Intrafaces: A Sociomaterial Take on User Interface Design

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**Abstract.** This paper introduces intrafaces as a sociomaterial take on user interfaces. Intrafaces enables actions where humans and technology are entangled in the moment and are useful when developing experiences. It invites us to add to the traditional path of user interface design and change perspective on how we comprehend the world. The essence of intrafaces helps us understand how experiences emerge, how human and technology mangles to achieve an action. To design experiences one needs to: 1. consider human and technology as one in action, not as separate entities, and 2. focus on what activity these entities, the social and the technology, together accomplish, and 3. use the notion of agential cut to identify elements and relations involved in the experience. If using intrafaces when designing, the innovation span extends from only considering technology/materiality as the owner of user interfaces to thinking materiality and the social as a collective where intrafaces enable and form the experience.

**Keywords:** Intrafaces, Sociomateriality, User Interfaces, Experiences, Digitization

Introduction

Todays increased focus on experiences where digitized artifacts are involved motivate for a new take on user interfaces design. This paper argues that existing ways of conceptualizing and using user interfaces hamper innovation possibilities to amplify the experience. Traditionally when innovating new digital artifacts, much time is spent on how to make them usable, context sensitive and with correct affordances. This is accomplished with the mean of user interfaces of the technology. We want user interfaces to enable efficiency, adapt to current circumstances and communicate action possibilities to the user. Usability is considered a property belonging to the user interface to enable ease of use and efficiency ([Shneiderman et al. 2005](#_ENREF_70)) and Lavie et al ([2010](#_ENREF_40)) point out the importance of including information about user and environment in the system for a context sensitive user interface. To achieve usability much focus is put on efficiency, effectiveness and satisfaction of the user. Developers follow certain guidelines to design usability and potential users of the artifact test the user interface in certain ways to test if it is implemented ([Norman 2002](#_ENREF_53)). Context sensitivity can be accomplished by sensor technology and algorithms that calculate usage which can thereafter be implemented as a module in a user interface ([Schiaffino et al. 2010](#_ENREF_66)). For example, different sensors in the car can inform the user of different states of the car, such as fuel consumption. As with usability is affordance also a property of the system according to Hutchby ([Hutchby 2001](#_ENREF_33)) and should communicate action possibilities for the user ([Norman 2002](#_ENREF_53)). For example, a physical knob can be graspable (communicates a possible action of being able to grip it) or turnable (communicates a possible action to turn the knob). Previous research emphasizes the importance of implementing usability, context awareness and affordance, in the technology; in the user interface. With this traditional view comes a distinct separation between the technology and the user. This help designers and innovators to dedicate certain qualities to the technology and others to the user. The separation of different entities, i.e. the user (the social) and the technology (the material), facilitate for an ontological view of the world where one isolates the user from the technology she interacts with.

However, this paper argues for a different view when innovating, namely a sociomaterial. In sociomateriality one draws on Niels Bohr philosophy-physics on how the social and the material are entangled and gets meaning and relevance in enactment, in action ([Barad 2007](#_ENREF_7)). Since many of our inventions today are experiences where the physical product, the technology, only is one component of many within the experience, should the sociomaterial enactment be in focus, neither the technology/material nor the social solely. Even though the nature of what is being designed has changed, from being purely a material product as is, to sociomaterial experiences, the ontological perspective on separate entities is too established with its concepts and language usage ([Kaptelinin et al. 2012](#_ENREF_36)). This paper argues that this has a hampering effect, limiting new innovations and designs. To overcome this hampering effect this paper suggests that a change of ontological perspective is necessary. This ontological change includes an embracement of sociomateriality where the material, the technology, and the social are equally included and dependent in the enactment, aka the experience. Without one there is no experience, the elements included are *one* in the experience ([Schultze 2012](#_ENREF_67)). The objective of this paper is therefor to explain and motivate a sociomaterial complement to user interfaces. It emphasizes the importance of a sociomaterial perspective when innovating and the paper introduce the concept of *intrafaces*. Inspired by [Barad (2007](#_ENREF_7)) the definition of intrafaces in this paper is; *emerging quasi-objects, distinguishable temporally with the help of an agential cut within an action, enabling intra-actions*. This can be contrasted to a *user interface* which enables interactions between the technology and the user. This contrast emphasizes the difference between intrafaces vs. interface, intra-action vs. interaction, within vs. between.

