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Dynamic Sense-Making in Use Processes of Digital Products

A Semiotic Approach to User Interface Design

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Abstract: Today's digital native users experience interface signs in a fundamentally different way than naïve users of the first graphical user interfaces in the 1980s. This is especially remarkable considering many interface signs, such as buttons, menus, icons for files, folders and so on have not changed in appearance particularly. Furthermore, contemporary multi-touch interfaces often represent real life objects in a hyper-realistic manner, perpetuating the classic concept of the real life interface metaphor as a means to facilitate use. These phenomena cannot be understood without a closer look at the users' cognitive processes when 'decoding' visual and auditory signs in the interfaces of digital products. To this end, semiotic theory has been applied to describe human-computer-interaction paradigms and graphical user interfaces in particular – but often based on oversimplified concepts of sign-types (index, icon, and symbol), focussing exclusively on attributes of the sign – it has ignored the user's perception and way of inferring from sign to meaning. In contrast to a sign-centric approach, a user-centric concept of sense-making allows for the semantic aspects to change dynamically with changing users. A deeper understanding of these change processes may facilitate decision-making in the design process.

Keywords: Interface, interaction, semiotics, digital natives, multi-touch, skeomorphism

1. Introduction

Interaction between humans and digital products can be seen as processes of sign-based communication. For the purpose of comprehending how users make sense of signs in digital product interfaces, semiotics and especially semantics can serve as an analytic method. Semantics deals not only with the *meaning* of signs, but also with *the way* meaning is constructed. To that end, semantic theory differs between three types of 'sign-to-meaning' relations: causality (index), similarity (icon), and convention (symbol). [21] A deeper understanding of the circumstances and conditions, leading to these different modes of interpretation, could help improve decision-making during the design process of digital products. However, on the rare occasions when semiotics has been taught in design programmes, it has frequently based on an oversimplified understanding of the sign process. Following design traditions, the focus has largely been reduced to the visual aspects of signs. Standard questions posed have been: what amount of detail allows an optimum of recognisability or legibility? What visual parameters can bring about a family resemblance in a system of signs (such as letters or pictograms)? As a consequence, only the properties of the signs are discussed – and the users' cognitive processes are completely ignored. It is blatantly clear that the experience, cultural background, and previous knowledge of a perceiver will have a decisive influence on the mode of making sense and can be critical in achieving successful communication between the system designer and the user. These predominantly sign-oriented and static concepts have resulted in semiotics being all too frequently considered outmoded in contemporary design theory and it barely plays a role in human computer interaction (HCI). Krippendorff in particular, accused semiotics of being too rational, and incapable of dealing with multiple meanings (polysemy), and excluding 'human agency in creating meanings'. [12] An element of truth my lie in this criticism when discussing the semiotics of Morris [17], that previously prevailed in the design related semiotics discourse, in Europe at least. But in his judgement he takes pains to ignore further developments in semiotics that extend beyond even Eco and Barthes, for both Anderson's 'dynamic

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semiotics' [2] and Keller's theory of 'sign metamorphosis' [11] explicitly address the decisive role of the perceiver in sense-making. They also provide theoretic models for polysemy and dynamic sign processes, i.e. changing sign-object relations that can be applied to analyse use processes of digital products.

The discussion on metaphors in HCI peaked in the 1990s. [8, 4] However, Apple has refuelled this issue with the hyper-realistic multi-touch user interfaces of the iPhone and iPad featuring real-life mimesis. From the point in 2010 when Microsoft introduced a new version of its Windows Phone – with a rigorously reduced, typographic, and abstract look [14] – the interface design community has been embroiled in debate upon which of these design approaches will be more sustainable. The key words leading the discourse have been terms such as 'honest' and 'authentic' on the one hand, and 'natural' and 'intuitive' on the other. Critics of the Apple approach have come up with the term 'skeomorph', commonly coined to describe faux material, decrying the use of real life mimicry in interfaces. [8]

This paper will begin with a review of the quite rare literature on interface semiotics. In the following section, it is necessary to give a brief introduction treating the basic principles of semiotics. Those familiar with semiotics, in particular the Peircian definitions of index, icon, and symbol, may prefer to skip directly to section four, which will give concrete examples for these sign types in interface design. Following that the classic issue of real-life metaphors in context of the novel level of photorealism in multi-touch applications will be discussed. For the purpose of estimating the effect of hyper-realistic representations on user perception, section six introduces the theory of sign metamorphosis. This concept allows for the dynamically changing ways of individual users' sense-making on the one hand, and for different user groups such as 'digital naïves', 'digital immigrants' and 'digital natives' on the other. Lastly, the theory of 'sign metamorphosis' will be extended by implementing the concept of 'indexicalisation', believed to be characteristic for the interface perception of experienced users and digital natives.

It is considered that a deeper insight into the semiotic differences of 'skeomorph' and abstract interfaces can clarify some aspects of the current user interface discourse and may amend common usability-clichés of what is deemed 'authentically digital' or 'natural and intuitive'.

