Specification of a UX Process Reference Model towards the Strategic Planning of UX Activities

Suzanne Kieffer[1], Luka Rukonic[1], Vincent Kervyn de Meerendré[1] and Jean Vanderdonckt[2]
[1]*Institute for Language and Communication, Université Catholique de Louvain, Louvain-la-Neuve, Belgium*
[2]*Louvain Research Institute in Management and Organizations, Université Catholique de Louvain, Louvain-la-Neuve, Belgium*

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Abstract: In this conceptual paper, we present a UX process reference model (UXPRM), explain how it builds on the related work and report our experience using it. The UXPRM includes a description of primary UX lifecycle processes, and a classification of UX methods and artifacts. This work draws an accurate picture of UX base practices and allows the reader to compare and select methods for different purposes. Building on that basis, our future work consists of developing a UX Capability/Maturity Model (UXCMM) intended for UX activity planning according to the organization's UX capabilities. Ultimately, the UXCMM aims to facilitate the integration of UX processes in software engineering, which should contribute to reducing the gap between UX research and UX practice.

1 INTRODUCTION

To date there is no consensual definition of User Experience (UX). While the origin of the term is generally attributed to Norman et al. (1995), the relevant literature reports numerous perspectives on and definitions of UX (Hassenzahl, 2003, 2008; Hassenzahl and Tractinsky, 2006; ISO 9241-210, 2008; Law et al., 2009). The International Organization for Standardization (ISO) defines UX as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service" (ISO 9241-210, 2008). Law et al. (2009) surveyed the views of 275 UX researchers and practitioners on their understanding of UX and its key characteristics. Respondents not only reported varying opinions about the nature and scope of UX but they also expressed mixed reactions to the ISO UX definition: according to respondents, although the definition integrates well the aspects of subjectivity and usage, the concepts of object (e.g. 'product') and context (e.g. social context and temporality) need clarifications. A recent analysis of the ISO UX definition based on formal logic illustrates similar inconsistencies and ambiguities in its formulation and structure (Mirnig et al., 2015).

The lack of consensus on the definition of UX has led to confusion over UX measurement and UX evaluation methods. Whether UX measures should integrate usability is a question that divides the UX community (Law et al., 2008, 2014). As pointed out by Bargas-Avila and Hornbæk (2011), UX research has become dichotomic between those who focus on the hedonic aspects of UX such as visual aesthetics, beauty, joy of use or personal growth, and those who focus on the pragmatic characteristics of the interactive product such as usability, utility or safety. The relevant Human-Computer Interaction (HCI) literature reports two approaches for UX measurement: either as a variation of the satisfaction construct of usability within a 'traditional' HCI approach focused on task-oriented, instrumental goals (Bevan, 2008; Grandi et al., 2017; ISO 13407, 1999; Albert and Tullis, 2013) or as a set of hedonic qualities different from usability within a 'new paradigm' in HCI focused on non-task oriented, non-instrumental goals (Hassenzahl, 2003, 2008; Hassenzahl and Tractinsky, 2006). Furthermore, whether UX measurement should follow a qualitative or a quantitative approach is another question that divides the UX community. Bargas-Avila and Hornbæk (2011) showed in their review of 66 empirical UX studies that 50% were qualitative, 33% quantitative and 17% combined both approaches. Lallemand et al. (2015) conducted a replication of the survey of Law et al. (2009) amongst 758 practitioners

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and researchers. The authors found no clear answer on respondents' attitude towards UX measurement although they reported a higher preference for qualitative approaches in industry, which seems to be consistent with the UX trend depicted in (Bargas-Avila and Hornbæk, 2011). Interestingly, despite the aforementioned division between traditional and new HCI paradigm, the UX community employs mostly traditional HCI/usability evaluation methods such as survey research, interview, observation and experimentation (Bargas-Avila and Hornbæk, 2011; Daae and Boks, 2015; Gray, 2016; Roedl and Stolterman, 2013; Vermeeren et al., 2010). Questionnaire is the prevailing technique supporting UX data collection (Bargas-Avila and Hornbæk, 2011; Law et al., 2014; Venturi et al., 2006). The questionnaires used are either validated (e.g. AttrakDiff, Flow State Scales, Game Experience Questionnaire, Self-assessment Manikin, CSUQ, SUS) or self-developed. Bargas-Avila and Hornbæk (2011) also report the emergence of constructive methods such as probes, collage/drawings, or photographs, and express concerns about the validity of such new methods.

