts and contributions for user modeling and Personalization research areas. The applications of learning systems and natural language dialogue systems have been evolving to a set of applications concerning Personalization issues, including recommender systems, social computing, intelligent web search, personalized help systems, adaptive interactive systems and intelligent user interfaces.

B. Personas

User Personas are referred as an approach to user modeling that improves the usability and user experience in a system. It is one of the most used user-centered design techniques.

1) Persona Lifecycle Phases

The Persona lifecycle is a metaphoric framework presented in [8] that categorizes the Persona process into phases similar to those of human reproduction and development. As shown in Fig. 1, there are five phases in this framework: family planning, conception and gestation, birth and maturation, adulthood, and lifetime achievement and retirement. The phases of the Persona lifecycle framework bring structure to the potentially complicated process of Persona creation and highlight critical (yet often overlooked or ignored) aspects of Persona use.

As the name indicates, the Persona lifecycle is a cyclical, largely serial, process model. As Fig. 1 indicates, each stage builds on the next, culminating but not ending at the adulthood phase. Note also that the figure shows that the final stage, lifetime achievement and retirement, is not immediately followed by a cyclical return to the first stage. This is because different Persona efforts culminate and restart in different ways. Personas can be reused, reincarnated, or retired depending on the project. The diagram represents both the order of the phases and the amount of effort required in each one.

2) Concepts and definitions

User Personas is a technique used to characterize the main user traits relevant for product development. They were

introduced into product design by Alan Cooper [9], and were previously used in marketing [10]. Personas surface when the team is establishing the requirements for a new product. During this phase, common problems arise: designers are not able to guess what users want, the users themselves might not know what they want, and not every user wants the same. Personas is an alternative technique to the typical software development process, which is designed for an aggregate user and where all functionalities are included, lowering the usability of the product.

A Persona should be a precise description of a user and what she/he wishes to accomplish [1]. It is a detailed narrative of imaginary people constructed out of well-understood, highly specified data about real people [8]. They help defining the product by replacing the abstract users by a specific one who becomes part of the design process [11]. Blomkvist [12] defined Personas as: Fictional, having names, pictures and lives; Detailed archetypical version of a user; Cover distinct groups of behaviors and motivations; and Based on data collected about potential users. According to [13], there are four types of Personas:

- a) *User Persona (direct product user)*: It represents the typical Persona used in development, and is split into two subtypes: The *Primary Persona*, which represents the primary targets of the product, and the *Secondary Persona*, which is not so important as the primary, but still might have additional requirements necessary to attend during the development;
- b) *Customer Persona*: It is not the direct user of the product. In a supermarket POS, there should be customers Personas but the end user is the cashier [14];
- c) *Severed Persona*: Who is not the end user of the system but can affect its use;
- d) *Negative Persona*: Who is not the end user of the system and definitely should not be considered during development. This type of Persona is used to know what should not be targeted, helping to avoid a misunderstanding of the system scope.

The process of creating each Persona in software development is not a trivial task, being a point of rupture amongst some authors. According to [8, 16], the first step is the user research, as possible and the collection of as much



Figure 1: The five phases of the Persona lifecycle [15].

possible data about the market. Personas needs a big amount of user data, and this information needs to be prepared before the Persona creation. The following step is to define the user classes. A user class represents a category of users that share similar traits. During this step, definitions like User role, goal and segment are necessary. User role describes the Persona's interaction with the product; the user goal is what it tries to achieve, and; the user segment defines the users in characteristics they may share with other users [8,14]. The next step is collecting the user data: after the classes are defined, the collected data is processed, creating the first drafts of the Persona. The succeeding phase is to convert the created drafts into the Persona documents. These documents should be the foundation documents [8] and follow a template defined by the team. They work as a concrete narration of a specific user, where imaginary items are added to the Persona's draft to replace the concept terms [14]. The final step is designating the type of each Persona, according to the four possibilities [13] previously presented. After this definition the Personas are ready to be used in the product development.

III. PERSONAS DESCRIPTION

Following [8, 16], the first steps are performed with the objective of collecting data about potential system users to create the User Personas. This Section describes the created Personas, used throughout the development of ADSyS [17].

A. Primary Personas

Three final, primary Personas were created, each representing a class of users that share the same needs. The three categories that have been discovered were also used during the Bayes Network development [18], in order to create in the system the capability of distinction between each class.

Adam Persona (Fig. 2) represents the class of users that have less or no experience with the system. To this class, the system needs to adapt and become more welcoming. A user that has never worked with the system will have a hard time discovering every function and knowing how to operate with them, hence the need of some sort of a welcoming guide. This type of tutorial should explain the correct use of every tool and clarify, when not used correctly, what was done wrong. There should also be sufficient explanations throughout the system, via dialogs or tooltips, which help the user adapting to ADSyS.