2. Related work

The interface discourse has long utilized semiotic concepts and terminology (e.g. syntax, semantics, icon, and symbol), but rarely in a rigorous or consistent way. Conversely, the semiotics community has barely discussed the domain of interface design. Andersen, one of the few scholars who has contributed regularly to the narrow discourse of interface semiotics, assumed that 'the purely analytic character of traditional semiotics has to be supplemented by a constructive one'. [1] Like many semioticians, Andersen's original training was in linguistics. This could explain a predominant focus on fundamental principles of sign processes in computer systems and the relations between programming languages, programmers, and users. Hence, the semiotic discourse on pragmatic questions of visual interface design is even more seldom. In addition, the scientific tradition of formulating universal truths tends to hinder a pragmatic view on context-dependent specific design questions.

It is hardly surprising that the most seminal publications on interface semiotics where written in times of paradigm shifts in interface design. Nadin wrote his paper 'Interface Design and Evaluation – Semiotic Implications' [18] when text-based interfaces were being replaced by graphic user interfaces. It was published in 1988, but was based mainly on a semiotic analysis of the Apple Lisa interface, Apple's very first GUI of 1983. It provides an excellent introduction to semiotics and computers as sign-processing semiotic machines. Nadin also addresses communicative aspects of interpretation and sense-making in computer interaction and is even so bold as to dip into the depths of visual icon design in practice. However, Nadin's concept of visual sign types, i.e. ways of representation, is questionable when it comes to his concept of 'indexical' signs (see fig. 1) – ciphers are usually not considered indexical signs, they are just as symbolic as arithmetic operator signs – a point that will be explained further in section 3.3 and 4.1.

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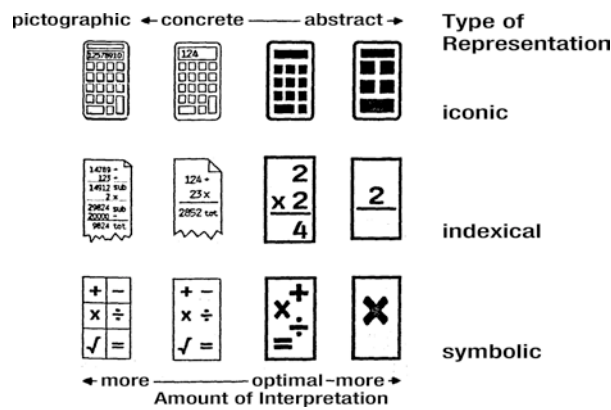
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Figure 1: Nadin's 1988 'Relation between representation and interpretation'. [18]

Further remarkable is Nadin's argument for quite abstract representations with little visual detail: 'As the symbol becomes more abstract, it also becomes more recognizable'. [18] In his opinion, too much detail distracts and hinders recognition of the sign representing a 'conventional' calculator, i.e. the calculator *category* as opposed to a specific individual calculator. Consequentially, Nadin criticised the 1984 Macintosh interface for being 'sometimes excessive in their details' – notably, talking about a black-and-white interface on a 72 dpi display!

In 1990, when 'Virtual Reality' was an emerging topic, Paul Brown introduced his classification of interfaces into the following three categories: 'command/control languages', 'menu-based/WIMP', and 'immersive/3D'. [7] He went on to associate these types of interfaces with the three semantic categories *symbol*, *icon*, and *index*. Language and text is predominantly *symbolic*. Graphic user interfaces employ mainly *iconic* representations. Finally, virtual reality interfaces are, according to Brown, immersive, quasi-natural, and therefore *indexical*. These aspects have been widely neglected even in Ronald Stamper's seminal publications, who introduced his 'Organizational Semiotics' view on information systems [24], as was the case with Clarisse de Souza in her 'Semiotic Engineering' method [23]. This may be down to their backgrounds in mathematics and linguistics respectively – both disciplines devoid of any great tradition in visuality.

This paper's author has published articles on multi-touch interfaces [19], and on semiotics of auditory interfaces, [20] which, in part, can be transferred to user interface design in general.

3. Semiotics

Semiotics, the study of signs and sign processes, is rooted in philosophy and linguistics. The various semiotic schools and their respective terminology cannot be reviewed here in detail. Nonetheless, to discuss a semiotic theory of interface signs and ensure clarity, it is necessary to introduce a minimum of semiotic terminology for those not well versed in it. This article will deal largely with the semiotic terminology of Charles Sanders Peirce, who introduced the triadic concept of the sign that emphasizes the role of the perceiving individual in the sign process. [21]