Nevertheless, from a buzzword in the late 90's UX has become a core concept of HCI, leading to the proliferation of UX methods intended to support and improve both UX activities and system development (Venturi et al., 2006). Yet, the relevant literature consistently highlights contrasting perspectives on UX methods between academia and industry (Lallemand et al., 2015; Law et al., 2009, 2014). While the academia mainly focuses on the development and the testing of new UX methods, the industry documents recommendations for their use in industrial context promoting design thinking as a strategy for innovation. Gray (2016) interviewed 13 UX practitioners about their use of UX methods. Participants reported adapting and combining UX methods according to the design situation, revealing a UX practice that is rather ad hoc than based on codified, deterministic procedures. According to earlier findings (Roedl and Stolterman, 2013), this pattern in UX practice results from issues with research outputs such as the over-generalization of design situations, the disregard for the complexity of group decision-making or for time and resources constraints at the workplace.

In this conceptual paper, we present a UX process reference model (UXPRM), explain how it builds on the related work and report our experience using it. The UXPRM includes a description of primary UX lifecycle processes, and a classification of UX methods and artifacts. This work draws an accurate picture of UX base practices and allows the reader to compare and select methods for different purposes. Building on that basis, our future work consists of developing a UX Capability/Maturity Model (UXCMM) intended for UX activity planning according to the organization's UX capabilities. Ultimately, the UXCMM aims to facilitate the integration of UX processes in software engineering, which should contribute to reducing the gap between UX research and UX practice.

2 RELATED WORK

In this section, we define the concept of process reference model and discuss three methodologies related to UX practice: Usability Engineering (UE), User-Centered Design (UCD) and Agile User-Centered Design Integration (AUCDI). We have selected these three methodologies as they involve UCD methods articulated across a lifecycle, which fits the definition of UX of Law et al. (2009): "UX must be part of HCI and grounded in UCD practice".

2.1 Process Reference Model

A process reference model describes a set of processes and their interrelations within a process lifecycle (ISO 15504-1, 2004, 2012). The description of each process includes its objectives and its outcomes. Outcomes, also referred to as work products, are the artifacts associated with the execution of a process. Process reference models are refined into base practices that contribute to the production of work products (ISO 15504-1, 2012). A primary process is a group of processes that belong to the same category and are associated with the same objectives. Usually, a process reference model is associated with a process assessment model, which is a measurement structure for the assessment of the capability or performance of organizations to implement processes (ISO 15504-1, 2004, 2012). Together, a process reference model and a process assessment model constitute a capability/maturity model (CMM). Typically, CMMs includes five maturity levels that describe the level of maturity of a process: initial (level 1), repeatable (level 2), defined (level 3), managed (level 4) and optimized (level 5). The purpose of such models is to support organizations moving from lower to higher maturity levels. In a CMM, both base practices and work products serve as indicators of the capability/maturity of processes.

For the record, this conceptual paper focuses on the specification of a UX process reference model and not on that of a UX process assessment model. To date, there is, to the best of our knowledge, no process reference model for the UX process. Lacerda and Gresse van Wangenheim (2016) recently conducted a systematic literature review of usability capability/maturity models. Out of the 15 relevant models they identified, five were UXCMM. None of the five UXCMM explicitly defined a UXPRM.

2.2 Usability Engineering

UE is a set of activities that take place throughout a product lifecycle and focus on assessing and improving the usability of interactive systems (Mayhew, 1999; Nielsen, 1993). There are small differences between Mayhew and Nielsen's product lifecycle. Mayhew groups the methods into three phases: requirements analysis; design, development, testing; installation. Nielsen advocates 11 stages in the UE lifecycle ranging from the achievement of process objectives (e.g. know the user or collect feedback from field use) to the use of methods (e.g. prototyping or empirical testing). Yet, both authors argue for conducting analysis activities as early as possible in the UE lifecycle, before design activities, in order to specify User Requirements (UR). In line with this recommendation, additional references demonstrate the significance of such early stages activities (Bias and Mayhew, 2005; Force, 2011).

