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Usability: A Cybernetics Perspective

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Abstract
Usability as a concept is well established, encapsulating the rich interaction between different kinds of users, information technology systems, and contexts of use. In the context of socio-technical systems, technology shapes societies and human interactions, and likewise technology itself is shaped by social, economic, and political forces. Therefore, the socio-technical landscape is constantly evolving. Usability professionals have developed new usability methods and processes in order to address these changes in the socio-technical landscape. Likewise, the very concept of usability has been evolving to better fit into this ever changing socio-technical landscape. The evolved and adapted concept of usability has been feeding back to its socio-technical environment, thus creating a feedback loop. This position paper reflects this feedback loop and the concept of usability as a means of communication and shared language between stakeholders in the socio-technical systems development context from the cybernetics perspective.

Keywords
Socio-Technical Systems, Usability, Cybernetics

1. Introduction

A socio-technical systems approach views organizations and societies as amalgamations of technical systems and social systems, where individuals and technologies interact with each other towards a common goal [1]. Therefore, the socio-technical systems approach recognizes that it is vital to facilitate these interactions between technology and people using it [2]. Furthermore, the socio-technical systems approach recognizes that systems used in workplaces should be technically efficient and, equally importantly, they should include social characteristics that will lead to high work satisfaction [2]. The socio-technical systems design has also been seen as an important democratizing factor, as it postulates that users who use the developed system should be involved in shaping the quality of their future work [3]. This human-centeredness of socio-technical systems approach is in line with the Scandinavian information systems tradition that has been advocating for this kind of inclusive, ideal and user-centered adaptation of technology and for design processes where all the different stakeholders and future users are represented during technical system development for organizations and society [4]. The socio-technical perspective has for a long time been the axis of cohesion for the information systems (IS) discipline, providing a common language, widely accepted research orientations, and shared assumptions and interests in form of communal knowledge, even though it is often forgotten in the IS discourse today [5].

In this conceptualization of human-centered socio-technical approach, humans act as active stakeholders in improving and contributing to their environment. Furthermore, the ideation, design, and development of new technologies imply that a human influences these technological advances in order that the technology fits the needs and capabilities of the human and social components. There have been calls for new, contemporary and open perspectives for socio-technical systems to ensure that the systems being developed are meaningful to all engaged actors [6]. Furthermore, the importance of

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human-centered approach and viewing the organizations as self-creating, dynamic and open systems, have been identified in the literature as a potential path to success with emerging new concepts and needs, such as smart innovations [6]. There have also been calls for revisiting the socio-technical perspective as the foundation for the IS discipline, to develop recommendations on how researchers, practitioners, and other stakeholders can contribute to it, and to innovate new ways for researchers, journals and academic units to advance the field [5].

In the context of socio-technical systems, the interactions between technology and human are mutual, as both of them influence each other. Technology shapes human interactions, relations and societies, and likewise technology is also shaped by social, economic, and political forces [7]. Furthermore, the socio-technical perspective addresses the individuals using and developing the technology as well as the technology itself [8]. As this perspective does not favor technological aspects over social, and focuses on efficiency and productivity as well as on human-centric values such as individual well-being, equality and empowerment, it is in line with the core values of the usability researchers and practitioners (see e.g. [3]).

Usability research has been developing new artefacts, such as methods, technologies, and processes for designing and evaluating the human-technology interaction, in order to answer the emerging challenges, technological advances and developments in socio-technical contexts. The experiences from these new artefacts have been communicated back to the researchers, who then have assessed the fit of these artefacts and changed them where necessary. This has been in line with the socio-technical perspective where the results have been closely monitored to establish if they have led to improvements in technology use and quality of working life [3].

Simultaneously, usability researchers have also updated and adapted the concept of usability as the foundation of developing these new artefacts. This evolved concept of usability has been driving and guiding the usability research and practice. This has also been in line with the socio-technical perspective where the theoretical concepts have been formulated and then tested against the empirical experiences in order to understand better if the developed theoretical concepts fit the practice and help to understand it better [3].