3.1 The three aspects of the sign and three dimensions of semiosis

It can cause a little confusion that one of the sign's parts is again called the 'sign'. In Peirce's terminology, it denotes the physically existing sign-carrier, i.e. the perceptible signal, which can be auditory, visual, haptic or olfactory. Moreover, the term 'object' for what the sign refers to might also be confusing. The 'object' can be a physical object or thing, but it can also be an abstract concept like 'democracy', or an action like 'erase'. Finally, the 'interpretant' should not be confused with the interpreter, i.e. the interpreting person. In fact it is the perceiver's interpretation, i.e. a mental conception of the sign's meaning. In other words, the interpretant is also a representation of the object but 'in the perceiver's head only'. [21]

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syntactics

sign

pragmatics   semantics
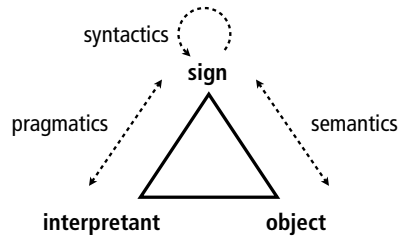
interpretant   **object**

Figure 2: The three aspects of the sign and the dimensions of the sign process. After Peirce [21] and Morris [15].

The sign process (semiosis) is also subdivided into three dimensions, which describe the relations between the sign and its object and interpretant: [17]

Syntactics: The relation between sign and other signs, rules for the formal structure of signs.
Semantics: The relation between sign and its object, its meaning.
Pragmatics: The relation between the sign and its interpretant, the effect the sign has on the perceiver.

3.2 The three types of relation between sign and object

Semantics are not only about the meaning of signs, but also about the principles behind encoding and construction of their meaning. Semiotic theory differs between three types of signs, based on distinct relations between the sign and the referred object. [21]

object sign   object sign   object sign

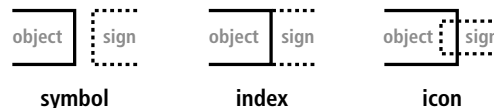**symbol**   **index**   **icon**

Figure 3: Schemes of the relations between signs and their object. After Bense. [5]

Symbol: based on *convention*; no factual link between sign and object.

Index: based on *causality*; physical link between sign and object.

Icon: based on *similarity* between sign and object.

4. Typology of signs in interfaces

4.1 Index

The most frequently used example for an indexical sign is smoke as a sign for fire. Smoke indicates a fire, and it does so by merely pointing to it, without being similar to the fire, and without cultural conventions behind it. [21] The index sign is linked to its object simply by the laws of nature – it is a symptom. In this sense, indexical signs do not exist in digital interfaces because interfaces are entirely artificial – based on symbolic programming code. Nothing on a computer screen is a naturally caused symptom of anything, everything is designed more or less arbitrarily. Still, we perceive index signs when using digital products: a soft purr indicates a working hard drive, and a hot laptop body indicates heavy processor use. However, if we accept the computer model world as 'real' for a moment, a bloated trashcan can be perceived as an index for 'files being in the trashcan'. Below this indexical layer of meaning, we find several layers of symbolic code (machine and programming language) and an *iconic* visual metaphor on top. Still, most of us actually know that these files are not inside a trashcan, but scattered across a hard drive.

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4.2 Icon

Most definitions of the iconic sign use the term 'similar' to characterize it. Thereafter, the icon is based on a similarity between the sign and what it stands for. [21] To speak in Morris's terms, it is based on 'shared attributes between sign and object'. [15] The principle of similarity is widely used in visual communication. For instance, a silhouette drawing of an object on a traffic sign becomes understandable by the depiction's similarity to that object. Sign and object share some attributes of shape.

A classic domain for similarity-based signs can be found in tool-palettes of drawing applications. The small visual representations of pencils, rubbers, stamps, and buckets share some visual attributes with their analogue equivalent. However, there are also signs that lack analogue equivalents, so there is nothing to be similar to, like the 'sharpen' tool in Adobe Photoshop: A plain triangle – a mere symbol. But what about tools that do exist in the analogue world, but ones that are not familiar to the user? For instance Photoshop's infamous 'dodge' tool. Users with darkroom experience may recognise it as an icon, for users without a background in analogue photography it seems to be just an arbitrary symbol – which looks like a lollipop (see figure 4).

Figure 4: Adobe Photoshop toolbar icons: Pencil, rubber, stamp, bucket, 'sharpen', and 'dodge' (from left to right).