2.3 User-Centered Design

Also referred to as Human-Centered Design (HCD), UCD aims to develop systems with high usability by incorporating the user's perspective into the software development process (Jokela, 2002). There are five processes in the UCD life cycle: plan UCD process, understand and specify context of use, specify user and organizational requirements, produce designs and prototypes, and carry out user-based assessment (ISO 13407, 1999). The specification of User Requirements (UR) is critical to the success of interactive systems and is refined iteratively throughout the lifecycle: most work products and findings from the five UCD processes directly feed into the UR specification (Maguire, 2001; Maguire and Bevan, 2002). Many business and industrial sectors such as telecommunications, financial services, education or healthcare have adopted UCD (Venturi et al., 2006). Regarding the healthcare sector, a Healthcare Information and Management Systems Society taskforce developed a Health Usability Maturity Model (Force, 2011).

2.4 Agile User-Centered Design

Also referred to as User-Centered Agile Software Development (UCASD), AUCDI is concerned with the integration of UCD/usability into agile software development methods. Agile UCD is different from non-agile UCD. Begnum and Thorkildsen (2015) compared agile versus non-agile UCD and found systematic differences in methodological practices between the two approaches in terms of breath of methods used, degree of user contact and type of strategies employed. The scientific consensus on AUCDI reported in two recent, independent studies (Brhel et al., 2015; Salah et al., 2014) is the following: UCD and agile activities should be iterative and incremental, organized in parallel tracks, and continuously involve users. Both studies also report two main challenges associated with AUCDI: the lack of time for carrying out upfront UCD activities such as user research or design, and the difficulty optimizing the work dynamics between developers and UCD practitioners. Regarding the first challenge, da Silva et al. (2015) also noticed that it is difficult for agile organizations to perform usability testing due to the tight schedules and the iterative nature inherent to agile. Regarding the second challenge, Garcia et al. (2017) identified a series of artifacts that can serve as facilitators in communication between developers and designers. These artifacts are prototypes, user stories and cards.

The first published works analyzing the possible benefits associated with AUCDI appeared in the late 2000s. Since then, the number of publications about AUCDI has steadily increased demonstrating a strong interest of the agile community in this research topic (Brhel et al., 2015). Several models have been proposed for supporting the management of the AUCDI process (Forbrig and Herczeg, 2015; Losada et al., 2013).

In line with the aforementioned paradigm shift from usability to UX, Peres et al. (2014) proposed a reference model for integrating UX in agile methodologies in small companies willing to achieve level 2 maturity. The proposed model includes practices, recommendations, and UX techniques and artifacts in four process areas: requirements management; project planning; process and product quality assurance; measuring and assessment. However, the proposed model does not include any lifecycle describing the interrelations between the four process areas, the terms UX and usability are used in an interchangeable way in the recommendations and base practices sections, and the suggested UX techniques and artifacts are exclusively traditional HCI ones.

2.5 Product Development Lifecycles

Figure 1 compares the product development lifecycles found in the related work. The product development lifecycles found in the related work include (Mayhew, 1999; Nielsen, 1993) for UE, (ISO 13407, 1999; Maguire, 2001; Maguire and Bevan, 2002) for HCD, (Jokela, 2002) for UCD, and (Begnum and Thorkildsen, 2015; Forbrig and Herczeg, 2015; Salah et al., 2014) for AUCDI.

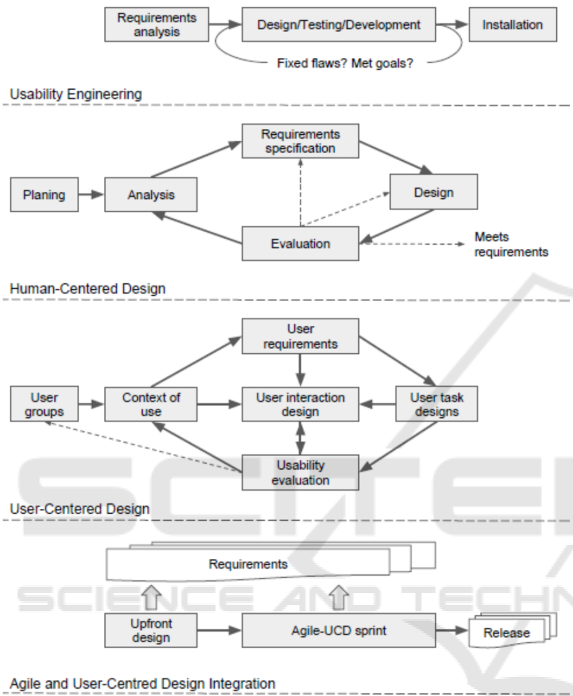

Figure 1: Comparison between the lifecycles found in the related work. Gray rectangles represent primary processes, black arrows their temporal interrelations, and gray arrows show how primary processes feed into process outcomes, i.e., multilayered white rectangles.