In this position paper, we look at usability as a means of communication and shared language between stakeholders that provides a new, contemporary and open perspective on socio-technical systems research and practice, and to this end we employ concepts from cybernetics.

2. Evolution of usability as a concept

In the early days of information technology, the developers were usually also the users of the systems that they were developing. Therefore, the designers of the new systems knew their own characteristics, needs and the contexts of use, and as a result they could easily design these systems to be tailored to fit their own work. However, as the organizations recognized the business potential of these information technology systems and started to use them as integral parts of their operations, the user base of these systems expanded considerably. As the information technology and systems became ubiquitous in organizations, society, and later also in everyday life and work, the users could be of any age, background, level of experience, technological skills, and knowing vital context-dependent information about their own work. As a result, the designers no longer knew the users, nor did they have any direct knowledge about the contexts where the systems were to be used. As a result, the developed systems did not answer the functional needs of the users or organizations, had unnecessary features while lacking features that were vital to the users and organizations, and these systems did not fit the established work processes. Therefore, it was recognized that the designers of information technology and socio-technical systems needed to obtain information about the future users, their tasks, and the contexts of use. Furthermore, it was realized that these practitioners needed new methods and processes to gather information from individual users, groups and organizations, and to turn this information into designs of easy to use and effective systems. In order to develop these new methods and processes for design practice, the researchers needed new conceptualizations and shared language for understanding the interactions between users and technology.

The concept of usability emerged as one of the quality constructs in the human-computer interaction (HCI) community in early 1980s to characterize visual displays and interactive systems from the

perspective of users [9]. This new conceptualization was intended to capture the attributes of interactive software products that would make them usable and that can be incorporated in design and further evaluated [9]. Usability was first conceptualized as a property of the system itself. As a result the early usability research focused on finding and documenting these systemic usability properties, which were to be taken into account in the design of the new and better systems.

However, some usability researchers saw this technology-centric paradigm as being problematic and wanted to conceptualize usability through research and documentation of the physical and cognitive characteristic of the users, which could then be taken into account in the design of the system. This second usability paradigm has resulted in for example cognition-based usability guidelines, such as the basic design of graphical user interface elements we still use today (see e.g. [9]).

A third, later paradigm conceptualized usability as the rich interaction between a particular user and a particular system in a particular context of use. In this paradigm, the usability was incorporated in the interaction between the user and the technology, each interaction being unique in such way that no universal best design guidelines could be made. User-based usability evaluation methods focusing on individual users, such as usability testing, originate from this paradigm.

In addition to these major paradigm shifts, the concept of usability also evolved to adapt to the advances in technology and other emerging needs in the socio-technical landscape. As a result, the focus of usability research and practice has been constantly expanding. At first, the concept of usability mainly focused on how effective the system was for the users to use, which is the degree to which the designed interface enabled the intended task accomplishment by a user.

However, soon the need to minimize the resources a user needed to expend to achieve their tasks was identified as an important concern, so the concept of usability was expanded to include also efficiency. As the number and complexity of the information systems increased, the need for a standardized process to design for better usability was identified, and the process of user-centered design was introduced. The user-centered design advocated for several small usability design and evaluation activities spanning the entire development process instead of few larger usability evaluations at the end of the process when the design was already finalized and the changes would be expensive.

As the use of technology expanded from the work context into the everyday life, the need for taking into account the more subjective pleasantness and ease of use as experienced by an individual user was recognized, and as a result the concept of usability was further expanded in early 2000s with the user experience aspect. The reason behind this evolution was the need to gain a better understanding on the emotions of users before, during and after the use of the technology, as the designers wanted better explanations for why some users would prefer one design over other. This was as a result of usability studies showing that appraisal of technology was influenced also by aesthetic aspects of the design, as well as user's expectations before and reflections after the use [10].

These evolutions to the concept of usability have been encapsulated into international standards, which were composed by committees of usability professionals. Their goal was to incorporate the current views and best practices of the time from usability research and practice. These different usability standards act as time capsules, having different approaches, viewpoints and conceptualizations to usability, thus representing the views and best practices of their time (see e.g. [11]).