4.3 Symbol

Symbols are based on mere conventions, neither the laws of nature nor any perceivable similarity link a symbol to its meaning. [21] Hence, the sign's appearance has no factual connection with what it refers to, which is why the symbolic sign often is referred to as being *arbitrary*. Possible signs for 'close window' may serve as an example. The word 'close' on a button is perfectly symbolic. It is a cultural convention understandable for anyone who is able to read the English language. The 'X' sign in the upper right corner of a window (in Microsoft Windows) is also symbolic. It could be argued, that it visually resembles the analogue sign of crossing something out, and hence, it would be an icon. However, the analogue 'X' sign itself is again a symbol, so the digital counterpart would simply be an icon for a symbol. This already illustrates that signs often have multi-layered meanings, and each of these layers may be based on different sign types.
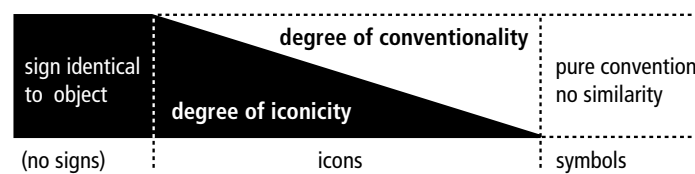
4.4 Iconicity

Figure 5: Gradual transition from icon to symbol, from high iconicity to high conventionality. [13, 14]

Similarity usually is a concept that is easily understood in everyday life. Especially in the domain of visual signs, it seems to be obvious when the sign is similar to what it refers to. However, similarity comes in grades and is perceived differently by individual perceivers. The silhouette drawing of a cow on a traffic sign is said to be similar to a real, living cow – at least in some aspects. In this case, similarity is based on the reduction to two dimensions, the elimination of materiality and colour, proportional scaling, and reduction in shape detail. However, similarity does not have to be based on analogue transfers like proportional scaling and reduction of colours. A merely diagrammatic similarity to reality, like in a subway map, is also considered iconic. [21]

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To describe these different levels of similarity, Morris introduced the term 'iconicity'. [17] In this sense, Madame Tussauds' wax figures are based on extremely high iconicity, whereas the subway map is based on low iconicity. At the end of the iconicity scale, the sign has no (more) similarity with its object – a mere symbol. [16] As will be seen in section 6, this delimitation is not only determined by properties of the sign, but is ultimately dependent on the perception of the user. If a low level similarity is nonetheless recognised by the user, such recognition depends strongly on the user's previous knowledge, cultural background, and frequency of use. [11]

4.5 Using index, icon, or symbol

A superficial view, immediately suggests an *index* sign to be the most intuitive sign to be understood, because it is 'natural'. The second choice would be an *icon*, for it can at least be understood potentially without any explanation via resemblance. The *symbol* would be last choice, as 'arbitrary conventions' are usually considered almost synonymous with 'inapprehensible'. However, the different sign types may only be good for a head start effect. Repetitive use can override all of the initial advantages. Index signs are understood intuitively not because they are 'natural'; the fact is that they have become intuitive only because we have been exposed to them for a longer time.

5. Iconicity of multi-touch interfaces

Real-world metaphor approaches have a long tradition in human-computer-interaction (HCI). The very first graphic user interfaces (GUI) of the late 1970s were based on a visible real world metaphor. However, technical limitations, rendered the iconography of the 'desktop' interface quite abstract (see fig. 6a). This comparably high level of abstraction helped the user to forget the origin of these metaphors once the learning phase was over and the meaning of interface elements had become internalised. The word 'menu' today, no longer conjures first and foremost the selection of dishes available in a restaurant. The concept of a restaurant menu illustrating the availability of choice was helpful in the early years of GUI, but today's users would be distracted and confused if confronted with a photorealistic imitation of a restaurant menu card listing commands such as 'cut', 'copy' and 'paste'. [19]
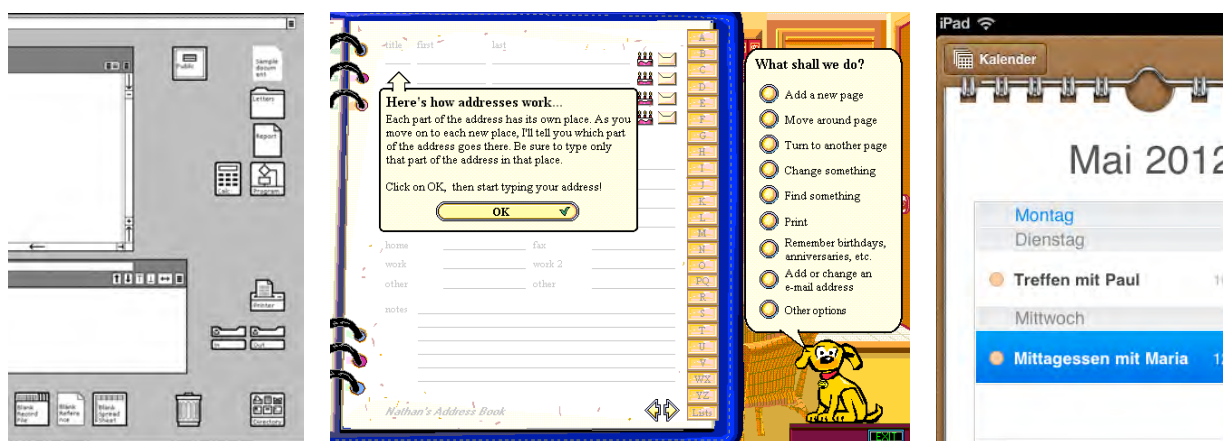

Figure 6: a) Xerox Star GUI (1981), b) Microsoft BOB address book (1995), c) Apple iPad calendar (2012).

