Emerged Theoretical Constructs to Rethink HCI Design

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***Abstract*— Despite incompatible theoretical perspectives on emotion in psychology, researchers in HCI continue to identify frustration as a basic negative affective reaction or emotion, a single predictor of goal satisfaction and a persistent problem with use of technology. Applying the Grounded Theory approach, we argue that the reported causes of frustration were not necessarily resulting in frustrating experiences, making frustration an unreliable predictor and at best a small part of a bigger problem: an individual negative experience, which we argue is a better predictor. The Grounded Theory approach allowed us to better generalize newly emerged concepts and categories, connecting them causally, consequentially or conditionally to human use of technology. This paved the way to find a knowledge gap in HCI theory, treating basic psychological needs from an eudaimonic perspective, and which could be addressed by developing potentially universally applicable new design principles. The emerged concepts include: a) the human-complex system interaction construct; b) the distinction of reactive and proactive design approaches; c) the perspective of designing for human well-being; and d) four distinct phases of disrupted interaction. In addition, we propose specific steps for the evaluation of HCI design to help minimize negative user experience.**

Keywords—HCI, frustration, theoretical constructs, negative user experience, proposed solutions, evaluative approaches, disrupted interaction, design principles

I. Introduction

About two decades ago, frustration with IT, was defined as a "modern malaise" [1], "a universal experience for computer users" [2] and a problem that is "increasingly more difficult to deal with" [3]. Frustration was investigated by several researchers [1-11], including its causes, levels of severity and debilitating effects on human performance. Given that the majority of the above examples are from the pre-smart phone and pre-Web 2.0 era, one may assume that new technological developments had changed the nature of past problems with IT. However, recent surveys revealed that the same problems [1-5; 9-11] continue to exist [6, 7, 20, 21,22]: application crashes, functional errors and network problems [5, 7], slow speed, drop-outs and other connection issues [5, 6]. Whatever the problems are, researchers and practitioners continue to use frustration as a predictor for user's dissatisfaction with technology [6, 21].

The purpose of this paper is to explore, compare and question past and current answers, definitions, interpretations, findings, solutions and recommendations. The Grounded Theory approach [12] has been applied to conceptualize existing qualitative data on user perceptions about frustration with technology for the last 20 years, as reported in literature (the selection of papers is described in Section III.A).

The objectives of the investigation were: to generate new concepts, categories and theoretical constructs, in order to seek new ideas and solutions for the design of qualitatively improved human- machine/computer/system interaction.

Section 2 describes frustration as the starting point for the investigation, discussing what frustration really is, what causes it, who is affected and why, and assessing proposed solutions and recommendations. Section 3 analyses a significant problem with technology – negative user experience, while Section 4 attempts to answer how to minimize negative experience. Section 5 discusses the concept of 'Human – Complex System Interaction' as an extension of the currently used concepts of HCI and HSI.

II. Frustration as a Problem

A. Causes of frustration with technology

About two decades ago [1] some of the frequently reported causes of frustration included: computer jargon; forgetting passwords; incompatible software and hardware; computer crashes; users' ineptness in IT; users' lack of knowledge and understanding; the amount of time taken to solve IT problems; and various other IT failures. Frustration was defined [8] as "a negative emotional state; a feeling; an experience; and an unpleasant side effect of the use of technology". Frustration was later defined as "a universal experience for computer users" [2], a major problem and a cause for industry concern [4]. The investigated causes [9] were diverse but familiar: users felt lost; there was a lack of consistency in terminology and look & feel; need for error prevention / error recovery; decluttering of interfaces; and long download time.

New problems were also encountered [10]: difficulty to set up new devices and Internet problems (46%), followed by computer problems (28%), problems with cell phones (21%), making some users impatient, discouraged and confused, with only a minority feeling confident to deal with IT problems. Frustration gained status as a problem that is increasingly difficult to deal with, yet at the same time it was viewed as a common side-effect of the digital divide [3]. Its causes were

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generalized as various 'malfunctions', such as frozen web pages, lost documents, etc. Frustration was reported as an emotion associated with a list of other emotions and mental states: anger, aggression, withdrawal from the goal, fixation or 'frozenness', stress, negative views about computers, or even physical discomfort [3]. The emotions of users were analysed from different perspectives and theoretical backgrounds [11], including the assessment of 'user experience' [6].