Overall, practical usability work must advance through new methods, technologies, and processes from the research to keep up with the emerging challenges and developments in socio-technical contexts. And as a response, usability researchers must update and adjust the concept of usability to develop better new methods, technologies, and processes for the practice. Identifying these feedback loops between usability research and practice on social and technological levels, which has been instrumental for evolving the concept of usability and its practices, leads us to take a look at the field of feedback loops, the cybernetics.

3. Cybernetics perspective

The founders of cybernetics, Stefan Odobleja [12] and Norbert Wiener [13], argued that in addition to a system producing a certain output in reaction to events in the environment, it is also important that the system continuously monitor the effects of the output and reacts to these effects accordingly. This forms a feedback loop that constantly reduces any discrepancy between the desired state and the

observed state. A thermostat that controls a radiator to keep the room at a desired temperature is an example of a simple feedback loop. The thermostat measures the temperature of the room and switches the heating on when the measurements show the temperature being too cold and shuts off the heating when the room has reached the desired temperature. This first-order cybernetics, or the traditional cybernetics, perspective focuses on aspects of the defined systems, instead of the actual situation and context, concentrating on the local state of the system [14]. From this perspective, the system was designed to be in isolation from its whole environment, often being portrayed as a black box with some inputs and outputs from the perspective of its environment. However, this approach was found limited when the technological systems became more complex and the number of interactions between humans and technology increased. While the traditional cybernetics was very useful for engineers for designing automated systems, it overlooked the role of and interactions with the outside observer, who might be the designer or the user of the system, or another system [14].

Wiener also argued that the study of messages and of communication facilities is the only means of understanding society as a whole, defining the cybernetics as "the scientific study of control and communication in the animal and the machine" [13]. Wiener predicted in 1950s that in the future, communication between humans and technology would increase rapidly due to the technological advances, and therefore the concepts of communication should be refined according to the increased complexity of these interactions [13]. Accordingly, cybernetics developed a hierarchical model with different interconnected levels of abstraction, when applied to complex technologies. This was manifested by the introduction of second-order cybernetics [15].

Second-order cybernetics was introduced to the field of cybernetics to address the increasing complexity of interactions between humans and technology by expanding and including the outside observations of the system, as well as the communication related to it [16]. Second-order cybernetics argues for human-centeredness, as the systems are manifested in the form of interfaces used by humans, and calls for human-centered design that aims at understanding how users understand and behave to create best possibilities for the interactions and communications between users and technology [16]. Second-order cybernetics, also known as cybernetics of cybernetics, or the recursive application of cybernetics to itself, introduces a feedback loop, or circularity, in which the user interfaces determine the interactions between humans and technology and where this interaction is designed based on observations of users. Therefore, second-order cybernetics has been described as cybernetics in which "circularity is taken seriously" [17]. As a comparison, first-order cybernetics has the engineering point of view, studying a system as if it is a passive, objectively given thing, to be freely observed, manipulated, removed, and taken apart, while the second-order cybernetics recognizes that a system is an agent of its own right, as it interacts with other agents, observers, and social systems. [14].

Having looked at the evolution of usability as a concept as well as the theory of cybernetics, we combine these two concepts and take a look at how usability could be conceptualized from the cybernetics perspective.

4. Usability: a cybernetics perspective

There are studies indicating different feedback loops in the field of human-computer interaction. Some studies observe that the system interfaces are designed by humans, namely the designers, who observe users in order to design the system based on these observations (see e.g. [16]). Some studies have identified the usability work as a form of continuous feedback from the system development process perspective (see e.g. [18]). Further studies have had cybernetics perspective to the requirements engineering to gather operational data for user profiling in the system development context (see e.g. [19]). Other studies have identified the need to expand this feedback loop to include the context of use, where the system adapts to the characteristics, needs, and states of individual users based on real-time data before, during, and after the actual use of the system (see e.g. [20]). When taking into account the feedback mechanism and evolution of the usability itself as illustrated above, we can put these studies and their different viewpoints together, and reason that usability as a concept could be viewed from the perspective of second-order cybernetics.

