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User Experience Evolution Lifecycle Framework

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***Abstract*—**Perceptions of quality from both designers and users perspective have now stretched beyond the traditional usability, incorporating abstract and subjective concepts. This has led to a shift in human computer interaction research communities' focus; a shift that focuses on achieving user experience (UX) by not only fulfilling conventional usability needs but also those that go beyond them. The term UX, although widely spread and given significant importance, lacks consensus in its unified definition. In this paper, we survey various UX definitions and modeling frameworks and examine them as the foundation for proposing a UX evolution lifecycle framework for understanding UX in detail. In the proposed framework we identify the building blocks of UX and discuss how UX evolves in various phases. The framework can be used as a tool to understand experience requirements and evaluate them, resulting in better UX design and hence improved user satisfaction.

***Keywords*—**Usability, user experience lifecycle, user satisfaction

I. Introduction

As technology has advanced, we not only see the interaction with products getting more usable, but also fashionable [1] and a social symbol for individuals [2]. As established by [2], [3], the fulfillment of functional characteristics, as part of user's goals (pragmatics) is not the only thing that users seek, rather there are certain underlying hedonic needs that they look for (in) the product to satisfy. The traditional usability aspects (such as efficiency and effectiveness) fulfill the do-goals (pragmatics), whereas aspects such as beautiful, aesthetic, appealing etc., satisfy the hedonic user goals [3], [4]. User needs having crossed the traditional boundaries, now assume the typical functionality of a product as a given. People look for features in the products that they use or intend to use, such as "cool", "attractive", "sleek", "handy" etc, to go with the basic functionality needs.

This additional dimension to the concepts of usability and functionality that extends beyond the classics of software engineering relates subjective concepts to the core product usability and hence shifts the focus towards achieving an intangible phenomenon of UX [5]. Today we find the notion of fulfilling hedonic user needs growing in importance, from the user's perspective and hence, also in the Human Computer Interaction (HCI) community [4],[6]. Such has become the importance of UX, that the user centered design (UCD) processes call for exclusive UX professions that should involve teams covering ergonomics, cognitive sciences, information quality, etc. [7] because all these disciplines affect the overall UX in one way or the other. Also, emphasis has been laid to broaden the standards of product development by incorporating UX aspects [8].

UX is a concept that has gained the attention of modern research. Not only has it become the centre point of the modern HCI community, but has also become a sought after quality aspect in most modern day products [5]. Having said that, we do not find a unified definition for UX [1], [2], [5], [6], [9]. So, while there is a desire to design and incorporate UX into products, its definition or implementation lacks cohesiveness, due to lack of a clear definition. Hence the question arises: *Why is it difficult to define UX*? Is it so because UX involves dynamic and fuzzy aspects, such as sensations, emotions and hedonics that are beyond conventional usability, hence making it difficult to be defined [9]? Is it something that does not restrict itself to the interaction of users with products?

In this paper we try to answer these questions by analyzing various proposed definitions and UX modeling frameworks from current researches. In doing so, we propose *User Experience Evolution Lifecycle* (UXEL) framework that not only identifies the main entities and factors that govern UX dynamics but also covers various processes/phases that evolve into UX, thus making an extensive UX platform for researchers and practitioners to design an improved UX that would eventually contribute to the overall quality of products and hence user satisfaction.

The rest of the paper is organized as follows; we highlight the related state-of-the-art research in UX modeling in Section II. Section III describes the building blocks of our proposed UXEL framework. In section IV we specify the complete UXEL framework followed by discussion notes in section V. We draw our conclusions in section VI.

II. Related Work

In this section we present various approaches in defining and modeling UX from current researches.