The MIT invention SixthSense is used to further illustrate the differences between user interface and intrafaces. SixthSense facilitate action with things in our surroundings, such as an airplane ticket or a map, and retrieve or exchange information about the thing. It also allows for showing information on any surface and is a “wearable gestural interface that augments the physical world around us with digital information” ([Mistry 2010](#_ENREF_45)). It is possible with SixthSense to take pictures just by making a “framing” with the fingers and thereafter watch and arrange the pictures taken on any surface. It can project information onto basically any surface or physical object in the close vicinity. So, with the concept of user interface, which can be considered as a layer between the technology and the user ([Marcus 2002](#_ENREF_44); [Nielsen et al. 1993](#_ENREF_51); [Shneiderman et al. 2005](#_ENREF_70)), it becomes difficult to identify where and when the user interface is in the SixthSense solution. It is everywhere, nowhere, momentarily and all the time depending on action. In other words, it is an emerging quasi-object distinguishable temporally. The only way to identify intrafaces included in the action is to make an agential cut ([Barad 2007](#_ENREF_7)) in the action. When making this cut one can identify what elements and relations are involved and what intra-actions are taking place within the entanglement at that very moment. This highlights the limitations of the concept of user interface and motivate for the usage of intrafaces. Intrafaces in the SixthSense solution are emerging momentarily within the entanglement of the social and the material, the entanglement is producing it and consuming it simultaneously in action. More importantly, it is likely to have effects on how the enactment is experienced.

The SixthSense solution characterizes the digitization of the world. The digitization of the world enables actions that differ from a non-digitized world ([Yoo 2010](#_ENREF_79)). Ways to experience by communicating, sharing, connecting and creating are constantly changing. The constant changes require a more flexible and dynamic view where the traditional way of thinking about user interfaces is limiting. The limitations origin from the traditional way of thinking about user interfaces with belonging attributes such as usability, context awareness, and affordance. It is limiting because usability is not a property of a user interface, but rather understood within each action that the human and technology performs ([Riemer et al. 2010](#_ENREF_64)). Furthermore, context cannot be considered stable and possible to separate from the action. Context is rather relational between the elements involved and arises from activity ([Dourish 2004](#_ENREF_21)). Also, affordance is not allowable actions specified by the environment, even if it is coupled with certain properties of the human and context. Instead, affordance can be defined as a relational process the human and the world (context, technology and other elements of the world) comes to be mirrored in the action possibilities ([Bloomfield et al. 2010](#_ENREF_13)).

This paper draws on current HCI literature and presents difficulties with the traditional concepts of usability, context and affordance. With these difficulties identified in the HCI literature in conjunction with a presentation of the emerging literature on sociomateriality ([Cecez-Kecmanovic et al. 2010](#_ENREF_16); [Leonardi 2011](#_ENREF_42); [Orlikowski et al. 2008](#_ENREF_55)) the concept of intrafaces is introduced. The paper discusses the importance of a new perspective in a world that is increasingly digitized and where experiences are becoming center stage. The concept is especially important for organizations with institutionalized structures, led by dominant designs in their product innovation, to enable a break from current path and think new.

An explanation of how the concept emerged is presented in the following section and is thereafter followed by a presentation of existing definitions of user interfaces based on current research. The paper continues to explain the concept of intrafaces and ends with a discussion of the concept.

Methodological Approach to Generate a New Perspective

This paper draws on a literature review based on Webster and Watson ([Webster et al. 2002](#_ENREF_77)) to build the basis for generating the intraface perspective. However, the research origins from several years of involvement in research projects focusing on the designing and development of user interfaces. The research projects have focused on product manufacturing firms where the increase, presence and importance of software in their products have effects on how they design their product. Along with the increase of software in the product also came redefinition of product goals. For example, a traditional goal includes a limit of five second, from start to finish, interaction with a certain user interface menu to accomplish a specific task. New goals are more difficult to measure and are expressed in wordings like “the user should experience emotional attractiveness”. Engineers developing the user interfaces not only struggle with the change of material, going from, for example, physical handles to digital displays, they also have difficulties to explain and define what user interfaces are, not only to themselves but also to the rest of the organization. However, the question of “what is a user interface?” is not enough to improve the understanding and further advance the development of experiences, but rather the questions of *when* and *where* is the user interface?

A literature review of HCI research focusing on user interface design and belonging concepts was accomplished to improve the understanding of current user interface design research. The literature review was done in three phases. The first phase included a structured search for a better understanding of the concept of user interfaces. It included searching ISI Web of Knowledge focusing on definitions of “user interface” and “user interface design”. The second phase was an effect of the first structured search ending up with literature that was mentioned in the first phase. The last phase emerged out of the ongoing discussion within the IS field about sociomateriality.

The first phase of the literature review started out with three different journals chosen on three different criteria. First, the journal had to be on the top of Journal Citations Reports on ISI Web of Knowledge and second, the journals had to represent different parts of the world and lastly, they all had to have a focus, but not solely, in user interface design. With these three criteria the following journals were used; ACM Transactions on Computer-Human Interaction (TOCHI), International Journal of Human-Computer Studies (IJHCS) and Scandinavian Journal of Information Systems (SJIS). 34 papers from the three journals were relevant and of specific interest to further understand what, when and where a user interface is.

