The phenomenology of getting used to the new: Some thoughts on memory, perception, numbing and the Zen-View

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Abstract. In this text I set out to reflect on the relationship between human perception and the usability of some designed artefacts. Beginning with own observations the text looks at the relationship between two phenomena: The ease with which we perceptually desensitise to conditions of our environment such as designed artefacts, and secondly, the designerly dilemma of innovative artefacts, that create an undeserved sense of trust that may result in unintended effects. It shows how these two phenomena are intrinsically linked to what the neuro-sciences describe as learning. Subsequently the text will look at several strategies that aim at preventing this type of adaptation. The text concludes with an example of a semantic designerly mapping that sustains the experience of initial surprise and prevents the effect of numbing. The paper argues that designers could benefit from a better understanding of the dynamics of human perception in order to inform design research methods and design education to consider these perceptual processes. The primary goal of this text is to create a debate around these phenomena and show their relevance to design problems.

Keywords: usability, human-factors, phenomenology, design research, design semantics, design methods

1 Introduction

In 2006 Klaus Krippendorff created a comprehensive definition of design semantics that consited of two distinct parts. The first part of his definition describes design semantics as *"A systematic enquiry into how people attribute meanings to artefacts and interact with them accordingly."* [1] The second part as *"A vocabulary and methodology for designing artefacts in view of meanings they could acquire for their users and the communities of their stakeholders.*" [1] The following enquiry attempts to investigate the relationship between his first definition, "how people attribute meaning to artefacts and interact with them" and a phenomenon which media art historian Oliver Grau describes as an audience over time *"harden[ing] to [a technology's] attempts at illusion*" [2]. This paper tries to investigate the relationship between these two states: How people create meaning from and interact with artefacts, and the effect of 'hardening' or numbing to a technology.

Computer Scientist Paul Dourish writes in the context of interaction design: *"Meaning is an aspect of use, interaction and practice, it is something that resides primarily in the hands of the user, not of the designer."* [3] It appears that the most a designer could do was suggest a meaning, and it was the audience's choice to accept that suggestion or construct their own. Maker and user may have very different perceptions of what an artefact means.
Krippendorff's first definition is about about semantics, the study of meaning. His second definition is about design semiotics, the study of signs. With the first definition the focus widens from the narrow field of a designer's repertoire of signs or what an artefact intends to communicate, to people's perception and how they view and use an artefact. This is a radical shift in focus when we think of design from the perspective of a rational engineering tradition. It moves the perspective from the relatively confined, clear, and safe terrain of methodically vindicating an artefact's properties by referring to an established design vocabulary into the much wilder, more complex and irrational world of how different individuals make sense of and construct reality. Traditionally this had been primarily the concern of fields such as philosophy, psychology, the social sciences or ethnography. So how do designers find out what is going on in peoples minds when these engage with their artefacts? The rising popularity of qualitative design research methods, such as participative methods that involve stakeholders or various interview techniques, may be an indication for the growing acceptance of these systematic enquiries and their benefits.
The focus of the following discussion is located between these domains, people's perception and the surprising ease with which we become desensitised - or numb - to environmental conditions in general, and specifically to new technological artefacts. The text demonstrates some of the effect's negative and positive dimensions and introduces various multi-disciplinary strategies to contribute to a designerly debate.
The text will make use of the terms desensitised, numbing and perceptual adaptation synonymously, in the sense of a person's lack of conscious awareness of an environmental condition.

1.1 Numbing to the new

I would like to begin with two personal observations that I made, and which lead me to the insight that human perception is more complex then we might assume and that as designers we need a better understanding of how we humans process our environment and engage with artefacts.

My first example concerns watching the music video "Out of Space" [4] by the band Prodigy from 1992. When I watched this clip for the first time in 1992, I perceived it as being of unprecedented speed and without narrative. In my memory this 4:23 min video consisted of a very rapid succession of short haphazard video sequences of low quality, juxtaposed in no clear relation to one another and edited at unprecedented speed. Watching the same video again in 2010 was a very different experience: Not only did it appear much less rapid and haphazard then remembered, but its speed was perceived as not very different to contemporary television advertisements targeted at a mature audience. It appears that either my memory is unreliable or my perception has adapted over time without my conscious awareness.