A second wave of realistic real world metaphors came up in the early 1990s when 'interactive multimedia' became popular. Abstract and text-based interface elements like menus, buttons and drop-down-lists were replaced by everyday objects in everyday environments, but this time employing 8-bit colour and a higher level of detail resulted in higher iconicity. Attempts to transfer this 'multimedia' approach to standard software (like Microsoft BOB) were neither aesthetically pleasing nor economically successful at that time (see fig. 6b).

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5.1 Metaphors and learnability

Metaphors in interface design have been one of the most extensively covered topics in HCI since the 1980's, impossible to be summarised here. A general discussion on metaphors can be found in Lakoff and Johnson [13], and Blackwell [6] provides an extensive overview on interface-related metaphors. Today, applications on tablet computers appear once more like real world objects. Multi-touch apps imitate paper sheets, stitched leather covers, and chrome-plated spiral binding. Both, the level of iconicity and aesthetic quality are superior compared to the 1990s (see fig. 6c). However, the justification behind real-world metaphors is still the same: it is believed they help understand and learn how to use virtual artefacts by transferring knowledge from real world interaction to digital product interaction. In their human interface guidelines for the iPhone and iPad, Apple recommend the use of real world metaphors as standard practice – still in 2011: 'When virtual objects and actions in an application are metaphors for objects and actions in the real world, users quickly grasp how to use the app.' [3] Back in the 1990s the people at Apple were more cautious about such claims. In the article 'Working with Interface Metaphors' Thomas D. Erickson also addressed potential problems: 'particularly important here is […] what might lead the user in the wrong direction or raise false expectations'. [9]

Without repeating the discussion on the limitations of metaphors [6] entirely, it is necessary to address some of the problems encountered in real-to-digital transfers. When we look at a book in the real world, for instance, we know exactly what we can do with it; how to handle it and navigate it. By the same token, however, we also know what we are *not* able to do with it. The photorealistic representation of a book on a screen is somewhat different. Naturally, the resemblance to a book gives some clues on how to interact with the interface, but it is also obvious that users can only interact in ways that are anticipated and implemented by the designer of the software. It may well be anticipated by the user that one will be able to 'flip pages', but does it also enable one to mark pages with dog-ears? Can one to rip out pages? The highly iconic interface simply does not tell (see fig. 7a). [19]
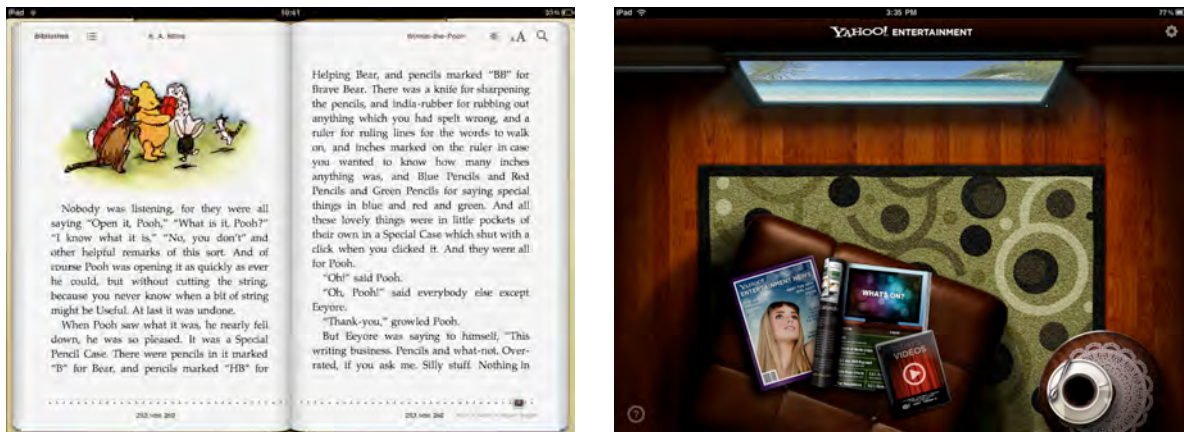

Figure 7: a) Apple iPad eBook, 2010 (left), b) Yahoo Entertainment App, 2010 (right).

Alan Kay, one of the GUI originators, already addressed these restrictive aspects of 'one to one' metaphors – as early as 1990. [9] When everyday objects are used as interface metaphors, some interaction techniques will be anticipated and expected, but the intersecting set of possible interactions shared by real and virtual artefacts is actually quite small and is entirely determined by the software design. Thus two gulfs open up that need to be bridged to enable effective use of such an interface. The first is the difference between what the real object affords to do and what the virtual one *cannot*. The second is the difference between what the virtual interface *affords* and what the real thing cannot. The Yahoo Entertainment App, makes this quite evident (fig. 7b). The only signs that communicate clearly that they are clickable are non-realistic and symbolic: the triangle on the video cassette (play), the question mark (help), and the gear icon (settings). The imitated physical affordance of the coffee cup is misleading, even potential interaction with the depicted magazines are prone to trial and error.