The second phase of the literature review included papers referred to by the papers from the first phase as well as an open search for concepts that came up during the literature review. Three concepts standing out were Usability, Context sensitivity and Affordance and therefor further explored. In the exploration of recent publications discussing user interface design and the three belonging concepts, another ontological view derived, namely sociomateriality. Consequently, the third face focused on getting a better understanding of sociomateriality in relation to user interface design.

With this as background the next section describes the outcome of the literature review.

The Separation in User Interface Design – a Review

Depending on how the user interface works, how well the user can interact with the technology through the user interface, the effects of it can be seen all the way up to Wall Street ([Shneiderman et al. 2005](#_ENREF_70)). Due to this, it has for long been conventional to measure the effectiveness, efficiency and ease-of-use of user interfaces ([Nielsen et al. 1993](#_ENREF_51)). For example, emphasizing standardization and consistency within the user interface has been two mottos to follow to reach these measures ([Shneiderman et al. 2005](#_ENREF_70)).

Standardization includes fixed ISO standards that are developed for a certain reason or specific organizational standards that complement existing ISO standards ([Bevan 2001](#_ENREF_10)). For example, “usable products can be designed by incorporating product features and attributes known to benefit users in particular contexts of use” ([Bevan 2001](#_ENREF_10))( p 542). However, complex user interfaces can have an inertial effect on novice users who are overwhelmed by all the options, and it is problematic for expert users who tend to use only a fragment of the system ([Findlater et al. 2010](#_ENREF_23)). To overcome the complexity dilemma implementation of adaptive user interfaces is done. These interfaces are said to help to improve user interaction with systems by facilitating user performance, minimizing the need for help, easing system use, and avoiding cognitive overload problem ([Lavie et al. 2010](#_ENREF_40)).

Consistency is assumed to reduce confusion for a user, which leads to faster learning and ease of use, especially between different systems ([Nielsen 1989](#_ENREF_48)). This has been confirmed by other researcher who argues that consistency can reduce training time up to 300% ([Polson et al. 1990](#_ENREF_61); [Shneiderman 1987](#_ENREF_69)) and [Shneiderman (1987](#_ENREF_69)) includes “the strive for consistency” as one of the main principles in user interface design. Consistency can be implemented in the user interface by always using the same menu structure or having an icon representing something specific across the system/s. Nielsen argues that “consistency improves the user's productivity by leading to higher throughput and fewer errors because the user can predict what the system will do in any given situation and because the user can rely on a few rules to govern use of the system” ([Nielsen 1989](#_ENREF_48)) ( p. 63).

So, the user interface is often considered as an attribute to the technology; the technology has a user interface which enables users to interact with the technology. This is illustrated by the dotted line surrounding the solid box names technology in figure 1. In addition, the solid connection lines between the technology box and usability, affordance and context sensitivity shows that these properties is a part of the technology.

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| Traditional view of user interface | ***Fig. 1.*** *Illustration of a traditional view of user interface belonging to the technology with certain properties.*  *Interactions are between the user and the technology with help of the layer surrounding the technology, the user interface.* |

Thus, user interfaces can be described as a structure for communication between a user and the computer ([Daintith 2009](#_ENREF_19)). When developing a user interface, standards and guidelines are used to achieve good and usable representations of reality in the user interface. That is, development of representations of the world is used to make it easy for the user to understand what to do with the system. For example, a digital recycle bin icon on the computer desktop is used to represent the physical recycle bin standing by the desk in the office. Some argue that the closer a user interfaces is to reality, the better it is representing the reality, the better user interface ([Shneiderman et al. 2005](#_ENREF_70)).

User Interface and Context

The concepts of context and user interfaces have a close relationship. To include knowledge and information of when a system will be used and how the surrounding environment works benefit the user ([Alarcón 2006](#_ENREF_1)). A system that is used in a complex situation, and has information about the context, can assist the user ([Reeves et al. 2004](#_ENREF_63)). For example, if a user is driving in a complex traffic situation, the system can choose to enable, or disable, presentation of certain information. Research has shown that user interfaces that have context awareness and are adaptive, help users to reduce cognitive load and deal with complexity, minimize the need for help and facilitate easier use of system ([Edmonds et al. 1999](#_ENREF_22); [Trumbly et al. 1994](#_ENREF_76)). However, others point out the difficulties of including context information of when the system is used, such as population that uses the system and in what environment. For example, the algorithm for interface adaptation used for one context where the system always is used in the same way may be efficient, while in another context the usage might vary more and the adaptation algorithm cause inefficiency ([Lavie et al. 2010](#_ENREF_40)).

Adaptive multimodal interfaces are also focusing on context awareness and are developed to improve users experience and make them satisfied by allowing several different ways of input and output. The focus on multimodal interface has recently received more focus due to attempts to make interaction more natural between the user and computer. Other examples of context sensitive user interfaces are interface agents, which provides personalized assistance by foreseeing when and how a user wants to be assisted ([Schiaffino et al. 2010](#_ENREF_66)). For example, sometimes a user wants to be interrupted while doing a task, while at other times or in another context the interruption would be inappropriate. User preferences, habits, knowledge, behavioral patterns, regarding a particular domain for a specific user can be recognized and thereafter used by an interface agent. According to [Schiaffino et al. (2010](#_ENREF_66)) is this possible by including a degree of certainty in a mathematical model and implement it into the system.