In summary, frustration was always associated with other emotions, such as emotional states, reactions and responses experienced by users during their interrupted interactions (events, processes and activities) with IT. However, not all users were necessarily frustrated over the same causes [1,2,4,8,9,10,11].

B. *Frustrated users*

According to literature, when something was not working, users demonstrated various emotional responses and exhibited dissimilar behaviours [11]: aggression and bullying [1] or withdrawal and resignation [3]. Some were trying to solve their problems with IT by contacting end-user support services [2,4,10]; or asking friends and family members [10] for help. Others used their ability to cope with stress [11]. The investigated papers reported frustration of various user populations: workers [1,4]; students [2,3,8]; potential website users [9]; social media users [11]; users of mobile applications [7]; users of different operating systems such as Android, iOS and Windows 7 [6], and the Internet users in general [5].However, the users' needs and goals were only mentioned in some papers. Furthermore, there were no explanations as to what makes them distinct, or why needs and goals are important for interactive systems design. Only a few papers [2,4,6] stressed the importance of understanding the users' goals, as a general statement in regard to some effect on the level of frustration [4]. Other authors recognized the difference between needs and goals [2,8] viewing both as motivations to act [8, 11].

HCI literature does not seem to clearly differentiate between needs and goals or give explicit definitions of the two. As a consequence, some questions are neither asked nor answered: What comes first (needs or goals)? What is more important? What do needs and goals ultimately represent? Such ambiguity is common, especially regarding the psychological needs of users [13]. However, it is important to identify and to clearly understand users' needs and goals when studying users' motivations [15] in order to be able to formulate design requirements for interactive systems. Furthermore, most papers barely mention cognition, yet user attitude was emphasized in almost every paper. This is surprising, because when attitude and its affects are studied, cognition must be recognized as an influential factor because it is a part of a tripartite model: emotional response, behavior and cognition [14].

C. *Previously proposed solutions and recommendations*

Some researchers viewed frustration as a serious issue at the workplace and offered solution to create helplines [1]. Others proposed 'cheap solution' to create an 'automated support-agent' [8]. It was noted [2] that some causes of frustration, such as freezed applications and dropped internet connections are challenging to solve. The recommendations in such cases did emphasize the need for more reliable software, superior user interfaces, clearer instructions and improved user's training [2]. Some researchers stressed that users must be involved in system design [4] or redesign of websites [9] with a group of experts and users. Others recognized that different devices need different solutions [10] or stressed the importance of preventing computer malfunctions before they occur [3].

There was a suggestion for designers to be proactive in assessing "how interface-induced changes may affect end users," pointing out the need to facilitate communication among users for collaborative coping [11]. Some authors advocated importance for designers and developers to pay attention to negative user ratings which, according to them [7], effects revenue. Furthermore, it was reported [6] that users, faced with an unfamiliar smart mobile platform, have a high task-failure rate in transferring pre-existing knowledge from one platform to another. The given recommendation, in this case, meant to address employers [6] who could provide a learning periods at their workplaces. While we could not identify a clear ranking of these proposals, what became clear is that the recommended solutions were all reactive in addressing existing or newly reported causes of frustration and other emotional responses. Therefore, at this stage we become motivated to investigate the question of how this can be turned around using a pro-active approach?

III. Concepts, Categories and Constructs

A. *Abbreviations and Acronyms*

Generally inductive and exploratory in nature, the Grounded Theory approach [12] was selected to explore frustration with technology, with the aim of generating new concepts, categories and theoretical constructs that may have a better predictive power regarding successful HCI design. We used open coding (content analysis) and axial coding techniques. Firstly: we looked for the emergence of new concepts, and secondly: we identified relationships between these concepts and the newly emerged categories [12]. The investigation began with informal questions about the phenomenon - frustration. The content of each selected paper was separated into small parts describing frustration as a phenomenon. This was done in order to generalize and abstract the various meanings found in the investigated literature. The same was applied to causes of frustration, interactions, applications, devices, users, solutions and recommendations.