In ongoing UX researches, researchers put forth a variety of definitions. We list and categorize these definitions into *Actors and Scenario(s)* as shown in Table I. Research in formulating UX frameworks and models has also worked towards defining and understanding UX. From the product-user perspective, UX is categorized into aesthetic experience, experience of meaning and emotional experience [11], outlined into six processes: anticipating, connecting, interpreting, immediate reflecting,

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TABLE I
UX DEFINITIONS

UX Definition	Description	Actors	Scenario(s)
D1	a continuous process of user engagement with the product [10]	user, product	interaction
D2	entire set of affects that results in user-product interaction [11]	user, product	interaction
D3	the evolution of usability [12]	product, designer	design
D4	elaboration of the satisfaction component of usability [13]	product, designer	design
D5	a categorization of "do-goals" (pragmatics) and "be-goals"(hedonics) [3], [14]	user, product	interaction
D6	infinite small experiences relating to people, products and contexts [6]	user, product, environment	interaction
D7	consequence of user's and product's characteristics when interacted in a specific environment [1]	user, product, environment	interaction
D8	degree to which specified users can achieve actual usability, safety, and satisfaction in use in a specified context of use [15]	user, product, environment	interaction
D9	A person's perceptions and responses that result from the use or anticipated use of a product, system or service [16]	user, product, environment	pre-interaction, interaction, post-interaction
D10	the degree of positive or negative emotions that can be experienced by a specific user in a specific context during and after product use and that motivates for further usage [17]	user, product, environment	pre-interaction, interaction, post-interaction

future reflecting, recounting and appropriating [10], seen as a non-instrumental product qualities and user emotions [18]. From the user-product-context perspective, UX is viewed as situational impact on consequences of user-product interaction [2], interaction of human needs with product qualities resulting in emotional, motivational and reflection changes [17], beyond the instrumental (conventional usability pragmatics), emotions and affect and experiential [1].

From the user-product-organization perspective, UX is visualized as users' and organizational values tied to the product [5]. From the user-product-context-designer perspective UX is divided into experience, an experience and experience as a story [6]. In Table II, we categorize these

TABLE II
UX MODELS AND PERSPECTIVES

Model	Model Name	Perspectives
M1	Framework of Product Experience [11]	User, Product
M2	UX framework elements [10]	User, Product
M3	Components of UX [18]	User, Product
M4	Key elements of UX model [2]	User, Product, Situation (Context)
M5	Framework of UX including influencing factors [17]	User, Product, Situation (Context)
M6	Facets of UX [1]	User, Product, Situation (Context)
M7	A simplified model UX [5]	User, Product, Designer
M8	An initial framework of experience [6]	User, Product, Designer, Situation (Context)

models into the *perspectives* that each model addresses.As can be seen from these various UX definitions and frameworks/models, UX is a very diverse concept. With each of its different aspects focusing on a single point of view, it is possible to be unaware of the rest. Hence, there is need for a unified framework to understand UX, its various components and their relationships. To gain a comprehensive view of UX, in addition to highlighting factors and perspectives that form the basis of UX, it is necessary to highlight the processes that influence and evolve into various phases of UX during its constituent of perceptions of instrumental an lifecycle. Using the current research on various aspects and viewpoints of UX as a starting point, this research works toward a unified definition of UX, by introducing UXEL framework for better understanding of UX. This would benefit UX design and satisfy not only the conventional user needs but also those that go beyond traditional limits.

III. UXEL BUILDING BLOCKS

The lack of consensus on the definition of the term UX still persists [1], [2], [5], [6], [9], but at a very basic conceivable level, UX can be defined as a resultant observable (sometimes not) and intangible phenomenon when a user gets connected (interacts) with a certain product in a certain environment (context).

The resultant phenomenon that we define here as UX, is influenced by both the human aspects as well as the system aspects [9]. As categorized by [2]–[4], these aspects form the pragmatics and hedonics of the product usability, and collectively affect the overall UX. Furthermore, as discussed in [3], [6], UX has a temporal dimension as well i.e. UX can change over time depending on the environment (context) of usage and state of user.

For any given interaction, we have a certain *product/service* that is designed by a *designer*, and used by a *user* in a certain given *environment*. Hence the role players that determine UX are the following four actors: *User (U)*, *Product (P)*, *Designer (D)* and *Environment (E)*.

To explain how each of the four actors contributes to UX, we take an example of a coffee mug. Consider a crockery manufacturing company that wants to introduce a new line of coffee mugs. The designers (D) of the team have a concept in their mind of a good mug. Their brainstorming and surveying the environment (E), where they are to launch their new product (P), leads them to create a mug based on their own initial concept yet tailored according to the needs of the end users (U). As part of his design, the designer strives to: keep it as close as possible to the basic needs (to drink coffee, durability), limit its cost, serve higher needs of users (coffee remains hot for longer period, the mug is cool to touch on the outside, the line of mugs

has a range of textures, weights, sizes and designs to suit the users' mood and aesthetic needs), induce brand association; getting them to like the product so they would come back to it, inducing evocation of a good experience etc.