This leads to the conclusion that the average video today may be edited faster then avantgarde videos were in 1992. I discussed this observation with peers and several agreed that they had had similar experiences. Conclusive evidence would require to compare quantitative formal properties of a selection of relevant historical videos to contemporary music videos, consisting of properties such as cuts, editing-speed, beats per minute, visual effects, colour saturation, camera movements, zoom effects and their simultaneous combination. However there appears to be some indication that a style of "radically novelty" has the power to surprise temporarily only and that our perception adapts over time leading to an increasing rate of stronger effects for music clips to capture our attention.

Related to the experience above is the second example, which is about another aspect of memory, about the disappearance of something quotidian from conscious perception. I believe many will have experienced surprise and disbelief upon the inability to remember the distinct appearance of a familiar building that has been demolished. Although, we may think, having passed by this building in the past, countless of times we may have difficulties to remember what it looked like. In our memory we may have a vague recollections of its height and shape but we cannot clearly recall details, especially if the building has no personal relevance to us. We may wonder how this happened, and why, despite having passed by it so many times, the building's details have disappeared from our memory? Such an experience questions the accuracy of our memories and our cognitive capacity to recall familiar environments. In that respect these experiences are deeply unsettling as they demonstrate that there are 'blind spots' in how we perceive and remember the world around us.

Paradoxically it may exactly be this process of repeated exposure unassociated with a salient personal experience that can be seen as the cause of this process of erasing it from our conscious awareness and memory. Neuro-scientist Wolf Singer writes about this filtering process: *"We see, what is useful to see."* [5] Apparently if seeing the building is not 'useful' and nothing attracts our attention from its busy urban context, we cease from actively perceiving it. It blends into the background until a change may attract our attention again, such as when it has disappeared.

The opposite takes place when we visit a town for the very first time. While we still orient ourselves we will experience it in great richness and detail. Everything is perceived as new and unfamiliar. This ephemeral outsider's perspective allows us to experience the place in a manner very different to that of the town's permanent residents.

What combines the two observations? In both cases the perception of an artefact changes over the passing of time. The novel and highly unconventional form of a music video begins to appear conventional (tacitly compared to the context it emerged from), while the familiar memory of a building in fact is not familiar and not memorised.

How are these two observations relevant for art and design? Knowledge of such perceptual processes may be invaluable and inform our processes of conceiving and making. We now know that novelty soon wears off and that details of artefacts we do not use regularly are forgotten although we are not aware of this process. It appears to be a property of our perception that we become 'blind' to conditions of our environment that are not important or significant for other reasons.

Media artist David Rokeby observes: "It seems that we stop seeing, hearing, smelling as soon as we have positively identified something. At that point, we may as well replace the word for the object. Since identification usually happens quickly, we spent most of our time not really sensing our environment, living in a world of pre-digested and abstracted memories." [6]

Why does this desensitisation happen? How do we get used to things so easily? From an evolutionary perspective it may be crucial: Our attention does not remain locked upon the known and familiar, but is captured instead by the new and unusual. Would we, for example, continuously be aware of the sensation of our clothes on our skin we would have difficulties paying attention to more important events.

Is this, from a design perspective, a beneficial or an adversarial effect? Of key relevance appears to be the fact that this process is regarded as an important part of how intelligent beings learn when directly engaging with a new condition. *"When a new event is perceived it is first treated as a novelty, with either a positive or negative reaction. Then the novelty is replaced by an expectation. This is the basis of learning. When the expectation is not met, there is the accompanying emotion of disappointment or even anger or frustration."* [7] Tom Mitchell, Chair of the Machine Learning Department at Carnegie Mellon, researches [8] the physiological processes between the brain and the central nervous system. He describes that, while initially an event receives attention *because* it is recognised as a *new* type of event, in a repeating encounter this curiosity and conscious attention is replaced through an *expectation*. Our perception is economical and selective in what reaches our consciousness. Speed of processing is given primacy over accuracy. Once we have learned how to use a new artefact, the novelty factor has worn off and we have certain expectations of what it affords. A continued treatment as novelty could be regarded as a result of amnesia, a loss of memory, whereas the ability to recall it in all its detail would be a case of eidetic memory, another medical condition in which photographic recollection of complex visual detail, so called eidetic perception [5], is seen as the result of a higher brain dysfunction.

There is evidence that numbing to the novelty factors of artefacts is part of how intelligent beings learn, especially to engage with technology in a continuously changing world. Numbing in fact is a useful function of learning would perhaps better be described as adapting. It allows our brains to adapt to change fast so that our limited attention is free again to select those signals that should be processed with conscious awareness.