As can be seen from Figure 1, product development lifecycles are very similar:

- They all are iterative (see for example the UE lifecycle where Design/Testing/Development is an iterative process or the AUCDI lifecycle where the Agile-UCD sprint is also iterative);
- They use a similar terminology: requirements, analysis, design, testing or evaluation;
- Except for the AUCDI lifecycle, they follow a similar sequence of processes: analysis, design and evaluation.

The main difference between these product development lifecycles lies in the perspective on the requirements. Requirements correspond to a primary process in UE (see requirement analysis), HCD (see requirements specification) and in UCD (see user requirements). By contrast, requirements correspond in AUCDI to a process outcome fed throughout the development lifecycle by the primary processes.

3 PROPOSED UX LIFECYCLE AND PRIMARY PROCESSES

Figure 2 depicts the proposed UX lifecycle and its primary processes. Based on the related work, the proposed UX lifecycle is iterative and includes four primary processes (analysis, design, formative and summative evaluation) and produces two outcomes (user requirements and product). We chose the name of primary processes and outcomes according to their frequency in the related work. We aligned the four primary processes with the sequence (analysis, design and evaluation) identified in the related work.

3.1 Analysis

The analysis process primarily aims to render a first account of the UR. The objectives of this process are to specify the context of use, to gather and analyze information about the user needs, and to define UX goals. Maguire (2001) proposes a set of five elements to specify the context of use: user group, tasks, technical, physical and organizational environment. The analysis of user needs consists of defining which key functionalities users need to achieve their UX goals. UX goals include pragmatic goals (success rate, execution time or pragmatic satisfaction) and hedonic goals (pleasure, aesthetic or hedonic satisfaction) (Bevan, 2008). The success of this process relies on the early involvement of users, as it improves the completeness and accuracy of UR specification (Bailey et al., 2006).

3.2 Design

The design process primarily aims to turn design ideas into testable prototypes. The objective of this process is to provide the software development team with a model to follow during coding.

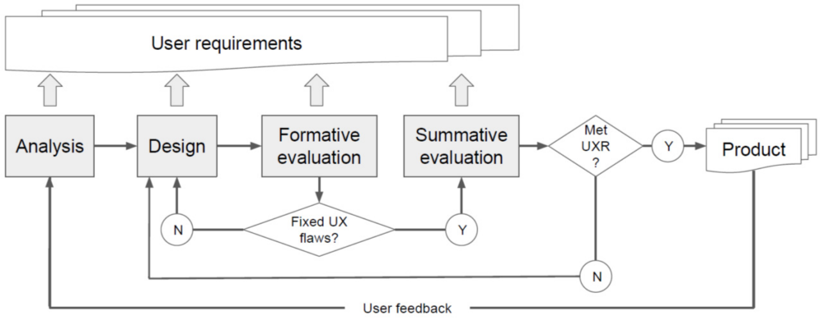

Figure 2: Primary UX lifecycle processes.

This model includes Information Architecture (IA) design, Interaction Design (IxD), User Interface (UI) design, visual and graphic design. Calvary et al. (2003) recommend modeling the UI incrementally according to three levels of abstraction (abstract, concrete and final), which correspond to similar levels recommended by Mayhew (1999) (conceptual model design, screen design standards and detailed UI). Another approach consists of reasoning according to the level of fidelity (low, medium and high) of prototypes (Lim et al., 2008; McCurdy et al., 2006; Walker et al., 2002). At the end of the design process, work products such as conceptual models or screen design standards directly feed into UR, while testable prototypes become inputs of evaluation.