The reviewed papers were chosen based on two criteria: direct relation to frustration as a problem and having been published in the last twenty years. Only few papers were found, suggesting a low-level of research interest in the topic. In fact, it was recently stated that "frustration, stress and other unpleasant experiences are not investigated" in papers on technology acceptance and user experience, although it is important for understanding experience of technology use [15]. Several papers were dismissed based on quality, and some were written by the same authors and/or have made very similar conclusions. The emerged categories were connected as causal, consequential or conditional to interaction and its process. Finally, we analysed conceptualized alternative explanations at the abstract level [12]. In this process, when extra definitions and clearer explanations were required, directly related literature was investigated.

B. *Is frustration the real problem?*

There are different and often incompatible theoretical perspectives in psychology: basic emotion; appraisals; psychological construction; and social construction, which influenced how researchers in HCI have been viewing emotion and its regulation as a concept (e.g. "psychological defenses by Freud"; "stress and coping by Lazarus"; attachment; self-regulation; and emotion regulation) [18]. By closely investigating frustration as a phenomenon we have found that it is a common emotion and as such does not get included in any list of more than a dozen basic emotions or emotion models. In fact, it is only mentioned as a tertiary emotion in relation to anger (a primary and basic emotion) [19]. It has become clear that there is mutual agreement that "emotion refers to a collection of psychological states that include subjective experience, expressive behavior (e.g., facial, bodily, verbal), and peripheral physiological responses (e.g., heart rate, respiration)" [18]. Everything else is debatable.

It has, recently, became evident that humans, as digital users/customers/consumers, are actually less predictable than it was assumed when it comes to making choices of interaction [20]. Users engage with technology if they believe that it will help them solve a particular problem, satisfy a particular goal, or provide them with positive experience. As users/customers/consumers, people make their decisions based on three factors: intention, circumstances and past experience. However, none of these variables are stable, and can quickly change even within a single interaction [20]. There was a considerable number of different emotional responses, states and appraisals [1-4] [8-11] reported by several researchers. There are various incompatible perspectives on emotion [18] which were systematically analysed, including the unstable factors that influence a user's decisions in technology use [21].

There is recent recognition, in the industry, that digital experience "will overtake price and product as the key brand differentiator," e.g., this is viewed by Deloitte as a new competitive differentiator [22]. 95% of digital opinion leaders in Australia agreed that a poor digital experience risks losing customers [21], and one negative experience can be estimated in a real dollar value for businesses. This knowledge contributed to our conclusion that the real problem of technology use is negative experience and not frustration per se. Therefore, instead of frustration, we view individual negative experience as a more stable and measurable predictor for user satisfaction with technology.

C. *Reported causes of negative experience*

The reported causes (faults, issues, problems, barriers, blocks, user's mistakes, obstacles or system-computer malfunctions) were diverse but each had one evident effect on the actual interaction process. The entire flow of the interaction process was not just interrupted for a short period of time. Rather, it was disrupted for a prolonged period of time due to different factors: the need to fix a technical problem and the need to recover from negative emotional reaction.

What we infer, is that not every reported cause has resulted in the negative emotional reaction but every single cause has resulted in some lost time. For example, as a minimum, the fixing of a problem always results in some lost time even if the user did not report negative emotion. This was evident in the majority of the investigated [1-4][8-11] papers. We use the term disrupted interaction to describe disrupted process and to define the general category for all reported causes. The assumed causality depicted in Fig. 1, additionally illustrates our assumption that disrupted interaction results in individual user experience.

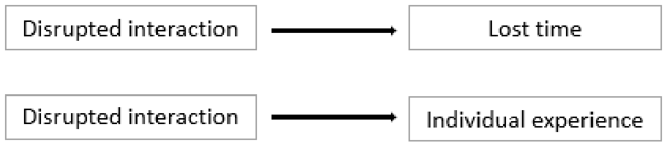

Fig. 1 The assumed causal relationships.

D. *Human-complex system interaction*

Due to the technological development of cloud computing and IoT that can support the development of ubiquitous computing, the overall construct for the interaction between human and technology, from our perspective, has expanded from human-computer and human-interface interaction to human-complex system interaction. We identified three major emerged categories. We view these categories as essential components of the new construct which reflects the reality of today's scope of interaction with technology: Humans; Computerized systems, and Infrastructure [2][4][5-7],[10], depicted in Table 1.