What is the relevance of these neuro-scientific insights for designers? During the process of learning the artefact's initially novel and intriguing capabilities gradually diminish behind their utilitarian functionality. In the beginning it may require time and effort to master the complexity of, for example, navigating the web with a web-browser application, but over time people gradually master this activity almost intuitively. In fact they may become so adapted to the browsers affordances that these soon are perceived as a precondition and they become reliant upon them, similar to an intuitive tool that disappears from conscious perception once one has become accustomed to it. Then the initially new technological artefact may become seamlessly integrated into a lifestyle.

Though, if our expectations are not met, and for example the Internet connection is not working as expected, we will probably get frustrated. From a usability perspective this seamless integration is a best-case scenario and a sign for a successful design.

However, while in some cases this process of perceptual adaptation may be beneficial, as in the effortless handling of computer mouse and web-browser and their seamless integration with short-keys that provide short-cuts for so called power users, this process of adaptation is not always desirable. Such an example would be the adaptation to speed for the driver of a car on the motorway. While driving the driver will adapt to the speed relatively higher then on conventional roads. When exiting the motorway the driver may seriously underestimate the remaining speed, and the car wont be able to stay on the tarmac. Unless the car is equipped with assisting technological features that automatically decelerate and control traction the car may leave the road behind. Many motorway exits show signs of motorists underestimating their speed. So while in some cases perceptual adaptation is convenient and even pleasurable there are critical individual exceptions.

From a design perspective this is another dilemma. While in most circumstances we want our designs to be most effective, there are certain cases when they prove too successful. To demonstrate the relevance of this as a designerly dilemma this paper will use two examples to illustrate the context, followed by a selection of strategies, some developed by other disciplines, that aim at preventing people from numbing their conscious awareness. While the paper is mostly concerned with research into interaction design, these examples include domains such as computer science, architecture, philosophy, spirituality, industrial design, fine art and psychology.

1.2 Example 1: The surrender of driver's responsibility to satellite navigation systems

Shortly after satellite-navigation systems were introduced in cars in the early 1990's media reported the first accident by a driver who had blindly trusted the system and driven consciously into a river. The road had wrongly been assigned by the system as being equipped with a bridge while in fact a ferry service connected the two sides. Since then many of these types of accidents have happened in which motorists followed the instructions of satellite navigation systems without much conscious critical awareness. In this we see an example of how a technology can provide a false sense of reliability and safety. What makes drivers suspend common sense and completely trust a technology? What is taking place during this process?

From a perspective of trust the product is successful. Many users appear convinced of its accuracy that they trust it blindly. From a health and safety perspective it is precarious though. Here we have an example of a designerly dilemma. The design functions so well and is perceived as so reliable that many users do not question its accuracy and uncritically follow its instructions against common sense. While the responsibility may lie in psychological factors of the users this also is a design problem. What could be a design solution? The producers of these systems experimented with different male and female voices and text messages that remind drivers that *they* were driving, not the system. Yet, the problem still persists after two decades. Many communities in countries in which Satellite Navigation systems are

common, have installed warning signs along designated spots that warn not to follow satellite navigation systems. While some of these signs are vernacular and hand-made, below is an official example from Britain installed by the city of Colchester after a number of traffic accidents in which trucks got stuck in a narrow street.

Without such as system many drivers would probably become aware of the hazard in time. Yet trusting the system, their awareness or alertness is somewhat suspended by the sense of reliability acquired while adapting to the system.

Figure 1: "Do Not Follow Satellite Navigation" road sign in Colchester, United Kingdom, 2007, (CC license from Unhindered by Talent@Flickr)

1.3 Distraction: Dividing attention between mobile devices and primary tasks

Other examples include users of mobile phones. Figures show that many humans have difficulties multitasking and diving their attention between several activities at the same time. As a result of road accidents related to mobile phones many countries have prohibited their use for motorists while driving. There is no legislation in place yet for pedestrians, although these are involved in mobile phone related accidents as well. Recently a pedestrian in New York City was in the news having fallen into an open and unsecured manhole while typing a text message on her mobile phone while walking along a sidewalk. [8] This example may be less a design problem then plain frivolousness but it shows that we have difficulties multitasking.

Like Yin & Yang, the car introducing the car accident, technological disasters are out-innovated by new technical inventions, an arms race of design solutions leading to a continuously operating pyramid scheme of innovation mitigating old problems while causing new ones.