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5.2 Hyperrealism and invisibility

Regarding interfaces employing hyper-realistic reproductions of everyday objects, the lack of knowledge of interaction possibilities is caused, ironically, by a lack of visibility. The highly iconic interface lacks visual cues telling what is operable and what is not. Gibson's theory of affordance explains how physical properties and visible mechanical constraints indicate what an object affords in real life. [10] When these index signs are imitated on screen, they become iconic representations of the original index signs (see section 6.1) and trigger exactly the same expectations. If these are not met, we encounter a standard usability problem: the lack of conformity with user expectations. This can only be avoided by adding visible *symbolic* signs that indicate interactive elements, e.g. abstract handles, buttons, or colour codes. It sounds contradictory, but in these instances the iconic signs (which imitate useless indices) are misleading, whereas symbols would function perfectly as index signs. Here, symbols are discernible and understood, not in spite of being artificial and abstract, but *because* they are artificial and abstract.

6. Sign metamorphosis

To understand the dynamic character of sense-making in use processes, the linguistic theory of sign metamorphosis, introduced by Keller may be helpful. [11] Its key assertion is that the sign-type – indexical, iconic, or symbolic – ultimately depends on the perceiver and their type of inference (compare sections 3.2 and 4). The semantic relation between a sign and its object does not exist objectively and independently from the perceiver. It is not a fixed property of the sign. The same sign may be understood on a similarity basis by one perceiver and simply by habit and convention by another. [11] Nonetheless, in large groups of perceivers, predominant patterns of interpretation emerge. These predominant patterns of interpretation change over time. Hence, today's patterns may differ from those predominant in the 1980s.

6.1 Metamorphosis from index to icon

When an index is imitated, it becomes an icon. To illustrate this effect, Keller uses the example of a simulated yawn. A real yawn is an index for a shortage of oxygen. Like index signs in general, yawning is usually not used for intentional communication. However, a simulated yawn can serve as an effective iconic sign for letting someone know how bored the listeners are. It is understood because it is similar to the real yawn. The same rule applies to visual signs. A visual icon can be considered a two-dimensional imitation of a physical object – it is then interpreted by an *associative inference*, based on the similarity between the object and its depiction. [11]
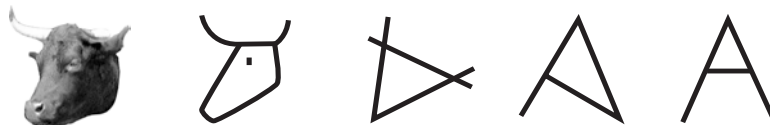

Figure 8: Transformation from an iconic depiction of an ox head ('aleph') to the symbolic letter 'A'.

6.2 Metamorphosis from icon to symbol

Keller points out that the associative way in which iconic similarity is interpreted, is a creative process without normativity. It is always possible that the interpreter has an association that differs to the intended goal of the designer. This procedure of association can be compared to the solving of riddles. Confronted with the same riddle several times, one needs no longer to associate and guess. As a result, by repetitive use, an icon will no longer be interpreted by similarity, but will be based on a habit, a rule. The actual similarity remains, but now it is unnoticed – it has become useless. As a consequence, iconic signs that are used frequently may lose their iconicity by simplification and abstraction (see fig. 8). A historic example is the metamorphosis of the iconic cipher 'III' to the symbolic '3', which developed over the centuries by cursive handwriting and a rotation of 90°. In everyday

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conception, the cipher '3' is a symbol for most people, until they learn about the relation to its iconic predecessor III and start to realise a visual similarity. Thereby the cipher '3' has again become an icon – for just as long as the similarity remains conscious. [11] Thus, a sign can be interpreted on a similarity basis, and *at the same time,* someone else may interpret it based on mere habit or convention. For a designer it may be comforting to know that in spite of their different *ways* of making sense, both interpreters can derive the same meaning. Still, over longer periods of time cultural development heads towards abstraction and symbolification. Signs detach from their original physical or biological context and become symbolic parts of culture: Onomatopoeia becomes unconscious, index signs for wealth transform to symbols of power, and brands transform from quality indicators to status symbols. Surprisingly, in interface design the trend appears to head precisely in the opposite direction. Driven by technical progress (colour monitors and increased graphic card video memory), user interface design became coloured and more and more realistic – probably not only to improve usability, but also for aesthetic reasons (see fig. 9).

Figure 9: Macintosh hard disk icons, abstract in 1985, more detailed in 1998, photorealistic in 2009 (left to right).