These essential and categorized components appear to be causally, consequentially and tightly interconnected. We view them as one system; one taxonomic structure; and a new extended construct and process, named Human-Complex System interaction. What does this mean? As a construct, it represents reality. When a user initiates an interaction, the interaction involves an entire complex system and not just an interface, application or computer. This complex system consists of users, computerized systems and its supporting infrastructure on a higher level of abstraction. This also means that the systemic characteristics of the overall ensemble that consists of the user – computerized system – infrastructure will affect an individual user's experience (see Fig.2).

TABLE 1. HUMAN-COMPLEX SYSTEM INTERACTION

Essential Components		
Humans	Computerized Systems	Infrastructure
Their Needs; Goals; Context of use (major factors); Users profiling factors: Users, operators, administrators, end-users; customers; consumers. Specific factors (personality): Values; Cultural background; Tasks/Duty; Demographic differences; Prior experience; Expertise; Skills; Capabilities	Analog, digital and hybrid computers as hardware; Software as applications; Operating systems; Software as a service; Cloud application; Web services;	Physical infrastructure; Internet; WAN; LAN; Mobile Networks; Power suppliers; Societal and Enterprise facilities (physical and organisational

and Limitations. Intensity of goal motivation.	Platform as a Service (PaaS).	structures). Data center facilities.

Fig. 2 Individual experience as the outcome of Human-Complex System interaction.

The effect will be negative or positive to some degree When experience is negative, due to disrupted interaction, it is a problem because it will affect user performance and attitude (negative view) toward technology (see Fig.3 and Fig. 4). Accordingly, the combined outcome will impact both: the business bottom line), and the individual users' well-being.

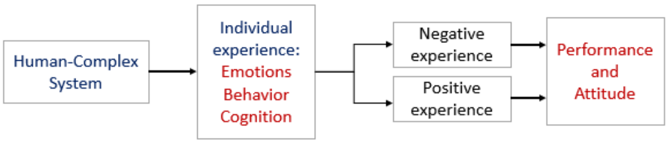

Fig. 3 The interaction with complex system in an overall performance and attitude toward technology

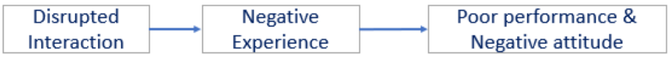

Fig. 4 Assumed direct causality between disrupted interaction, negative experience, poor performance and negative attitude

E. *Performance and attitude in relation to experience*

User performance, being a process, can be scored, ranked or measured by different means, however, user attitude cannot be precisely measured. To understand its complexity, definition and meaning we turned to social psychology. An empirically validated tripartite model of attitude is that it has three distinguishable interrelated components: affect (emotional response), behavior and cognition. The correlations between these elements are moderate, i.e., each can be measured separately or one of the three can be the focal concern. However, all three are interrelated and interconnected and represent the experience of a single individual [14]. This means, that to predict attitude as an outcome, the following components must be viewed as one predictor of three factors: emotional response (affect); behavior and cognition (perceptual responses). All three can be measured by verbal statements. However, there are ambiguities which are inherent in the subjective, post hoc interpretation of factors. These ambiguities must be taken into consideration [14].

F. *Emerged approaches*

When the reported solutions and recommendations were critically analysed, it was possible to identify two distinct categories, namely reactive and proactive approaches, recommended by researchers to find solution. The solutions, proposed by researchers, were described as: preventative or characterized as 'determine and fix' but the majority had the characteristics of a mitigation strategy. There were other solutions, reported as solutions by users who were trying to fix problems themselves.

By comparing all solutions, three categories emerged: known, infeasible or unexplored. However, they could not be generalized any further than the 'solutions' (as a category) and became sub-categories. Recommendations were highly differentiated, ranging from very specific to very general guidelines or directions. What became clearer, is that approaches for solutions were all reactive – responding to a specific problem, and none were proactive – responding to changes of interaction with technology (e.g. brain- computer interface, haptic interface or pre-touch sensing in mobile phones). With the emerged focus on negative experience as an identified problem, we conceptualized and categorized approaches that aim at minimizing negative experience (see Fig.5 and 6).