When a product reaches the target user, the designers wants him/her to have the best possible experience. This is the time when the actual UX begins, whether it is positive or negative. The designer does not know precisely where and under what exact circumstances the users would first use their product. It could be a comfortable garden with friends or an office with a stern boss or a harsh surrounding. It could be that the user first uses the product in the streets of a poor neighborhood. There can be unforeseen environments, mindsets and backgrounds of users as well as the prevailing mood during the first interaction which results in varying user experiences during subsequent use of the product. Thus the product perceptions on both user's and designer's part vary with respect to the environment. Fig. 1 categorizes the scenarios of these perceptions. As shown in Fig. 1, the U-P and P-D intersections respectively represent the user's and designer's perceptions about the product. The three scenarios shown in Fig. 1 are explained as follows:

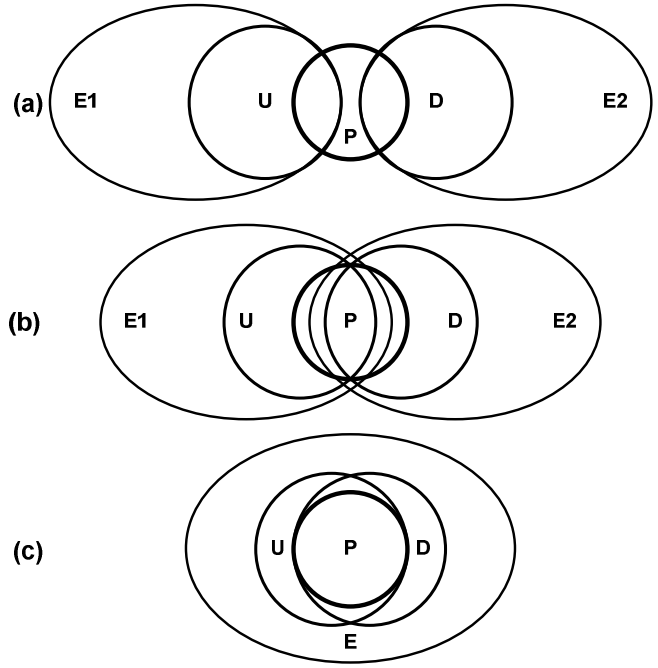

Fig. 1 User's and designer's perceptions of the product with respect to environment in UX dynamics

A. Worst Case

Depicted by Fig. 1 (a), this scenario is unlikely unless a product is designed very poorly or it is being used at a place it was not intended for. The environments which the designer intends (E1) for the usage and the actual usage environments (E2) do not coincide at all.

B. Typical Case

Depicted by Fig. 1 (b), this is the most likely scenario, in which the user's and designer's environments (E1, E2 respectively) overlap, i.e. the design has taken care of visualizing the environments or contexts in which the product will be used, but as true in most scenarios, it cannot foresee all contexts that might occur.

C. Best Case

Depicted by Fig. 1 (c), this is the scenario that product designers aim for. This is an ideal situation in which all the possible usage environments are perceived by the designers while designing a product. Hence both users and designer are surrounded in the same environment (E).

This example illustrates that UX is not a standalone concept rather it depends on certain entities and factors. We define these entities and factors as UX touch points. The entities include the *Actors* whereas factors include the *Actors' characteristics*. *Actors*, as already defined in this section, include *User*, *Product*, *Designer* and *Environment*. The designer actor does not represent an individual who designs a certain product, rather it represents the whole organization that has specific business goals and process flows for development of certain products.

Each actor has certain characteristics that become an influencing factor on the eventual UX. Each user is unique in his cognition, social background, intellectual level, experience with different products, emotions, moods etc. All these user specific attributes govern UX dynamics differently [6]. Similarly a product has its own characteristics in the form of internal and external quality and, when used in a specific context, exhibits quality in use [19]. A designer has his own perceptions about designing different products, HCI knowledge, working environment, professional experience etc. which collectively affect the UX. Environment, that can contain all possible usage scenarios (seen and unseen), is a very essential actor in UX dynamics and together with the other three actors, defines the context of use and hence affects the overall UX [6]. Table III summarizes the UX Actors and their respective characteristics. Each actor's characteristics listed in Table III, are a general reference and do not restrict to what we have defined here. Collectively, both the Actors and their respective characteristics influence the overall UX.