6.3 From any sign to index

In Keller's linguistic perspective, sign metamorphosis is a one-way street of signs starting as indices or icons, and ultimately becoming symbols at the end. [11] This may be the case when looking at language and writing, but it does not necessarily apply to digital interactive systems. When users interact with interfaces, they continuously interpret visual and auditory signs emitted by the system. These signs follow the logic that has been encoded into the system by the system's designer, but whereas repetitive use in the analogue world leads to symbolification of signs, in digital interactive systems it can also lead to *indexicality*. Whatever sound is used as an alert sound, it will soon become an *index* for error, for it only needs to be repeated often enough. This works even with the most arbitrary sounds, like a frog croak or a simple artificial beep. In section 4.1 we learned that an index is based on a *causal* relation. So, does that mean there are causal relations between interaction events and the corresponding visual or auditive signals? Most definitely not in a 'natural' or physical sense. However, in the perception of the user, it makes no difference if a feedback sign is determined by physical parameters when interacting with the real world, or if it is triggered by the user's interaction with the virtual world – determined by man-made algorithms. The only required condition that leads to an indexical sensation is *perceived* causality. When a user *always* hears the same sound when trashing something, and when it is *never* heard when the trashcan is missed, then this sound quickly becomes an *indicator* for trashing – independent of the sound's features and qualities. In the user's perception, his or her activity in the computer model world *causes* the feedback sign. It is reproducible and predictable, and therefore causal and indexical.

6.4 Indexicality: Digital naïves, digital immigrants, and digital natives

When Nadin published his article on interface semiotics in 1988 [18], graphical user interfaces (GUI) were still new and unfamiliar to most computer users. Computer users being confronted with iconic representations of files, folders, printers and trashcans on a computer screen, correctly conceived these icons to be *representations* of real objects. Icons were perceived consciously as signs that replace digital, symbolic, and invisible code. Users were very aware that the desktop metaphor is a *metaphor*, and that it was there to facilitate using computers – with the exception of pocket calculators they were the only digital product of the period. GUI users had but little computer experience, they were digitally naïve. In their everyday language, 'files' and 'folders' denoted physical objects

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made of paper and cardboard. By contrast, today's young adults grew up with digital products. Digital natives do not conceive the computer model world as a representation of an office or anything. [22] Depending on their age, they were most likely unaware of cardboard folders before they encountered the corresponding representations on screen. As a result these representations have never been perceived as such by these users. Due to the lack of knowledge of the originally depicted objects, digital natives are quite likely unable to construct any similarity. For them, 'icons' are just arbitrary symbols.
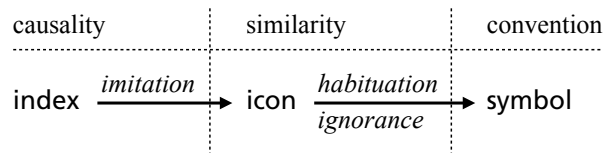

Figure 10: 'Standard' sign metamorphosis.

In addition, *digital immigrants*, who did not grow up with digital technology but have adopted it, may also develop indexical perception by continuous use. When the digital model world behaves consistently over long periods of time, and when user interaction triggers predictable and reproducible feedback, then a user will soon internalise feedback signs and consider them as *indicative* for his or her actions. In this way signs that were once consciously conceived as representations of something, become quasi-natural index signs. In the actual world, feedback is 'created' by the natural law of physics. In the digital world, feedback is caused by the laws of human-made algorithms. Once these algorithms are implemented, these signs are determined absolutely by the user's interaction and the algorithms – and the interface signs can be internalized as if they were 'natural'.
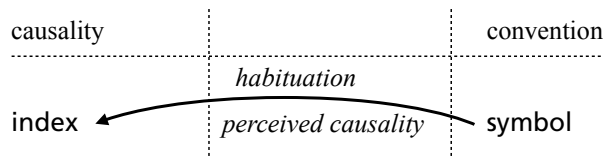

Figure11: Digital sign metamorphosis: Indexicality by habituation and perceived causality.

7. Conclusion

In linguistic theory, sign metamorphosis has been described as a one-way street towards abstraction: An iconic sign will 'wear off' over time and become a conventional symbol. In contrast to this, today's multi-touch interfaces of smartphones and tablet PCs seem to foster an opposing trend by featuring highly iconic representations of real objects. This raises the question, what kind of functions do these detailed representations actually fulfil today. The purpose of real world representations cannot simply be the same as was the case in the 1980s. Although real life metaphors helped to understand computer use in the early period of GUI, today this didactic function appears to be obsolete. For digital natives, the digital model world is not a model or a representation anymore – it feels just as real as the rest of the world. Digital products are ubiquitous today. Hence, users make assumptions about how digital products can be operated and controlled based mainly on experience with *other digital interfaces*. Only on rare occasions, does this knowledge continue to be derived from interaction with physical everyday objects. For users that have grown up using digital media, the discrimination between knowledge from the analogue world and knowledge from the digital domain appears antiquated and obsolete. For the 'digital native' user a double click is more familiar and feels more natural than climbing a tree or peeling an orange. [19]

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Hence, a semiotic explanation of the digital native phenomenon could be subsumed as a sign metamorphosis taking a shortcut from symbols directly to indices. The concept of iconic similarity between virtual objects and real life objects has lost its informatory function. What remains is the predominantly emotional or nostalgic function of hyper-realistic interfaces, which are rather more a subject of fashion – and no longer that of learnability. Being subject to the moods of fashion, wooden bookshelves, chrome-plated record players, and leather-bound books may too disappear again – thus sharing the traditional faith of iconic signs in a cultural process leading towards abstraction and symbolification.