3.3 Evaluation

The evaluation process primarily aims to check whether the design solution meets the UX goals documented in the UR. The objective of this process is to measure the UX with the testable prototype and to compare results against UX goals. The evaluation of earlier design solutions relies on formative evaluation, which refers to the iterative improvement of the design solutions. On the other hand, the evaluation of later design solutions typically involves summative evaluation, which refers to finding out whether people can use the product successfully. Together, formative and summative evaluation form the evaluation process. At the end of the evaluation process, design solutions documented in the UR are updated, while low- or high-fidelity prototypes become inputs of coding/programming if they meet the UX goals documented in the UR.

3.4 Iterative and Incremental Release of Product

Design and evaluation are intertwined within an iterative and incremental test-and-refine process that aims to improve the product. While formative evaluation supports the detection of UX design flaws, the design process supports the production of redesign solutions that fix those UX flaws. The product development team repeats this cycle until UX flaws are fixed. Once they are fixed, the redesigned solution passes through the summative evaluation process to check whether users can use the product successfully before programming. The relevant literature (Calvary et al., 2003; Forbrig and Herczeg, 2015; Holtzblatt et al., 2004; Mayhew, 1999; Peres et al., 2014) is consistent regarding this iterative and incremental aspect of the design process. In addition, formative evaluation requires low investment in resources and effort, which efficiently supports decision-making throughout the design process and significantly helps reducing late design changes (Albert and Tullis, 2013; Arnowitz et al., 2010; Bias and Mayhew, 2005; Mayhew, 1999; Nielsen, 1993).

3.5 Iterative and Incremental Specification of UR

The cornerstone of the proposed UX lifecycle is the iterative and incremental specification of UR. As can be seen from Figure 2, the outcomes of each of the four processes directly feed into UR. The work products resulting from the analysis process (typically, summary information learned) document a first version of the UR, which is later completed and/or refined as the other process areas take place. In other words, the specification of UR consists of concatenating UX work products and artifacts delivered and refined by the product development team throughout the UX lifecycle. The UR typically include the following sections: the specification of the context of use, the specification of UX goals, the general design principles, the screen design standards and strategies for the prevention of user errors.

Table 1: References collected through the TLR.

Field or discipline	Books, proceedings, technical reports	Papers
Agile and AUCDI	(Patton and Economy, 2014)	(Brhel et al., 2015; da Silva et al., 2015; Garcia et al., 2017; Wautelet et al., 2016)
Cognitive science and psychology	(Crandall et al., 2006; Fowler Jr, 2013; Hutton et al., 1997; Lavrakas, 2008)	(Cooke, 1994; Trull and Ebner-Priemer, 2013)
HCI	(Albert and Tullis, 2013; Arnowitz et al., 2010; Bailey et al., 2006; Card et al., 1983; Carter and Mankoff, 2005; Ghaoui, 2005; Holtzblatt et al., 2004; Mayhew, 1999; McCurdy et al., 2006; Nielsen, 1993; Theofanos, 2007)	(Calvary et al., 2003; Grandi et al., 2017; Khan et al., 2008; Lim et al., 2008; Mackay et al., 2000; Maguire, 2001; Maguire and Bevan, 2002; Markopoulos, 1992; Rieman, 1993; Tsai, 1996; Vanderdonckt, 2008, 2014; Walker et al., 2002)
UX	(Law et al., 2008, 2007)	(Bargas-Avila and Hornbæk, 2011; Bevan, 2008; Law et al., 2014; Vermeeren et al., 2010)

4 SUPPORTING UX METHODS AND ARTIFACTS

4.1 Identification

To identify the supporting UX methods, we ran a Targeted Literature Review (TLR) instead of conducting a Systematic Literature Review (SLR). A SLR usually aims at addressing a predefined research question by extensively and completely collecting all the references related to this question by considering absolute inclusion and exclusion criteria. Inclusion criteria retain references that fall in scope of the research question, while exclusion criteria reject irrelevant or non-rigorous references. The TLR, which is a non-systematic, in-depth and informative literature review, is expected to guarantee keeping only the references maximizing rigorousness while minimizing selection bias. We chose this method for the following four reasons:

1. Translating our research question into a representative syntactical query to be applied on digital libraries is not straightforward and may lead to many irrelevant references (Mallett et al., 2012);
2. If applied, such a query may result into a very large set of references that actually use a UX method, but which do not define any UX method or contribution to such a method;
3. The set of relevant references is quite limited and stems for a knowledgeable selection of high-quality, easy-to identify references on UX method, as opposed to an all-encompassing list of irrelevant references;
4. TLR is better suited at describing and understanding UX methods one by one, at comparing them, and at understanding the trends of the state of the art.