As we have discussed previously, usability has evolved from simplistic systemic property into a holistic concept that covers the essential attributes of socio-technical systems in their development and

use. It allows all stakeholders to be involved in the development of the system, and it acts as a lens for observing the socio-technical landscape (see e.g. [21]). Furthermore, we have seen that this involvement of stakeholders in the context of practical usability work in turn feeds back to the concept of usability. This evolved and adapted concept of usability has in turn been feeding back to its socio-technical ecosystem, creating a feedback loop as described in the theories of second-order cybernetics which state that knowledge cannot be passively absorbed from the environment, but it has to be actively constructed by the system itself through its interactions with observers, social systems and other systems [14]. We postulate that this viewpoint has striking resemblance to how the concept of usability has been evolving when the technological advances and changes in socio-technical landscape have rendered the existing paradigms and conceptualizations inadequate.

Therefore, we reason that usability as a concept is constantly evolving, driven by its interactions with its ecosystem and its stakeholders through different forms of feedbacks between users, developers, researchers, and other stakeholders and adapting to its ecosystem based on this feedback. As a result of this feedback loop, the concept of usability has evolved over time to capture new attributes and meanings, the observer and the system co-evolving together as theorized in second-order cybernetics. Usability methods and processes, such as usability testing, offer constant feedback for practitioners during their design process and for the researchers observing the use of the methods and processes they have developed. Furthermore, there have been calls for systems that offer real-time personalization of the system and its interface during the use (see e.g. [20]. Therefore, we argue that having a cybernetics perspective on the concept of usability and its evolution in socio-technical systems context would help the researchers and practitioners to better understand and contribute to the evolution of usability and socio-technical systems.

In addition, we postulate that when educating future practitioners and researchers, this perspective would be beneficial in creating a better understanding of the evolutionary history of usability and the notion that the concept of usability is not set in stone, but is constantly evolving to fit the needs of the socio-technical landscape. As such, the future practitioners and researchers must understand that they have to update their knowledge base constantly in order to benefit from the latest usability concepts, methods and processes that are fit to the current technological and social context. Furthermore, they should understand their role in this evolution.

One of the conundrums in the field of cybernetics is how to recognize when a concept, system or device, which has the capacity to evolve over time to fit into its environment and arising needs, has indeed been evolving with a new property [22]. A community of observers has been identified as a way to verify that there is an emergent property [22]. We posit that usability professionals creating new international standards can be seen as such community of observers, who identify new aspects and needs from usability research and practice, and therefore the international usability standards reflect this evolution of usability as a concept, encapsulating the views and best practices of their time.

5. Discussion and conclusions

In this position paper we outlined the concept of usability from the second order cybernetics perspective, where the rich interaction between socio-technical systems, individuals, research of this interaction, and the design of these systems form a feedback loop as described in the theories of second order cybernetics. We postulate that conceptualizing usability through cybernetics perspective could be one potential answer to the calls for new, contemporary and open perspectives ensuring that the developed socio-technical systems will be meaningful to all engaged actors, as well as potentially leading to new ways for researchers to recommit to the IS discourse from the socio-technical perspective (see e.g. [5], [6]). The fields of usability, socio-technical systems, second-order cybernetics, and Scandinavian information systems research share their focus on human-centeredness, so these fields could develop a shared axis of cohesion and the concept of usability could act as a bridge between these fields.

Our aim was to outline the history of usability research and practice from the cybernetics perspective, as this perspective allows the researchers to further conceptualize, encapsulate and analyze the role of usability in socio-technical systems, as well as to better understand and study the evolution of the concept of usability, and to position the concept of usability as means of communication and

shared language between different fields of research that share the human-centered approach. Furthermore, the practitioners could adopt and utilize this perspective to better understand the development of new socio-technical systems fitting the needs of users and organizations, and to understand the field of usability as a constantly evolving entity. Further empirical and theoretical research is still necessary, as the evolution and the role of the concept of usability from cybernetics perspective should be refined further. We hope that this position paper will further revitalize the discussion and research of the role of usability as the core concept in socio-technical systems development.

6. References

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