Clara Persona (Fig. 2) embodies the user category of someone who is used to working with scheduling plans during its career. She has the knowledge of the constraints and terminology that a scheduling problem has, but small to no experience in using ADSyS. This user class needs concise, specific helps in order to be more proficient with the system. The other main need is to know the system-specific details and definitions (information that may be provided via the specific helps). This necessity is due to the fact that MH definition and parameterization, although known in general, has a different terminology in multiple systems, particularly the abbreviations. With the presented features Clara is able to make a swift transition from her background in scheduling to being skilled using ADSyS.

Leonard Persona (Fig. 2) personifies an expert user, not only in scheduling but also in using ADSyS. This user category

needs a different approach from the previous one, as what they desire is not more helps or a guiding approach, instead preferring a quick access to advanced system tools that allow them to be more efficient using the system. The Leonard Persona also wants the system to be configurable, letting it take the decision on global definitions (e.g. for every helps if it should be present and automatic or no warning messages). System messages targeted at Leonard should also be concise, offering the option of further detail only at the request of the user [1].

B. Secondary Persona

Due to the dynamic environment of user experience growth from the UM module, a non-primary Persona was also conceived. The three primary Personas all have a static profile, with constant values that do not represent a real learning curve that typical users will have while using the system. This fourth Persona is someone viewed as an “on-off” type of user, who goes through the three previously described BN classes: beginner, intermediate and advanced. It is not a primary Persona because there is no need to develop a new interface just for her [9,12], as she will be balancing between the three main Personas.

Name	Adam Tuff	Clara Terlford	Leonard Hart
Description	21 years old, is a student in the IT area. Had a class about scheduling and is trying to learn more about the subject	41 years old, works in the industry area. Has never used a specific system to design scheduling problems	32 years old, is a scheduling expert. Is used to deal with the specifics of a scheduling problem and in using ADSyS to do so
Experience	Minimal, only knows some small concepts that help him understanding the goal of a plan	Is used to work with scheduling plans - knows the rules and terminology, but has no knowledge of this system	“Maximum” experience, already knows the system and its terminology
Scenario	Will use ADSyS in order to finish a university assignment, where he needs to find a possible solution to a given problem	Due to some changes at her workplace, Clara will now start working with ADSyS when there is a scheduling problem or decision to be made.	Leonard has been an avid user of ADSyS for multiple purposes, whether it is to obtain a batch of results for a specific problem or to introduce a real-world change to a previous solution (using the Dynamic Mode)
Requirements	Wants the system to automatically fill each formulary with the appropriate values. Wants to be guided while constructing a problem. Needs helps, explanations/tooltips for every function in the system, but expects them to treat him as an “intelligent user”	Wants concise, non-intrusive helps and suggestions. Needs an explanation for system specific details (Dynamic mode, order/task set editor, MH parameterizations). Desires an easy access to the tools she wants	Wants to use the system in an efficient way – needs advanced features (e.g. Wizard, Multiview, Dynamic mode). Doesn’t want all helps to interfere with his activity – configurable helps and automation

Figure 2: Primary Personas – Adam, Clara and Leonard.

Sarah Persona (Fig. 3) is therefore a secondary Persona, who has a similar amount of knowledge as Clara, but does not have a clear scenario in which to use ADSyS. That means that she can use the system rarely, and be closer to a beginner classification, or she might happen to start using the system continuously at her workplace, making her a lot closer to an advanced, Leonard-like profile. Sarah was created to reinforce the feeling that although each primary Persona is static, a real user of the system is not. Sarah requirements are that the system must handle the evolution of a user (either gaining or losing knowledge of the system) in the best possible way.

Following the Persona creation, an analysis of the requisites for each one was made (Table 1). Each row represents a feature required by one of the Personas, and each cell measures the weight that each feature has for each Persona, ranging from 0 to 3. The primary Personas also have a weight themselves, summing to a total of 100, which signifies their importance to system development. The last column is the weighted sum, and the higher the value, the more importance it has during the system development. Sarah is also included in the features table only as a reminder of the dynamic system needs, and is not taken into account in the other features – as her profile would overlap with other profiles needs and, possibly, create false priorities.

IV. VALIDATION AND DISCUSSION OF RESULTS

A. Feature development

After gathering the data for the Personas creation, the key features to be implemented in the system were determined. It is clear that there is a division in the priority matrix (Table 1), with two clearly identifiable groups: the high priority features – with a weighted sum to 150 or more – and the others. With that information, the development was focused on implementing the first category in ADSyS, and only after that the second group would be analyzed.