For the owners of iPhones there is an application that aims to ameliorate the dangerous implications of typing while walking. The application "Type n Walk" [9] uses the built-in camera to augment a live video feed behind a screen-based mode for writing. This live perspective of the view ahead allows the user to focus on the screen

while typing and walking simultaneously, without having to divide the attention between the screen and the immediate path ahead. In its unique use of augmentation "Type n Walk" resembles telepresence, where people have the experience of leaving their local space and their body behind to feel present at a remote or virtual location. In this detachment from the physical world "Type n Walk" reminds of such a technologically induced out-of-body experience.

Figure 2: "Type n Walk" screenshot of iPhone application demo video by 'Type n Walk," which augments a live video feed from the built in camera in the background of the typing area. This allows to pay undivided attention to the screen and watching the immediate path ahead at the same time.

While this design solution aims at making texting safer and easier by being less distracted, there must be areas which require the opposite: Making the use of an artefact less easier but more difficult. In this area designers will consciously implement features that make the use of an artefact more difficult so that it requires the users full attention. In which domains would this be useful? Where do designers consciously design so users do not too easily adapt to an affordance? Where is it necessary not to numb but to stay aware or even alert? In this context safety critical artefacts such as child proof cigarette lighters and containers for hazardous materials such as medicine bottles or household chemicals come to mind.

2 Strategies against perceptual adaptation, which support conscious awareness and reflection

Our brains adapt to change with surprising ease and speed. This innate ability enables most of us to adapt successfully to a fast changing and complex technological world. On a daily basis we learn how to use new operating systems, new interfaces of game consoles, remote controls, mobile media, vending machines and atm machines. This change also entails mirroring social and emotional involvement via image, link, or

video sharing tools such as Flickr, Twitter, Youtube, Delicious and Facebook, via desktop computers and mobile devises. While most of these media and their interfaces have not been around a decade ago, they have become intrinsic parts of the lives of many. Effort has been made on both sides, by the makers and the users. These media have been designed with great care with, to paraphrase Krippendorff, 'a vocabulary and methodology for designing in view of meanings' but the design has been 'completed' by people's adaptability to 'attribute meaning from artefacts and interact with them.' Over time attributing meaning to an interface requires less conscious effort and is becoming a more deeply engrained ability.

In some critical circumstances the ease with which technology allows us to perform is deliberately impeded, some computer systems for example require to re-confirm critical activities such as deleting files or spending money during online transactions. Here designers have purposefully made an operation more complex then necessary in order to interrupt the flow of activity with the aim to receive the users conscious attention during performing their decision. From a designerly perspective we have to ask ourselves where it is necessary to hinder and interrupt a sequence of activity to enforce a moment of conscious awareness if not reflection? What could strategies in support of conscious awareness and reflection look like? Where are they useful and where are they not?

What follows are selected examples from different disciplines that argue in favour of reflective mental states and conscious awareness. Their strategies either sustain or regain a mental state of conscious awareness or they require conscious effort to perform a task. The first applications coming to mind are cigarette lighters with so called "child resistant" features. Their function as a lighter is purposefully made difficult in order to prevent children from being able to start a fire. The designerly solutions for these lighters are manifold and range from intricate covert mechanisms to rather unsophisticated triggers that simply require the brute dexterous force of an adult's hand to be activated.

In 2006 computer scientist John Lenaric published "The antiusability manifesto" [10] in which he argues that usability was not always desirable for ethical reasons. His rationale of ethics can be interpreted as being located in two domains. On one hand it was ethical to allow users a conscious awareness in regard of choice and options. Lenaric writes *"To be automatic undermines one's opportunity for reflective choice",* thus emphasising the act of individual reflection and conscious control. The other domain is to encourage to design for a change of behaviour. *"The way one is compelled to use any device by virtue of its design can modify the behaviour of a user for better or worse. They can be either features or obstructions or both."* For the latter idea we can easily see an application in artefacts which display their consumption of energy, thus alerting users to conscious economic behaviour and sustainable conduct. Here the ethics can be interpreted as encouraging a change of behaviour as a result of increased transparency allowing reflective choice. Shying away from 'automatic use' may be an important requirement in future applications to save energy or resources. An elevator, for example, could recommend using the stairs and voice the number of calories that would be burned during this process.