TABLE III
UXEL ACTORS AND THEIR CHARACTERISTICS

Actor	Actor characteristics
User (U)	(a) Cognition (b) background (c) cultural and social values (d) moods/state of mind (e) prior experiences
Product (P)	(a) Product quality (b) pragmatics (c) hedonics (d) Peer reviews (e) Brand association (f) conceptual model (g) product design (h) cost (i) feasibility analysis
Designer (D)	(a) Organizational and UCD processes (b) ISO quality models (c) Testing (d) Brand communication and marketing (e) Deployment (f) Designer's cognition and perceptions (g) HCI domain expertise
Environment (E)	All possible scenarios - (a) known contexts (b) unknown contexts

IV. UXEL FRAMEWORK

In the previous section we outlined the UX touch points (Actors and their respective characteristics listed in Table III) that form the building blocks of UXEL. Fig. 2 outlines the

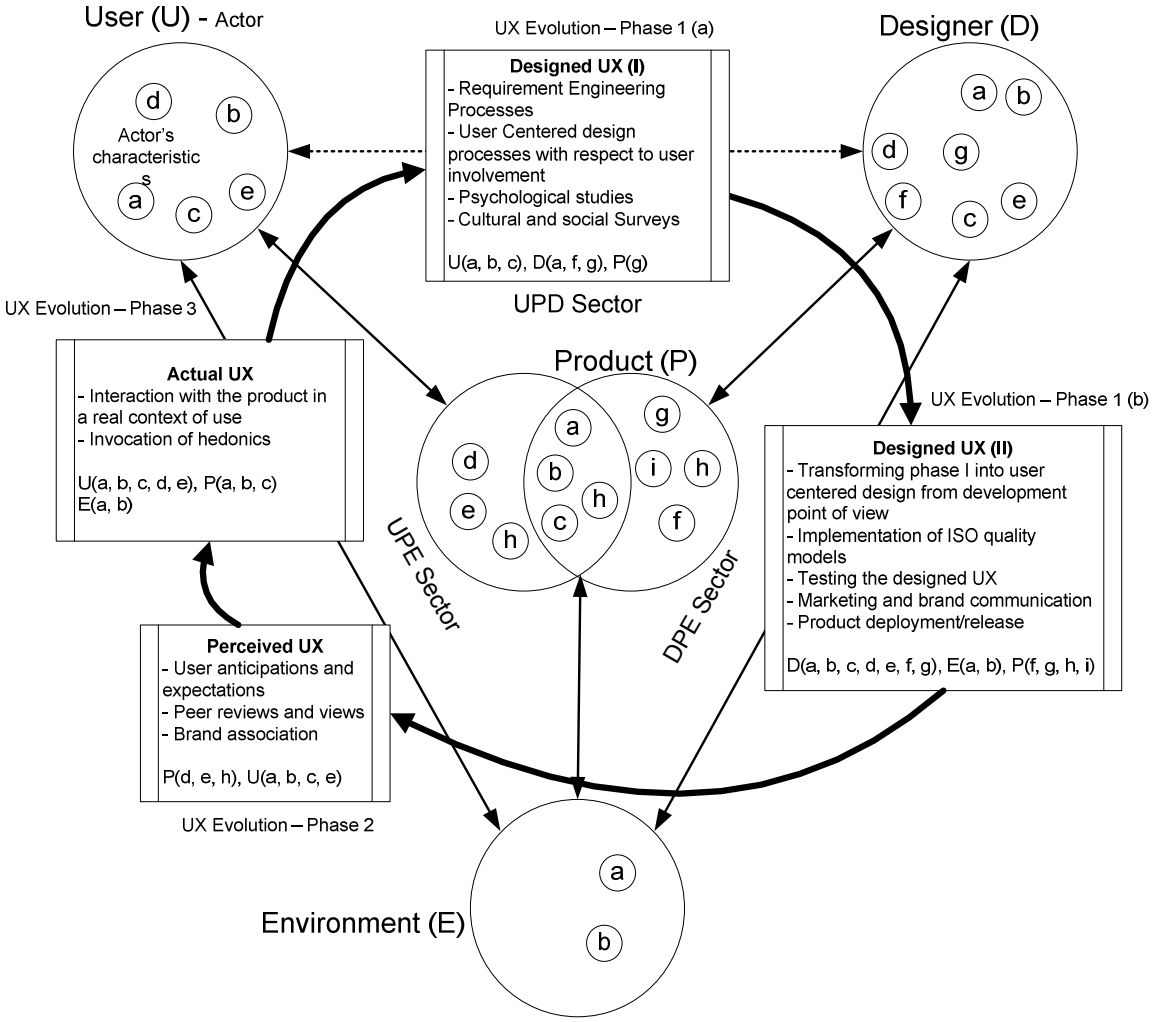

Fig. 2 UXEL framework (Actors' characteristics as defined in Table III)

detailed UXEL in which each actor along with its characteristics is shown. The *Product actor* (P) is split to depict product characteristics from:

A. User's Perspective

Includes (d) peer reviews, (e) brand association and (h) cost

B. Both Users' and Designer's Perspectives

Includes (a) product quality, (b) pragmatics, (c) hedonics and (h) cost

C. Designer's Perspective

Includes (f) conceptual model, (g) product design, (h) cost and (i) feasibility analysis

The Product actor's *(h) cost* attribute (common in all three perspectives) has different meaning in each perspective. From user's point of view it is the retail cost and other costs (such as traveling, shipping etc.), from the common perspective of users and designers it is the retail cost after the product has been released to the market, and from the designer's perspective it involves internal project costs.

All the actors are connected via *interaction/connection links*, forming three sectors namely *User-Product-Designer* (UPD), *Designer-Product-Environment* (DPE) and *User-Product-Environment* (UPE). Each interaction link is a unique and complete process that influences the UXEL. The process here could represent (but not restricted to) activities involving requirements elicitation activities, organizational work processes/flows, design activities or real time user-product interactions. We now define each of the six interaction links of the UXEL framework.

A. User-Designer (U-D) Connection

This interaction link encompasses processes that involve surveys on user needs, user requirements engineering and user-centered design (UCD) activities among the other organizational processes that are followed in that organization. The U-D link, represented by a dotted line denotes that the interaction between the user and the designer is not always direct.

B. Designer-Product (D-P) Connection