User Interfaces and Usability

Usability is a very central concept in the HCI academic discipline with dedicated tracks on conferences and special issues of journals focusing on the subject. It is also important outside of the academic world with associations devoted to professionals working with usability and several webpages writing only about usability methods, guidelines, test and evaluations. The U.S government even has a website dedicated to usability (www.usability.gov) and there is an ISO standard, 9241, ([Iso 1998](#_ENREF_35)) defining what it is and how to measure it.

The concept is rather mature and can be defined as a property that assesses how easy a user interface is to use ([Bevan 2001](#_ENREF_10); [Goodwin 1987](#_ENREF_26); [Hartson et al. 2001](#_ENREF_30); [Lavery et al. 1997](#_ENREF_39); [Norman 2002](#_ENREF_53)). Improving usability is about optimizing efficiency, effectiveness and satisfaction for the user, by the mean of user interface solutions. Many different aspects are included in the usability concept including acceptance, use, and adoption ([Bevan 1991](#_ENREF_9); [Tractinsky 1997](#_ENREF_74)), learnability and relevance ([Lecerof et al. 1998](#_ENREF_41)), user experience, engagement and emotions in general ([Hartmann et al. 2008](#_ENREF_29)) social emotions in particular, such as enjoyment, connectedness, cohesion ([Lim et al. 2011](#_ENREF_43)) to name a few.

Just as context, is usability a notion difficult to understand and grasp, but the two concepts are also highly related. Much research brings up the relation of usability and context where usability is dependent of context of use ([Kong et al. 2011](#_ENREF_37)). For example, the usability of a navigation system in a car is much dependent on if the car is moving or if it is standing still. Even though all stakeholders want a system with high usability, research shows the difficulty of testing and evaluating usability in the correct context ([Ovaska 1991](#_ENREF_56)). To overcome this obstacle, tools have been developed to enable usability evaluation and testing in the correct context ([Bevan et al. 1994](#_ENREF_11)). The context of use, i.e. user goals and needs, tasks to be accomplished, environmental characteristics are different aspects to take into consideration when usability is in focus.

Other research shows how aesthetics have effects on usability measures. Aesthetic user interfaces can be perceived as highly usable just because they are considered beautiful ([Tractinsky 1997](#_ENREF_74); [Tractinsky et al. 2000](#_ENREF_75)) and [Hartmann et al. (2008](#_ENREF_29)) show that even though an aesthetic user interface has less favorable usability features compared to a less aesthetic user interface with high usability features, the majority chooses the aesthetic one with less usability for future interaction. Consequently, a beautiful user interface can be as efficient and effective as a usable user interface. So, the relation is complex, it is not only “what is beautiful is usable” as [Tractinsky et al. (2000](#_ENREF_75)) argue. The [Hartmann et al. (2008](#_ENREF_29)) paper point out that more graphical metaphore-based designs, as they studied, are perceived as having better aesthetics, yet at the same time worse usability, while other papers show that mapping an artifact to a person’s capabilities provides both for usability and aesthetically rewarding experience ([Djajadiningrat et al. 2004](#_ENREF_20)).

Obstacles within development processes and usability include resource constraints, attitudes and resistance, lack of understanding of the concept in general and also lack of usability experts ([Clegg et al. 1997](#_ENREF_17); [Rosenbaum et al. 2000](#_ENREF_65)). To overcome this, an immense amount of different techniques, tools and methods have been developed to ease the process of attaining systems with high usability. This includes a technique of how to cope with interactive systems ([Navarre et al. 2009](#_ENREF_47)), a taxonomy of usability ([Alonso-Rios et al. 2009](#_ENREF_2)) , heuristic evaluation ([Nielsen 1992](#_ENREF_49); [Nielsen 1994](#_ENREF_50); [Nielsen et al. 1990](#_ENREF_52)), cognitive walkthroughs ([Holzinger 2005](#_ENREF_32)), action analysis ([Andre et al. 2001](#_ENREF_3); [Pinelle et al. 2003](#_ENREF_60)) to mention a few. However, even though they all involve end users and context they implicitly address usability as a property to the system, embedded in the user interface.

User interfaces and Affordance

Affordance is a well-known and used concept in user interface design, just like context sensitivity and usability. Affordance, or perceived affordance ([Norman 1988](#_ENREF_54)), encompasses the properties of a thing that determine how it can be used. For example, the affordance of glass is that it is breakable and “see-thru-able” (transparent) and to increase or decrease the volume of a knob, it can have the affordances of graspable and turnable. Affordances are fundamental properties of material that determine how it can be used and is perceived by the user “suggesting” different interaction possibilities ([Norman 2002](#_ENREF_53)). A user interface’s affordance can be described as something that is shaped and sized for a certain interaction, such as to afford finger manipulation ([Zhai et al. 1996](#_ENREF_83)). It is the material as is, which possesses the affordance ([Hutchby 2001](#_ENREF_33)).