The TLR allowed us to collect 41 references listed in Table 1 and the following on-line resources: http://www.allaboutUX.org, http://www.nngroup.com and http://UXpa.org.

4.2 Classification

To classify UX methods (Figure 3), we first distinguished between methods that focus on knowledge elicitation and methods that focus on artifact-mediated communication, as they serve a different purpose. Knowledge elicitation methods aim to describe and document knowledge (Cooke, 1994) while artifact-mediated communication methods aim to facilitate the communication and collaboration between stakeholders (Brhel et al., 2015; Garcia et al., 2017). Then, within knowledge elicitation methods, we distinguished between those involving users versus those not involving users, as they also differ in terms of purpose and planning. Methods not involving users (Table 2) aim to predict the use of a system. These methods do not involve user data collection; instead, they rely on the opinion or expertise of an expert. Methods involving users aim to incorporate the user's perspective into software development and as such, rely on user data collection.

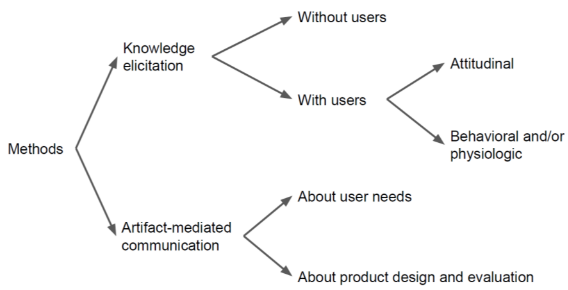

Figure 3: Classification of UX methods.

Table 2: Knowledge elicitation methods not involving users.

Method	Techniques	Objectives	UX activities
GOMS	GOMS CMN-GOMS, CPM-GOMS, NGOMSL, Keystroke-Level Model	to produce quantitative and qualitative predictions of how people will use a proposed system	UX evaluation
hierarchical task analysis	hierarchical task analysis	to identify the cognitive skills, or mental demands, needed to perform a task proficiently	cognitive task analysis
inspection	cognitive walkthrough; design or expert review; heuristic evaluation	to predict the learnability of a system; to predict usability and UX problems	UX evaluation
literature review	(systematic) literature review; systematic mapping	to locate, analyze, synthetize relevant published and/or unpublished work about a topic; to understand the current thinking and the state of the marketplace about a topic	context-of-use, stakeholder analysis; user research

The methods for user data collection include:

- Attitudinal methods (Table 3) focused on capturing self-reported data about how users feel;
- Behavioral methods (Table 4) focused on capturing data about/measuring what users do and/or user physiologic state.

We distinguished artifact-mediated methods focused on communicating about user needs (Table 5) from those focused on communicating about product design and evaluation (Table 6).

4.3 Knowledge Elicitation Methods

Table 2-4 include four columns: the identification of the method, the related techniques used as base practice for carrying out the method, the objectives of the method, and the related UX activities. To feed these tables, we adopted a bottom-up approach:

1. We extracted UX methods and techniques from the resources identified during the TLR;
2. We described each technique in terms of related methods, objectives and UX activities;
3. We grouped the techniques into categories according to the description of their objectives;
4. We suppressed duplicates;
5. We labeled each technique category with the name of the method they relate to in (Cooke, 1994; Gvero, 2013; Albert and Tullis, 2013; Vermeeren et al., 2010) and then compared the names resulting from this first round against the remainder of the methods identified in step 1 to check for and fix inconsistencies;
6. We assigned each method a class amongst without users, attitudinal, behavioral and/or physiologic.

To distinguish between methods and techniques, we complied with the hierarchical arrangement between approach, method and technique defined in (Anthony, 1963): “The organizational key is that techniques carry out a method which is consistent with an approach“. For example, heuristic evaluation and expert review are techniques to carry out the inspection method, brainstorming and focus group are techniques to carry out the group interview method.