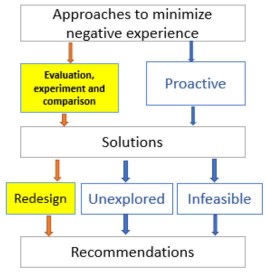

Fig. 5 Conceptual construct for the approaches to minimize negative experience.

Fig. 6. Example of approach operationalization.

Reactive approaches, defined from our perspective, are those that deal with known failures of technology that cause negative emotions, and whose consequences are known (or sometimes not known yet). Proactive approaches are those that deal with exploration, investigation and identification of potential (or yet unknown) failures with known, unknown and potential consequences. Known solutions are those that are already in common practice and applicable at a global scale. Unexplored solutions are those that are proposed but yet to be proven and applicable. Infeasible solutions mean there is no feasible condition to apply a solution even if such exist. E.g., there is no infrastructure to apply it; or platforms are incompatible; or services are not available; etc. It is possible that infeasible solutions might become solvable in the future; therefore, they might go under the known or unexplored categories. Infeasible solutions could, of course, mean that they could never be solved or could not be solved temporarily. In order to show how to operationalize these approaches for finding solutions we depicted this as a step-by-step process in Fig.6, using one of the analysed papers [9] as an example.

G. *Disrupted process of interaction with complex systems*

How do we view the conceptual process of disrupted interaction in the context of the user-computerized system-infrastructure construct? We identified four distinct phases (see Table 2), with definitions and interpretations of each phase.

TABLE 2. DISTINCT PHASES OF THE DISRUPTED PROCESS

Phase Definition	Specific Interpretations
Initiation Action initiated by a user.	This action is motivated by needs or goals; or both. There is a difference between needs and goals. Needs are: physical and psychological. Goals are: chosen or imposed
Interaction Interaction with a complex system involves three elements: user- computerized system- infrastructure. We view interaction as an input which will affect the subsequent activities.	Each essential element represents the entire range of that element as shown in Table 1. Each represent a general category which can be further specified/detailed. These elements are in an interdependent relationship with each other. They are fundamental for this relationship. The capabilities of each element are resources necessary for the activities in the process.
Disruption The process of interaction is disrupted, changing the user's individual experience. The flow of the entire process involving the interaction is broken.	The disruption will not necessarily result in negative experience for a user, but it will definitely affect the user's performance; as a minimum it will result in lost time
Recovery Regardless of whether the user has a negative or a positive experience with disrupted interaction – the recovery to continue the interaction will need to be considered.	This is the process of returning to a normal state after a disrupted interaction. The recovery can be done by the user, by the system or by another person. This process will be affected by many factors: how the user experienced the disruption: negatively or positively; what time it will take to recover and if it is possible to re- establish interaction or not.

H. The process of interaction with complex systems

Accordingly, we propose a conceptual model of the negative and positive experience evolution (see Fig.7).

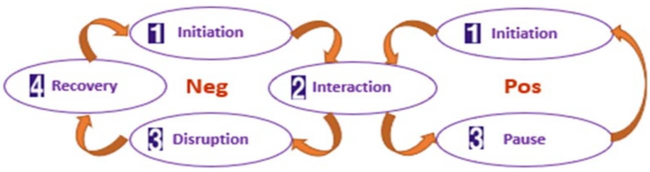

Fig. 6 Negative and positive experience phases.

This model demonstrates that any stopped interaction will result in an emotional response. The response will vary to some degree: positive (is just a pause) or negative due to disruption which represents a prolonged period of time to fix a problem and to recover from negative emotions. Negative experience will subsequently affect performance and attitude (stored in long term memory). Overall, a user's performance can be used as a specific framework for measurement. For example, it can be measured against a performance goal, specific requirements or individual expectations; or other measurable outcomes. Overall attitude may be characterized by specific framework and measured using the user's expressed opinion because such attitude will be formed through user's evaluation of experience. This will allow the comparison between different results. Finally, we view the benefits for users, as central to this process, and taking the perspective that interaction with complex systems should be designed for human well-being. Human well-being, in this process, represents the beneficial outcome for users and is viewed as an impact of the entire process.

IV. HOW TO MINIMIZE NEGATIVE EXPERIENCE?

To move forward and to understand how to minimize negative experience, it was necessary to assume new concepts, meanings and constructs.