However, it has been pointed out that there are differences between affordance in physical material and affordance on a digital material, such as digital screen ([Norman 2002](#_ENREF_53)). But real world material affordances are yet often used in user interface design. For example, a digital lid on the trash box icon that can be opened and closed, or an opening on the digital document folder where you can place your digital documents, just like a physical document folder. So, to develop a user interface, one often uses the perceivable affordances from the physical world and implements it in digital format.

To be sure to achieve a certain affordance of a system one needs to consider at least three important aspects when designing, namely ambiguity, uniqueness and dominance ([Goonetilleke et al. 2001](#_ENREF_27)). If something is designed to allow for multiple interpretations, that is, if it is ambiguous, it results in too many interaction possibilities. For example, an icon representing a face can be perceived differently depending on context. More so, there are icons that can be perceived different in a given context as well ([Goonetilleke et al. 2001](#_ENREF_27)).

With this in mind the paper now continues with explaining the concept of sociomateriality and intrafaces.

Sociomaterial Intrafaces

Sociomateriality is a concept that embraces the notion of socio-technical entanglement, which includes the underlying assumption of an entanglement of things (the material) and people (the social). It is about questioning and rethinking “the supposed ontological separation among the social and the technological” ([Cecez-Kecmanovic et al. 2010](#_ENREF_16)). The increased digitalization makes it difficult to look at the world separating it from ourselves, we are in the world, being a part of the world ([Schultze 2012](#_ENREF_67)). Ontological concepts such as cybernetics ([Ashby 1956](#_ENREF_4)), performativity ([Barad 2003](#_ENREF_6); [Pickering 1995](#_ENREF_57)) and actor network theory ([Callon 1991](#_ENREF_15); [Latour 2005](#_ENREF_38)), quadruple objects ([Harman 2011](#_ENREF_28)) all discuss human and non-human objects in entangled networks, social–technological assemblages and entanglements or material-semiotic relationships and dependencies. However, they are all sociomaterial concepts with different nuances, emphasizing on different aspects.

Already in 1990 a first mentioning of the word *Intrafaces* were suggested and addressed by Forrester and Reason ([Forrester et al. 1990](#_ENREF_24)). They draw their conclusions based on issues arising from navigational and learning problems in hypertext domains. Yet, they make clear separation between the user, the interest the user has, the tools employed and “the ‘ensemble’ of representations brought to bear” ([Forrester et al. 1990](#_ENREF_24)) p. 279). However, they make an effort in including sociomaterial perspectives even though it is not explicitly mentioned. They write: “In the everyday world of system design, procedures are devised largely on an *ad hoc* [=in the doing, in the action. Authors interpretation] basis, and the argument here is that unless a more considered theoretical framework is developed – to include user, system, task domain and the learning process itself – little cumulative progress will be made. We must identify more clearly what exactly is involved when a person uses (and learns from) a computer if we are to realize the considerable potential of more recent technological developments such as CD storage devices and hypertext systems” (p. 279). This text addresses many sociomaterial perspectives along with motivations why this is important. They define their ontological perspective as a set of key elements within a dynamic interconnected context. Furthermore, they define intrafaces as: “…a dynamic relationship between the user, an interest, (e.g. problem specification, task solution, browsing activity), and an ensemble of representations (via screen, notepad, user’s memory, and so on) and tools (e.g. software manipulation, pencil, user tactics and techniques)”. The definition of intrafaces used in this paper is *emerging quasi-objects, distinguishable temporally with the help of an agential cut within a socio-technical entanglement in action, enabling intra-actions*. One of the important distinctions here includes the lack of separation and representationalism in this paper’s definition compared to Forrester and Reason’s. Furthermore, the dynamic relationships emerge *within* the entanglement and the elements involved in general, not *between* the social and material.

One reason for focusing on *within*, is the communicability and agency of material ([Yoo et al. 2012](#_ENREF_81)). Not only can human beings communicate and have agency on the material, but material can communicate and affect humans and empower actions in certain directions. There are many examples of where actions are empowered due to the agency of the material. For example, many people have experienced the necessity of moving around to find a good connection when on the phone. As Forrester and Reason point out “The prevalent and largely mistaken conception is that the interface is the representational window through which the user (usually human, but not necessarily so) addresses, manipulates and is informed about the system.”([Forrester et al. 1990](#_ENREF_24)) p. 284). Sociomateriality argues that it is as much the system that addresses, manipulates and informs the user.