Addendum: In June 2013 Apple introduced the new interface design for its mobile devices. As discussed and expected beforehand [8] it abandons the use of faux leather, felt, chrome, and wood veneer in favour of a more abstract, graphic design language. [4] Even if it did not serve as a didactic means this time, but merely as a sensual attraction for the purpose of introducing an audience of novices to a new interface paradigm: once again the real life metaphor has done its duty and can be dismissed. From the point of view of sign metamorphosis, this development seems to be both conclusive and appropriate. Or, if you will – 'it's only natural'.

References

[1] Andersen, P. B. (2001) *What semiotics can and cannot do for HCI*, In Knowledge Based Systems, vol. 14, no. 8, Elsevier, pp 419–424.

[2] Andersen, P. B. (2002) *Dynamic semiotics*, In Semiotica 139, vol. 1, no. 4, pp 161-210.

[3] Apple Computer (2011) *iOS Human Interface Guidelines*, Available at http://developer.apple.com/library/ios/documentation/userexperience/conceptual/mobilehig/MobileHIG.pdf [Accessed 24 March 2013]

[4] Apple Computer (2013) *iOS 7,* Available at http://www.apple.com/ios/ios7 [Accessed 11 June 2013]

[5] Bense, M. (1971) *Zeichen und Design*, Agis, Baden-Baden.

[6] Blackwell, A. F. (2006) *The reification of metaphor as a design tool*, In ACM Transactions on Computer-Human Interaction, vol. 13, no. 4, pp 490-530.

[7] Brown, P. (1994) *The Ethics and Aesthetics of the Image Interface,* Computer Graphics, vol. 29, no. 1.

[8] Chatfield, T., (2013) *Apple: An end to skeuomorphic design?* Available at: http://www.bbc.com/future/story/20130509-apple-designs-break-from-the-past. [Accessed 9 June 2013]

[9] Laurel, B. (1990) *The Art of Human Computer Interface Design*, Addison Wesley, Reading.

[10] Gibson, J. J. (1979) *The Ecological Approach to Visual Perception*, Houghton Mifflin, Boston.

[11] Keller, R. (1998) *A Theory of Linguistic Signs*, Oxford University Press, New York.

[12] Krippendorff, K. (2006) The Semantic Turn – A New Foundation for Design. Taylor and Francis.

[13] Lakoff, G., Johnson, M. (1980) *Metaphors We Live By*, The University of Chicago Press, Chicago.

[14] Microsoft Windows Phone Dev Center (2010). Principles – The foundation that drives our design. from http://dev.windowsphone.com/en-us/design/principles, accessed 2 June 2013

[15] Morris, C. (1939) *Esthetics and the Theory of Signs*, In The Journal of Unified Science, vol. 8, no. 1/3, pp 131-150.

[16] Morris, C. (1964) *Signification and Significance: A Study of the Relation of Signs and Values*, MIT Press.

[17] Morris, C. (1971) *Writings on a General Theory of Signs*, Mouton, The Hague.

Consilence and Innovation in Design - Proceedings and Program
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5th International Congress of International Association of Societies of Design Research

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[18] Nadin, M. (1988) *Interface Design and Evaluation – Semiotic Implications*, In Advances in Human Computer Interaction, vol. 2, pp 45-100.

[19] Oswald, D. (2011) *Touch Interfaces – between Hyperrealism and Invisibility*. In Proceedings of ISEA 2011.

[20] Oswald, D. (2012) *Non-Speech Audio-Semiotics: A Review and Revision of Auditory Icon and Earcon Theory*, In Proceedings of ICAD 2012, pp 36-43.

[21] Peirce, C. S. (1956) *Logic as Semiotic: The Theory of Signs,* In The Philosophy of Peirce: Selected Writings, Routledge & Kegan Paul, London, pp 98-119.

[22] Prensky, M. (2001) *Digital Natives, Digital Immigrants*, In On the Horizon, MCB Univ. Press, vol. 9, no. 5.

[23] de Souza, C. S. (2005) *The semiotic engineering of human-computer interaction*, MIT Press, Cambridge.

[24] Stamper, R. (1993) *A Semiotic Theory of Information and Information Systems*, Invited papers for the ICL/University of Newcastle Seminar on 'Information'