From Table 1, the most necessary feature is “explanations and helps”. This consists of creating a method for users to understand what each tool in ADSyS does and how to use it. Not only the system has to provide clear tooltips and dialogs that offer an explanation to the user, but these messages need to account for another feature in Table 1, which states that the messages must be “concise and non-intrusive”, in accordance with the user experience [18]. “Configurable system”, another

	Description	Experience	Requirements
Sarah Bray	37 years old, has some scheduling knowledge but does not have to use it regularly	Has no specific experience with ADSyS or scheduling systems, but is a prolific PC user and has worked in scheduling before	A dynamic and flexible system that can adapt to her evolution, growing with her and easing the learning curve
Scenarios	A	B	
	Started using ADSyS on a daily basis, due to some changes in her routine. Has gained knowledge and is experienced, being now classified as a scheduling expert	Has not worked on a scheduling problem for a long time. Although retaining semantic knowledge of the system over time, she tends to lose syntactic knowledge. The system must treat her as a beginner user	

Figure 3: Secondary Persona – Sarah.

feature with a high priority, relates to the explanations in allowing the user to decide the amount and level of help she/he wants to experience (e.g. While Adam wants all types of helps, Leonard does not want the basic explanations, instead choosing only to be warned about critical plan errors). “Advanced Features”, the last high priority feature to Leonard, represents the use of advanced tools within the system (e.g. Multi-View, Dynamic mode and Wizard). The other high-priority system feature is the dynamism of the UM module, and it is a clear need for Sarah. This requires the BN to work correctly and be properly tested by each Persona, until each output from the network gives an accurate classification. These four features have the highest priority to ADSyS Personas and were the main focus of development, with each one being successfully implemented.

Table 1. A feature by Persona-weighted priority matrix

	<i>Adam</i>	<i>Clara</i>	<i>Leonard</i>	<i>Sarah</i>	
<i>Weight</i>	25	30	45	20	Sum
Prefill formularies	3	1	0	-	105
Initial guidance	3	0	0	-	75
Explanations/ helps	3	2	1	-	180
Adaptive interface	0	1	1	-	75
Concise/non-intrusive helps	0	2	2	-	150
System-specific details	1	3	0	-	115
Configurable system	0	1	3	-	165
Advanced features	0	1	3	-	165
Dynamic, adaptive system	1	1	1	3	160

The second group of features – weighted sum to 115 or less – was not the primary focus, but they have also been worked on as a part of ADSyS development. The first is “System specific details”, which represents a way for Clara to understand what each abbreviation means, how to use each Metaheuristic and the respective parameterization. This point is also related to an Adam’s need, “prefill Formularies”. The result is that Clara wants to be able to define every detail of the scheduling problem, while Adam expecting the system to insert the most appropriate values. The system is left with the decision of inferring the user level via the BN, and then adapts the formularies according to their experience and desire. The last features are Initial guidance and Adaptive interface. The first is a must-have for Adam, where he needs a system walkthrough when he starts using it, in order for him to learn how to use it and what every tool does. The second is a common need for Clara and Leonard, and denotes that the system must change its interface fittingly to the user most used tools and shortcuts (e.g. if Leonard never uses the “repair plan” shortcut, it should not be neither the focus nor be visible in the interface, and may be hidden under a menu).

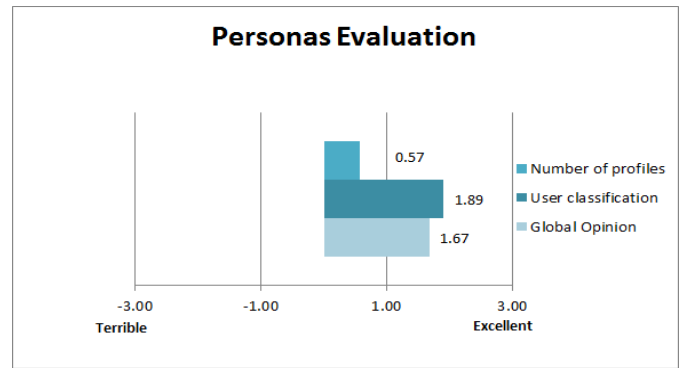


Figure 4: ADSyS Personas evaluation.