A. Designing for real world

When designing systems and processes, we think about the nature of the world because the systems/processes must be operational and functional in the real world. If the system or process does not reflect reality, how could it be effective? There are three essential components (users, computerized system and infrastructure) that form a coherent system, and these components must work together to support a process that involves human interaction with technology. Today, there is no centralised control over these parts; rather the entire process appears to be self-organised at different levels, and each level is likely to affect the other. Each level is likely to be interconnected and interdependent: if one component stops functioning, then the flow of interaction is disrupted.

At a high level of abstraction, an interaction can be viewed as an interaction between multiple agents: the user, the computerized system and the infrastructure (where some of the involved agents may be emergent from the interaction among lower level agents). It is possible to assume that at the next level down, a single user as an agent, can interact with a user + computerized system (hybrid model) as an agent. It is possible to assume that one individual (agent), one computerized system (agent) and one piece of infrastructure as an agent can interact with many individuals agents (users-computerized system-infrastructure), resulting in a new pattern of organisation. In any case, this will require integration of dissimilar capabilities of all agents or groups of agents under one goal - performance and human well-being. This goal then will require minimizing negative experience by reducing disruption of the flow of interaction. Integration is required because, the individual elements of this system are nested inside sub-systems, and in turn become a part of a larger system of systems, which is human-complex system interaction, demonstrating the presence of multi- dimensional properties and exhibiting a high level of differentiation. Is it possible to negotiate such integration? We think it is possible, because a) the users are human, and b) computerized systems and related infrastructure are human constructs. Therefore, humans are in a position to negotiate such integration. If such an agreement is accepted, successful integration is an opportunity for a better outcome for all under one human-complex system construct.

B. User experiences, attitudes and needs

In psychology and social psychology, the trichotomy of feeling (affect/emotion), acting (behavior) and knowing (cognition/mental action) has been viewed as three facets of individual human experience and three distinguishable components of attitude [14]. In general, attitudes were defined as positive or negative evaluations or evaluative reactions formed by humans through their direct experiences. In HCI, the functionality of a system, rather than a user's experience, was the main focus and concern until the need for designers to address experiences became a commercial imperative [16]; initially this made users central to design, and more recently, placed experience into the center of the design process. Currently, there is a user experience (UX) model in HCI and a technology acceptance model (TAM) in Information Systems. The first describes "the experience of using interactive products, aiming to inform design". The second, gives a theoretical grounding to the acceptance of IT and its use. Though, they are both substantially different, both maintain "a primary interest in the users' emotions and experiences", but both lack consideration of psychological needs and negative emotions. In fact, negative experiences and emotions are practically not investigated in current research [15]. Only recently, both models began to introduce some of the basic psychological needs based on different theories, including Self-Determination theory (SDT).

However, both models have failed to recognise the different view advocated by SDT which is an eudaimonic perspective [21]. Instead, both accepted and focused only on hedonic (presentable and innovative) and utilitarian (useful and usable) constructs and perspectives on needs, values, motivations, quality perceptions and attributes [15]. To close this gap, SDT promotes well-being through three basic psychological needs: competence, relatedness and autonomy, although its potential to help minimize negative experience must be investigated further.

C. *Negative experience evaluation*

It was acknowledged that experiences "are increasingly recognized as important to performance and well-being" [15]. Shifting the entire perspective of interactive systems design to human well-being allows us to focus on how to minimize negative experience and re-think how individual experience can be evaluated. The following specific steps have not been formally validated, but emerged as a result of a conceptual analytical process, and as such are proposed as conceptual steps of an evaluation (see Table 3):

- Specify the user's needs or goals because this is a starting point before interaction takes place (initiation of an action of interaction);
- Specify the capabilities of the user, the computerized system and of the infrastructure (input);
- Specify three factors: emotional responses; behavior, perceptual responses;
- Specify the degree of perceived experience: positive or negative;
- Specify a framework to measure performance (output);
- Specify a framework to measure attitude toward technology (output);
- Specify benefits for the user's well-being at a local level (impact);
- Specify the benefits for user's well-being at a global level (impact).