4.4 Artifact-Mediated Communication Methods

Table 5-6 include three columns: the identification of the artifact, the objectives of the artifact, and the related UX activities. To feed these tables, we adopted a bottom-up approach:

1. We extracted UX artifacts from (Bargas-Avila and Hornbæk 2011; Garcia et al., 2017; Holtzblatt et al., 2004; Mayhew 1999) as they are representative of the contrasting perspectives on UX of the relevant communities;
2. We described each artifacts in terms of its related objectives and UX activities;
3. We suppressed duplicates;
4. We checked for and fixed inconsistencies with the remaining of the TLR literature;
5. We assigned each artifact a class amongst about user needs or about product design and evaluation.

Table 5-6 do not include any column for the methods, as artifact-mediated communication methods go by the name of their resulting artifact (e.g. persona is the artifact resulting from the method entitled "creating personas").

Table 3: Attitudinal methods.

Method	Techniques	Objectives	UX activities
cards	cards; emocards; emotion cards	to identify user mood and reactions about their interaction with a system	UX evaluation
experience sampling	daily or repeated-entry diary	to identify user thoughts, feelings, behaviors, and/or environment on multiple occasions over time	job/task analysis; contextual inquiry; user research; UX evaluation
group interview	brainstorming; group discussion; focus group; questionnaire	to identify users and stakeholders who may be impacted by the system; to improve existing ideas or generate new ideas	context-of-use analysis; job analysis; stakeholder analysis; user research
prospective interview	contextual, in person or remote interview; questionnaire; role-play; twenty questions	to identify key users, user characteristics, user goals, user needs; to identify user behavior; to improve existing ideas or generate new ideas	job/task analysis; contextual inquiry; user research; UX evaluation
retrospective interview	cognitive or elicitation interview	to gain insights into particular aspects of cognitive performance during user past experience with a system	cognitive task analysis; contextual inquiry; UX evaluation
survey	interview; questionnaire	to assess thoughts, opinions, and feelings of a sample population about a system	user research; UX evaluation
think-aloud	co-discovery; talk-aloud protocol; (retrospective) think-aloud protocol	to gain insights into the participant's cognitive processes (rather than only their final product); to make thought processes as explicit as possible during task performance	job/task analysis; contextual inquiry; user research; UX evaluation

Table 4: Behavioral methods.

Method	Techniques	Objectives	UX activities
automated experience sampling	automated interaction logs	to gain insights into the user experience with a system based on automatic logging of user actions	job/task analysis; contextual inquiry; user research; UX evaluation
constructive	collage/drawings; photographs; probes	to identify unexpected uses of a system or concept	formative UX evaluation
experiment	A/B testing; controlled experiment; remote experiment	to support, refute, or validate a hypothesis about sample population, task, system; to establish cause-and-effect relationships	job/task analysis; user research; UX evaluation
instrument-based experiment	experiment with calibrated instrument (biometrics, eye tracker, sensors, etc.)	to gain insights into user behavioral, emotional and physiologic responses with a system (e.g. gaze, happiness, stress, etc.)	cognitive task analysis; UX evaluation
observation	field observation; systemic observation (from afar)	to identify how users perform tasks or solve problems in their natural setting	contextual inquiry; user research; UX evaluation
simulation	paper-and-pencil evaluation; Wizard of Oz experiment	to detect UX problems; to identify the use and effectiveness of a system which has not been implemented yet	formative UX evaluation

Table 5: Artifact-mediated communication methods about user needs.

Artifact	Objectives	UX activities
customer journey map	to depict key interactions users have with the system over time (i.e., touchpoints); to map touchpoints with user thoughts, feelings and emotional responses	specification of the context of use
service blue-print	to depict relationships between different service components (front-end, back-end and organizational processes) that are directly tied to touchpoints in a specific customer journey	specification of the context of use
persona	to depict key user profiles (personality, roles, goals and motivations, frustrations, etc.)	specification of the context of use
work model	to depict the current work organization of users; to depict intents, triggers, breakdowns in the tasks (problems, errors and workarounds)	specification of the context of use
UX goals	to establish specific qualitative and quantitative UX goals that will drive UX design	UX goals setting

Table 6: Artifact-mediated communication methods about product design and evaluation.