To further explain sociomateriality certain relevant concepts are presented in the text that follows, namely, intra-actions, agential cuts and quasi-objects and their relations to agency.

Intra-actions and Agency

*Intra-action* is a concept coined by [Barad (1996](#_ENREF_5)) to emphasize emerged actions *within* the entanglements of elements, social and material. This can be contrasted to *interaction* where the emphasis is on actions *between* the different separated elements, such as a computer and a human. To understand what intra-actions are performed and what elements are included, observation of the action *in the moment*, is necessary. When observing an action, the understanding of what elements in the entanglement are involved make the observational lens more flexible to include necessary elements that influence an action aka experience.

This also means that the meaning of an action is either at the technology or the user, with intra-actions meanings emerge, or co-articulates ([Iedema 2007](#_ENREF_34)). Both the social and the material have effects on each other within an entanglement and the intra-actions within the entanglement have effects that have implications on how the entanglement develops. This implication can also be described as agency ([Pickering 2001](#_ENREF_58)). Agency is a dialectic dance of resistance and accommodations between the different elements within the entanglement ([Leonardi 2011](#_ENREF_42); [Pickering 1995](#_ENREF_57)). The co-evolvement of agency is an important part of sociomateriality and makes the lens more open to flexibility and dynamism ([Leonardi 2011](#_ENREF_42)).

Agential Cuts and Agency

To separate and understand the different elements within the entanglement an agential cut can be made in the enactment. This cut enables us to separate and identify the different elements included in the entanglement in a specific moment ([Barad 2007](#_ENREF_7)). Depending on when this agential cut is being made, the separation of the entanglement will be different. That is, certain elements might have different roles, different agencies and more importantly, elements are added to, as well withdrawn from, the entanglement throughout an action.

As mentioned above, within an entanglement are all elements equally influential and they jointly coproduce agency, that is, it is temporally emergent in practice ([Pickering 2011](#_ENREF_59)). The entanglement constructs “goals that refer to a presently nonexistent future states and then seek to bring them about” ([Pickering 2011](#_ENREF_59)) (p. 18) in “the doing”. So, agency evolves mutually in the action. For example, not only is the user making decisions and influencing the computer, but the computer encompasses agency and takes the user in a certain direction. Consequently, the agency evolves within the entanglement of the computer and the user and only with an agential cut one can identify where the agency is currently strongest among the elements involved. Agency is not a property to a certain entity, but to “the ongoing reconfigurings of the world” ([Barad 2007](#_ENREF_7)) p141). This is also illustrated in brain-computer intrafaces where it is difficult to know who has the agency when, the brain (social) or the computer (material) ([Williamson et al. 2009](#_ENREF_78)), they are one in action.

Quasi-objects and Agency

The French philosopher Michel Serres use quasi-objects to describe something that emerges in action, cooperation between material and the social, it creates the collective and its meaning. It is in some way enabling the entanglement. Serre explains quasi-objects referring to the meaning of a ball in action. When the ball is used it creates the meaning of the action ([Serres 1980](#_ENREF_68)). Consequently, a quasi-object is a transparent mean and can be explained as a connective medium ([Bodker 1990](#_ENREF_14)). It is neither a subject nor object; it is neither material nor social, it emerges and disappears and it can be considered as multiple and single simultaneously.

To further explain what a quasi-object is, the classic text by Bateson about the blind man with a stick is used. Bateson finishes the text with “Where does the blind man’s self begin? At the tip of the stick? At the handle of the stick? Or at some halfway up the stick? These questions are nonsense, because the stick is a pathway along which differences are transmitted under transformation, so that to draw a delimiting line across this pathway is to cut off a part of the systemic circuit which determines the blind man’s locomotion ” ([Bateson 1972](#_ENREF_8)) (p. 318). In the Blind man example is the quasi-object equal to information transmission. The information transmission can emerge between the stone and the stick, the hand and the handle of the stick or somewhere on the way up the stick or in the man’s brain. But more importantly, quasi-objects can emerge at several places at the same time. This highlights the quasi-object as an information transmission where the separateness of the social and the material is of little help.

Revisiting Context, Usability and Affordance

Now when the concepts of intra-actions, agential cut and quasi-objects are explained it is time to revisit context, usability and affordance and present them from an intraface perspective.

Context and Intrafaces

It is difficult to understand when context awareness and context sensitivity is something to emphasize in the design process ([Lavie et al. 2010](#_ENREF_40)). Context is traditionally considered as a form of information, which is delineable and stable and where one separates not only the user and the technology, but also often activity and context ([Dourish 2004](#_ENREF_21)). However, context is not simply about information, but is a more complex relational property that exists when a diverse set of elements enacts. It is not delineable where one can define and foresee what counts as a context, but dynamic and features constant re-configurations ([Suchman 1987](#_ENREF_71); [Suchman 2007](#_ENREF_73)). A context is never stable and it is not possible to determine what contextual elements to include from time to time. Context can therefore rather be considered as an occasioned property that is relevant to particular settings, actions and elements involved ([Dourish 2004](#_ENREF_21)).