Questioning existing answers on what frustration is, what causes frustration, who are the frustrated users, and what solutions and recommendations were proposed to deal with frustration, allowed us to conclude that frustration is not a problem per se. In the use of technology, negative experience, caused by disrupted interactions, is the real problem and can be a better predictor of poor user performance and negative attitude towards technology.

Step 1
The needs (physical and phycological) or goals (chosen or imposed) must be specified because they represent the motivation to initiate interaction which is not necessarily the user's choice but will affect the initial state of every individual in their commitment to initiate interaction with a complex system.
Step 2
User's capabilities can be specified as knowledge, education, training, expertise etc. Computerized system capabilities should be specified according to standards and specifications as a minimum. Network capabilities, or network capabilities as a service, should be specified on both levels: local (printer/internet access/browser) and global according to its scale of service. Each can be specified and stated explicitly or include details if needed.
Step 3
There are three factors: emotional response, behavior and perceptual response. They are distinguishable and measurable. Each could add or reduce the intensity or negative /positive experience. This does not mean that other factors cannot be added. This means that these three must be specified and measured to define experience.
Step 4
The degree of perceived experience should be specified as a minimum – positive or negative, where each can be further specified and compared if necessary.
Step 5
The framework that is used to measure performance should be specified because the analysed measures will affect objective conclusions and lead to specify local and global impacts of the proposed solution. The resulting measures can be compared if they are generalizable and applicable to a wider range of users (e.g. universal applicability).
Step 6
The framework to measure attitude toward technology should be specified because the analysed measures will affect a conclusion about subjective opinion toward technology. These subjective opinions can be compared on local and global levels.
Step 7
The benefits for users at the local level means that they are specific to one particular study/survey/experiment; specific in defining user, computerized system and infrastructure; and specific to period of time.
Step 8
Only compulsory to specify if the local benefits are proven to have impacts for users at a global level (e.g. universal applicability).

It can be argued that each interaction with technology results in a particular individual experience (with the outcome measured using an appropriately chosen metric). With technology evolving, the causes of disrupted interactions are bound to continue changing but will always result in a particular individual experience. Today's solutions, as proposed by researchers, follow one generalized approach – reactive to the problems that were known before. This is an unsatisfactory state of affairs, as we need proactive approaches to tackle the increasing complexity of the future, where not just users will be interconnected but also the computerized systems (e.g. IoT). This evolving complexity requires the consideration of an extended construct, which we call ‘human-complex system interaction’, representing a reality that we need to consider when designing interactive systems. In this context, the process of disrupted interaction was described as consisting of four distinct phases that flow in a loop fashion: initiation, interaction, disruption, and recovery. After recovery, the action can be initiated again. To initiate action, a user needs motivation or a goal. This is where we found a knowledge gap in literature, insofar as treating basic psychological needs of users. More significantly, there is a knowledge gap in the HCI literature, failing to discuss basic psychological needs from a eudaimonic perspective [13][15].

When interaction is disrupted, not all but many users will perceive this as a negative individual experience, which can be evaluated in order to seek a solution to minimize it. It is important to consider the impact of negative experience on the user’s well-being. After all, who else are we designing applications, producing computerized systems and building infrastructure for? We are aware that ours are only preliminary categories, definitions and interpretations, made on the basis of the analysis of a limited number of papers, and there is the undeniable possibility that the provided descriptions in the reviewed papers have inherent ambiguities due to the subjectivity of users’ self-reporting. Furthermore, we are aware that the proposed evaluation of negative experience has not been tested with real data, rather it has emerged from analysis of secondary data, reported by other researchers.

V. CONCLUSION

This investigation was exploratory in nature, questioning existing answers to HCI design. In the process of this investigation 1) human-complex system interaction emerged as a new construct, 2) we identified the user’s well-being as the overall design perspective, and 3) we distinguished two approaches to HCI design (reactive and proactive), whereupon there is much need for the second. We also conceptualized a process to evaluate HCI designs from the point of view of negative experience. For the overall process of human-complex system interaction, we specified and explained four distinct phases, arranged in a loop structure. Frustration, as the investigated problem was subsumed under a bigger problem, which was defined as an individual’s negative experience. We found a significant knowledge gap in treating basic psychological needs discovered by SDT from the eudaimonic perspective, indicating the need to seek design principles to motivate designers and developers to design for human well-being in the context of human-complex system interaction.

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