Artifact	Objectives	UX activities
affinity diagram	to organize and cluster user data (typically from contextual inquiry or brainstorming) based on their natural relationships	design ideation
concept map	to organize and explain relationships between concepts and ideas from knowledge elicitation	design ideation
card sort: closed or open card sort	to organize and label topics into categories that make sense to users	IA design; UX evaluation
user scenario: full-scale or task-based scenarios	to describe how users achieve their goals with the system, identifying various possibilities and potential barriers	UX design; UX evaluation
user story and epic	to capture a description of a software feature from the user's perspective	functional requirements
task model	to describe the tasks that the user and the system carry out to achieve user goals; to review relationships between tasks	UX design
low-fidelity prototype: paper, sketch, wireframe or video	to turn design ideas into testable mock-ups; to test-and-refine design ideas; to fix UX problems early in the product lifecycle	UX design; formative UX testing
high-fidelity prototype: coded, wireframe or WOz	to turn mockups into highly-functional and interactive prototypes; to evaluate how well the prototype meets UX requirements	summative UX testing
general design principles: Gestalt theory, visual techniques, guidelines and standards	to arrange screens in such a way that they are aesthetic and consistent and communicate ideas clearly (color schemes; fonts; interactors; semiotics)	graphic and/or visual design

5 USE OF THE UXPRM

We currently use the UX process reference model (UXPRM) for planning UX activities in two industrial projects. Our mission in these two projects is to support the integration of UX practice in an organization, whose core business is the sector of energy (Project 1) and the automotive sector (Project 2). Both organizations use an agile approach for software development. In both projects, we use the UX process reference model in the two following ways. On the one hand, we use the proposed UX lifecycle to communicate about primary UX lifecycle processes, especially to advocate for the integration of analysis activities as early as possible in the product development lifecycle.

On the other hand, we use the classifications of UX methods and artifacts for roughly assessing the UX capabilities of our industrial partners; especially we use the Tables 2-6 as an interview guide or checklist during semi-structured interviews to identify the UX methods consistently employed/delivered by the development teams. Even rough, such assessment of UX capabilities has allowed us to gain insights into the current organization of software development. In addition, we were able to identify the potential barriers (e.g. limited access to users) and opportunities (e.g. important needs for better UX with products) regarding the integration of UX. In particular, we were able to better scope and plan UX activities by aligning UX activities with the UX capabilities of the organization.

The UXPRM, we believe, can provide practitioners with a basis tool for assessing UX capability and planning UX activities, and therefore help better answering the needs and expectations of the industry.

We also believe that our conceptual and methodological approach is a promising and exciting research avenue to explore further.

6 CONCLUSION

The lack of consensus on the definition of UX has led to confusion over UX processes and UX practice, which results into important contrasting perspectives on UX between the traditional HCI and the UX community as well as between academia and industry. To contribute to reducing this gap, we propose a UX process reference model (UXPRM), which depicts the primary UX lifecycle processes and a set of UX methods and artifacts to support UX activities. The UXPRM draws an accurate picture of the UX base practices and methods supporting UX activities. The contribution of this paper is twofold:

- Conceptual, as it specifies a complete UX process reference model including both the description of primary UX lifecycle processes and a set of UX methods and artifacts that serve as UX base practice. To date, there is, to the best of our knowledge, no such UX process reference model.
- Methodological, as it can support researchers and practitioners to plan UX activities based on the rough assessment of the UX capabilities of an organization. This is a first step towards the strategic planning of UX activities.

7 FUTURE WORK

Building on the promising usefulness of the proposed UXPRM for supporting UX practice, our future work consists of developing a UX capability/maturity model (UXCMM) in order to facilitate the integration of UX activities into software development. In turn, this aims to reducing the gap between UX research and UX practice. We argue that planning the most profitable and appropriate UX methods to achieve specific UX goals depends on the alignment between the capability of an organization to perform UX processes consistently and the capability of UX methods to support the achievement of UX goals cost-efficiently. Accordingly, our future work consists of developing a UX processes assessment model (UXPAM), which is a measurement structure for the assessment of UX processes. Typically, UXPAMs specify indicators, scales and levels of the achievement of UX processes, together with measurement tools such as questionnaires or models.

Both the UXPRM and the UXPAM form the intended UXCMM, which will support the assessment of the UX capability/maturity of an organization and the identification of the UX methods that best align with the organizations' capabilities and maturity. The UXCMM, we believe, will ultimately allow UX practitioners and researchers to deliver better UX activity plans.

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