[Redström (2008](#_ENREF_62)) illustrate with the Interactive Pillow (see Redström, 2008 for more detailed information) how context is an occasioned and relational property and how *situational doings* have little or no use of the traditional concept of context. Context is “actively produced, maintained and enacted in the course of the activity at hand” ([Dourish 2004](#_ENREF_21))(p. 22) and therefore only identifiable in the moment of the action. The social and material elements involved are spread out and the quasi-objects emerging within the entanglement have effects on the context that cannot be foreseen. It is a constant re-configuration of the world ([Suchman 2006](#_ENREF_72)).

Intrafaces and Usability

Usability can no longer be considered a property to the technology according to ([Riemer et al. 2010](#_ENREF_64)), or more specifically, to the user interface. Usability only manifests in the sociomaterial use context and should not be conceptualized as something in its own right. One needs to understand the entanglement of the social, which can include use context, social ideas, norms and practices, as well as the technical aspects when talking about usability ([Riemer et al. 2010](#_ENREF_64)). Usability can exist and not exist at the same time depending on social and material elements and their specific entanglements in the action just like [Hartmann et al. (2008](#_ENREF_29)) mention in regards to aesthetic user interface solutions. Also, [Molich et al. (2004](#_ENREF_46)) report on a study where seven labs together identified 310 usability problems in total, but only one single problem was identified by all seven labs. This study also showed that 75% of the problems were identified by one lab.

Consequently, usability is rather something emerging within a specific sociomaterial entanglement. Usability is dependent on how quasi-objects occur within the entanglement and can thereafter be studied, interpreted and possibly measured.

Intrafaces and Affordance

[Gibson (1977](#_ENREF_25)), who originally introduced the term affordance, uses it as a way to explain all "action possibilities" existing latent in the environment. This means that there is a relation between the material and the environment. More specifically, action possibilities consist of a relation between the action made and the context. Affordance is a property of an ecology consisting of material, environment and human (or animal) in conjunction ([Gibson 1977](#_ENREF_25)). For example, a big stone in a garden can be something to sit on for a bird, something to step on to reach a branch for a human, or somewhere to sleep in the sun for a lizard. In other words, the stone can be “sittable”, “climbable” or “sleepable” depending on who is using it and in what context. the Gibsonian definition of affordance is “the allowable actions specified by the environment coupled with the properties of the organism” ([Zhang et al. 2006](#_ENREF_84)) ( p. 337). [Cooper (2001](#_ENREF_18)) argues that it is impossible to neglect the incompleteness of objects and bodies; they are always partial. This goes along with Heidegger’s discussion of “things” where he defines a jug not only by its material but by its void inside of it. This void not only shapes the jug but the jug is also shaped by it ([Heidegger et al. 1967](#_ENREF_31)).

Bodies and objects are defined momentarily through entanglements with other partial objects and non-objects, such as voids, and the affordance of this entanglement can only be understood in action. So, in order to define affordance one must include the action of the sociomaterial entanglement in the occasioned and relational property of context. Affordance emerge in the imbrication of the social and the material ([Leonardi 2011](#_ENREF_42)). [Bloomfield et al. (2010](#_ENREF_13)) takes it yet further and say that “It is therefore a *process* through which the body [the social: authors comment] comes to grant particular affordances to the (made) world [the material: authors comment] and conversely, the world comes to be ‘mirrored’ in the effectivities or action capabilities of the body. Sociality and materiality appear irredeemably entangled with one another” (p. 429).

Discussion

[Bilandzic et al. (2012](#_ENREF_12)) point out the complexity of a world where relations between people and digital technology is changing due to temporal and spatial differences. For example, the constant presence of a person, in time and space, by digital mean and information infrastructures, such as Facebook or mobile phones, is contradicting to the actual physical presence of a person which is limited both in time and space. In a world where the separation of the IRL (In Real Life) identity from the Avatar’s identity in a computer game only can be done by an agential cut, sociomateriality matters ([Schultze 2012](#_ENREF_67)). The digitalization has effects on how we can and should perceive and apprehend the world and of course consequences when designing experiences. The digitization of artifacts used both consciously and unconsciously ([Yoo 2010](#_ENREF_79)) blurs the boundaries between the user and the artifact ([Yoo et al. 2012](#_ENREF_81)) and the distinct separation between the social and the technology can be questioned ([Schultze 2012](#_ENREF_67)). In addition, with the increased digitalization [Yoo (2013](#_ENREF_80)) encourage IS scholars to “stretch the boundaries of their intellectual imagination beyond the comfort of IS journals and conferences” with the sociomaterial perspective.