Overall, Personas and their needs (Table 1) set the tone for ADSyS development. The first priority was to create a system suitable for Leonard, the expert. The User Interface module was not the first focus, but instead the scheduling area needed to be concluded – Leonard prioritizes a powerful, high-functionality system, even if it implies a higher memorization effort and a bigger cognitive load on users. Then it was Clara’s time, with her needs being focused on. Tooltips, dialogs and others were introduced so that people with scheduling knowledge could use ADSyS. Not only that, but the UI was also improved in order to create a more user-friendly environment, with a higher utility rate. With the UI improvements with features like Multiview Leonard could also use the system more efficiently. Adam came at last, and with him the introduction of proper explanations for every function, a guide through errors, and other methods for easing the learning curve of a new user to scheduling and, to the system.

B. Persona evaluation

In order to analyze the current state of the developed features and their accordance with the Personas desire, amongst other ADSyS related features, a preliminary evaluation was held with a group of users that portrayed each Persona [12] (e.g. a scheduling expert that resembled Clara or an inexperienced member as Adam). The system had a great reception, and the main points featured by the participants were in accordance to Personas plans (e.g. one of the invitees with scheduling experience pointed the fact that ADSyS needed a system-specific detailed explanation – just like Clara).

The most relevant information from the evaluation session to Personas development is presented in Figs. 4 and 5. The responses obtained from the surveys were classified in a seven level symmetric Likert scale. In the questions related to

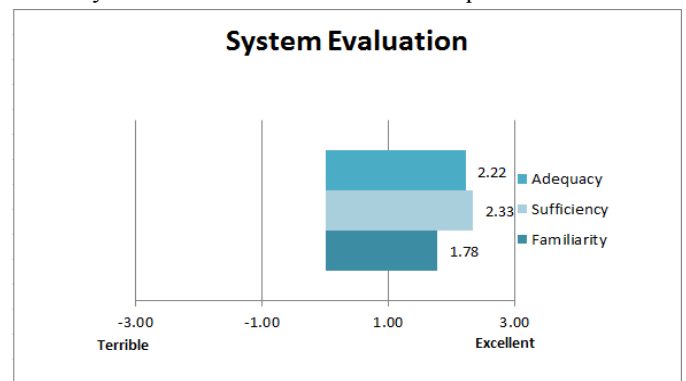


Figure 5: Grades from the global ADSyS evaluation

Personas classification (Fig. 4), it was asked if the number of profiles and the user classification was appropriate, in accordance to their expectations. The final bar in Fig. 4 represents the global feeling that users had about the user modeling approach, concerning both the Personas and BN method. The lowest value (0.57) is the classification given to the number of planned primary profiles/Personas. Although positive, it can create a feeling that the Personas are insufficient for real user needs. However, the idea concluded from the evaluation session and post discussion is that the number of profiles is adequate, and most people gave it a 0 classification not due to being a low number, but as a neutral value, because they were not surprised by them – they were expecting this approach.

Fig. 5 reveals the classification given to ADSyS in a global scope. A clear reading from the grades is that each participant (and their Personas counterpart) felt comfortable using the system, as it was familiar given their knowledge. From the less experienced to the most, everyone felt comfortable using the system, given its dynamic adaptation to their experience. ADSyS is also sufficient and adequate for the user needs, from a beginner who needs guidance to an expert who desires advanced features. This fact proves that the developed Personas are correct and symbolize truthfully the common users for ADSyS.

The clear result is that using a Personas approach has been successful. It created clear and precise objectives to develop and personified system users, creating an overall experience with high usability and according to true user needs, solving one of the major issues in software development [10]. The development focus has also been conducted appropriately, with the most important targets being the most satisfied with the system – Clara and Leonard.

V. CONCLUSIONS AND FUTURE WORK

An approach to using Personas for support user modeling in a scheduling system is described. Using the obtained knowledge from the scheduling field and the current users of ADSyS, three primary Personas (and a secondary one for support) were developed, ranging from a user without any knowledge in scheduling to a real expert in the area. The built Personas also characterize the learning curve of a typical user of the system. For each Persona, specific information was discovered. Each one has a custom description and experience, a particular scenario where they use ADSyS, and a different set of requirements that the system must fulfill or provide. ADSyS is able to categorize every user into one of the three developed Personas. Each category then has a pre-designed set of interactions with the system (e.g. custom interfaces and specific messages). Using Personas has improved the utility in ADSyS: The system shapes itself to mirror user needs and, as a consequence, they are able to accomplish their goals more efficiently, and doing so in a friendly, comfortable environment. The results from real and potential ADSyS users are very promising, and the developed Personas match truthfully their real world impersonations. The conclusion can be made that using Personas to support user modeling is successful.

Future work includes an evaluation session oriented specifically for user Personas and the UM module; and further development of the features ADSyS offers specifically to each Persona, improving even further the system's usability and therefore increasing its effectiveness, efficiency and user satisfaction.

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