This interaction link involves design activities that may include ISO quality models and/or organizational processes flows while designing a certain product, keeping in view the user requirements.

C. User-Product (U-P) Connection

U-P interaction link is a continuous process of engagement during an interaction with a certain product. This connection is one of the main interaction links in the UXEL framework because it is when this connection is established, the contextual experience is invoked. This connection, on the user part, triggers various hedonic attributes, such as satisfaction, pleasure, evocation etc.

D. Environment-User (E-U) Connection

The E-U interaction link defines the context of use of a certain product by the user. The environment affects the hedonic user attributes, hence influencing the interaction with the product. This connection also governs the temporality aspect of UX, because the actual UX can change over time with respect to different environments in which the interaction is being made.

E. Environment-Product (E-P) Connection

The usability of a certain product varies according to the environment (the context) in which it is being used. The E-P interaction link defines how the product's pragmatics varies in different circumstances.

F. Environment-Designer (E-D) Connection

The E-D interaction link is part of the design process in which designer specifically visualizes various contexts of use for the product that he is designing.Each interaction link affects and is affected by other connection links. Collectively they act as the basis of a complete UCD process. These interaction links are summarized in the Table IV.

TABLE IV
UXEL ACTORS' INTERACTION SUMMARY

Interaction Link	Interaction Scope
U-D	UCD processes, subjective surveys
D-P	Design processes, requirements engineering
U-P	A continuous process of engagement
E-U	Context specific experience
E-P	How a product is affected by the environment
E-D	How designers visualize different contexts of use

In summary, UX does not restrict itself to a phenomenon that originates from the user interaction with the product; rather it evolves through three *phases* namely, *Designed UX*, *Perceived UX* and *Actual UX*. The continuous evolution of the lifecycle is represented by the following three sectors (see Fig. 2) that form the three phases of the UXEL framework:

A. UPD Sector

This sector of the UXEL framework forms the first part of the *Designed UX* (UX Evolution – Phase 1 (a) as shown in Fig. 2. It involves User, Product and Designer actors and builds the design phase with respect to the product with user involvement in the form of UCD processes and requirements engineering. This phase also includes surveys that gather psychological and socio-cultural information of the target user base.