With this start of the discussion section, let us go back to Bateson’s blind man. The blind man with the stick in Bateson’s text will have little improvement of his experience if the only focus is on the handle of the stick, as traditionally done within user interface design. To consider the man-stick entanglement as a whole to understand how experiences can be created, enhances, intensified and improved allows for a more flexible and dynamic approach to design. Again, this becomes even more relevant with the increased digitization with its attributed of generativity and re-programmability ([Yoo 2013](#_ENREF_80); [Yoo et al. 2010](#_ENREF_82)).

Also, it has been recognized that there is little research is done focusing on sociomateriality and user interfaces ([Riemer et al. 2010](#_ENREF_64)). Although no one picked up Forrester and Reason’s call for a sociomaterial perspective on user interfaces after it was introduced in the 90’ies, it is now time to move forward and study this further. Especially since the increased presence and importance of digital material have effects on what we do, how we do it, why we do it and if we do it. In other words, it is important to study to further understand how (digital) material is, and should be, involved in experiences ([Yoo 2010](#_ENREF_79)). However, the separations between the social and material, which is the current norm, limit us to innovate unimpeded. It forces us back into assigning usability to the technology, developing algorithms for context awareness to be implemented in the technology and trying to find representations from the physical world to be embedded in the digital technology to communicate affordance. This results in forgetting about the overall experience.

Furthermore, when using the established concept of *user interface* in the sociomaterial perspective one drops the focus on the *user* and emphasizes the action. Not including *user* in the concept highlights that all elements, social and material, within the entanglement are equally important. Without intrafaces there will be no action and intrafaces don’t belong to the user, nor to the technology, but to the entanglement in action. The intrafaces enable intra-actions within the assemblage which in turn have an effect. This effect is a part of the experience.

Consequently, traditional user interface concepts presented and discussed can obviously have other meanings depending on ontological perspective as seen in Dourish ([Dourish 2004](#_ENREF_21)), Reimer and Vehring ([Riemer et al. 2010](#_ENREF_64)) and Bloomfield et al’s ([Bloomfield et al. 2010](#_ENREF_13)) papers about context, usability and affordance. That is, from a sociomaterial perspective it is argued that contextuality is a relational property that holds between objects or activities and the scope of contextual features is defined dynamically. It is temporary and continuously changing and arises from the activity ([Dourish 2004](#_ENREF_21)). Sociomaterial usability can consequently only be understood within each of the particular use contexts, which in turn emerges from the enactment of the entanglement ([Riemer et al. 2010](#_ENREF_64)). With this perspective, one can question usability tests and guidelines of user interfaces. Lastly, affordance is when ‘sociality’ and ‘materiality’ appear irredeemably entangled with one another ([Bloomfield et al. 2010](#_ENREF_13)). This means that the sociomaterial entanglement with its emerged intrafaces get their purpose and meaning in the action and emerges and evolves in the reconfigurations.

The figures below shows a sociomaterial entanglement in action, the elements are all one in the doing (figure 2). When a cut is made the different elements can be categorized and recognized (figure 3). Furthermore, intrafaces within the entanglement can be identified and further studied to understand its relevance to the action (figure 4).

|  |  |  |
| --- | --- | --- |
| entanglement | entanglement with a cut | entanglement with intrafaces |
| **Fig. 2.** A sociomaterial view of elements included in the entanglement | **Fig. 3. A cut in the entanglement enables separation of the different elements and help us understand what property belongs to what element at that moment** | **Fig. 4. The arrow represents the different intrafaces that might emerge during an action.** |

These figures implies a first set of guidelines to further advance experiential design where digitized artifacts are involved ([Yoo 2010](#_ENREF_79)). Firstly, when starting to design an experience it is necessary to consider the social and the material as one in action, not as separate entities. Secondly, by performing an agential cut the different elements included can be identified and valued. For example, asking questions like “what elements are more important than others in this experience?” and “can we improve the experience by consciously adding new elements into the entanglement?” Lastly, when all the elements are identified, the next step is to understand emerging relations between the different elements. In other words, recognizing the intrafaces and possibilities to manipulate or provoke new intrafaces to arise or disappear depending on what experience is designed.

Lastly, depending on what ontological view designers have in a developing process, the outcome will be different. Institutionalized processes need to be adjusted to fit to current circumstances where digitization is increasing in amount and importance.

Conclusion

This conceptual paper introduces the concept of intrafaces. Intrafaces are quasi-objects that emerge within sociomaterial entanglements enabling information transformation between involved elements that result in some action, which have an effect on the expereince. It is of high relevance to change from the traditional view of user interfaces to intrafaces to enable new innovations of experiences where the social and the material are equally important and influential. However, intrafaces does not replace user interfaces, but rather complements it and opens up new ways of thinking about what and how to innovate.

Still, intrafaces is a new concept and needs further study to understand and define its relevance. For one, it would be interesting to see how it can be included in innovation processes in an efficient and valuable way. Furthermore, the guidelines presented in this paper need to be further developed and tried out in, both from an academia as well as from a practioner’s point of view.

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