B. DPE Sector

This sector of the UXEL forms the second part of the *Designed UX* phase (UX Evolution – Phase 1(b) as shown in Fig. 2). This phase involves Designer, Product and Environment actors and builds the design phase with respect to the product involving development models, organization specific process flows with emphasis on visualization of various contexts of use. This phase involves the transformation of the first phase of UX design into UCD from development perspective, implementation of ISO quality models, product marketing and deployment/release etc.

C. UPE Sector

This sector involves User, Product and Environment actors and shifts the *Designed UX* to *Perceived UX* phase (UX Evolution – Phase 2 as shown in Fig 2) which is the second phase of UX evolution. This phase involves the product specific expectations and anticipations based on the advertisement, brand association, or peer reviews etc. It is when the interaction with the product is made in a specific context that the third and last UX evolution phase i.e. *Actual UX* (UX Evolution – Phase 3 as shown in Fig. 2) is initiated, which in itself is not an instant phenomenon, rather it changes over time. As discussed by [20], *an experience* is something with a definitive beginning and an end. This last phase imparts various emotional and hedonic affects on the user and causes positive/negative drive towards the product.

For all the three phases (Designed, Perceived and Actual UX), the prospective characteristics of the involved actors are accordingly highlighted as shown in Fig. 2. For example, in the first part of the Designed UX phase, the potential attributes involved are:

A. U (a, b, c):

User's (U) cognition, background and social/cultural values (referred to as (a), (b) and (c) respectively in Table III).

B. D (a, f, g)

Designer's (D) organizational and UCD processes, cognition and perceptions, and HCI domain experience (referred to as (a), (f) and (g) respectively in Table III).

C. P (g)

Product's (P) conceptual model (referred to as (g) in Table III).

V. DISCUSSION

The proposed UXEL framework provides a detailed view of UX. The framework integrates the four actors with their respective characteristics (as listed in Table IV), as the foundation of the UXEL. Contexts play an important role in UX dynamics. For this reason we list Environment as a separate actor that plays its active part in influencing the other actors and thus the overall UXEL. The interaction/connection links among

the actors form three distinct phases that evolve from *Designed UX* to *Perceived UX* to the *Actual UX*. Such an integrated model forms a common ground of understanding, allowing HCI/usability teams and those professionals that do not necessarily belong to HCI/usability domain, to view UX from a wider range of perspectives, hence contributing to better UX design. The proposed model can be used in requirements engineering in terms of understanding and anticipating UX requirements. UX feedback management is another way of using this model to consistently analyze and evaluate UX. A successful product vendor has separate dedicated marketing department/team that builds the popularity of their specific product(s) in the competitive market. The proposed model can provide basis for building brand association, resulting in better bond between user and product and hence a better UX.

UX is a domain, that is composite of many fields [21] and therefore, any UX framework or lifecycle should cover details such that at a *bird's eye view*, it depicts the complete picture of UX and if we look in depth, we can easily understand all the relevant and related domains that contribute to UX. Each sector (see Fig. 2) of the proposed lifecycle is an overview of the detailed processes and workflows that are involved within. For example, if we zoom in to the UPE sector, we come across studies and processes that relate to Human cognition studies, Human Computer Interaction etc. to mention a few. Similarly sectors UPD and DPE, if dug in deep, refer to UCD methods, requirements engineering, usability engineering, development and quality models etc.; all representing separate domains in their entirety.

VI. Conclusions and Future Work

In this paper we have developed a *UX evolution lifecycle* (UXEL) framework for understanding the diverse UX dynamics. In doing so, we identify the building blocks of the framework, explaining how they act in forming a UX lifecycle that evolves during various stages. We describe these stages as *evolution lifecycle of UX* in terms of *Designed, Perceived and Actual UX*.

The proposed framework can be put to use for UX requirements engineering and evaluation purposes. Our future work focuses on developing UX elicitation and evaluation models in order to understand experience requirements in depth and evaluating them as part of better UX design and user satisfaction.

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