Another approach was chosen by Lars Hallnäs and Johan Redström in their text "Slow technology: Designing for reflection" [11] published in 2001. Although emerging out of a computer science context their concept pertains to virtual as well as

physical artefacts. Their reasoning is that as technology was increasingly extending beyond the workplace out into peoples everyday lives, efficiency was not always a necessary requirement. Their concept encourages states of reflection and contemplation over efficiency and performance by emphasising two factors: Slowness and aesthetics. The slowness necessary to consciously reflect on a process, for example in a learning situation, and the aesthetics of interaction, which emphasise phases of transition. The authors point to architecture and interior design as examples of disciplines with more holistic views that take a whole environment into account. At the heart of their enquiry appears to lie an idealistic view of design that it should support the quality of life.

Through the ubiquity of high quality screens in mobile devices it is possible to see support for their claim for aesthetics. Highly aesthetic transitions, visuals and finely rendered typography are becoming standard 'eye candy' on ebooks and mobile applications. These may not be comparable to qualities of the natural world but add an emotional and pleasurable property to the interaction with digital devices in their own right.

An architect's strategy against adaptation is introduced with Christopher Alexander's "Zen View" [12] presented as pattern 134 in the text "A Pattern Language." Alexander writes: *"If there is a beautiful view, don't spoil it by building huge windows that gape incessantly at it. Instead, put the windows which look onto the view at places of transition- along paths, in hallways, in entry ways, on stairs, between rooms. If the view window is correctly placed, people will see a glimpse of the distant view as they come up to the window or pass it: but the view is never visible from the places where people stay."*

The pattern's title alludes to architectural features recorded in monasteries. Often located in spectacular geographical settings allowing highly aesthetic vistas upon the landscape they often are architecturally inward oriented and surrounded by high walls. This constrains the perspective upon the surrounding environment during many activities.

Alexander's method requires little effort from its users. All thought and critical reflection has been put into place by the designer in a top-down manner. It is based upon the simple yet highly effective principle of limiting exposure to an aesthetic experience. It is temporary and ephemeral in nature and the combination that the experience may be the unexpected result of a mundane activity seem to contribute to the quality. As a result it is possible to enjoy the experience over and over again.

This principle is also applied to artefacts that reveal an unexpected aesthetic side in unexpected moments. Examples would be software error messages in rhyme form, a colourful fabric inside an otherwise very formal jacket or the fine detail of sculptures on buildings that cannot be seen from street level. Becoming aware of the aesthetics and attention to detail in unexpected moments creates such an experience of the 'Zen View.' The principle works by radically limiting exposure.

Media artist David Rokeby describes another method that succeeds through enforcing the opposite, an over-exposure:

"I had an experience in art school[…]. One of my professors told us one day that we would be looking out a window for the whole three-hour class. I was incensed. I'd been willing to go along with most of the unusual activities these classes had entailed,

but I felt this was going too far. I stood at my assigned window and glared out through the pane. I saw cars, two buildings, a person on the street. Another person, another car. This was stupid! For fifteen minutes I fumed, and muttered to myself. Then I started to notice things. The flow of traffic down the street was like a river, each car seemingly drawn along by the next, connected. The blinds in each of the windows of the facing building were each a slightly different colour. The shadow of a maple tree in the wind shifted shape like some giant amoeba. For the remaining hours of the class I was electrified by the scene outside. After fifteen minutes, the "names" had started separating from the objects." [5]

The method experienced by Rokeby appears to be related to Eastern spiritual thought and meditation such as described in "Zen mind, Beginner's Mind" [13] or "The Miracle of Mindfulness" [14]. Both texts introduce pragmatic methods to sustain states of conscious reflective awareness. Rokeby's method is based on over-exposure and is time consuming. It allows to regain a temporary outsider's perspective upon a well known scenery and can possibly be also applied to interactive scenarios.

The final examples emerged from a computer science background and are by William Gaver, Steve Benford and Jake Beaver. Their three ambiguities of design, described in detail in their 2003 paper "Ambiguity as a Resource for Design," [15] appear as three broad classes: Ambiguity of information, ambiguity of context and ambiguity of relation. They regard ambiguity as a rich resource for designers to encourage close personal engagement with systems. In their paper they analyse existing artefacts originating from art as well as design and describe tactics for emphasising ambiguity that may help to understand and craft its use. They see the advantages of ambiguous artefacts as experiential factors, that make artefacts intriguing, mysterious and delightful. *"By impelling people to interpret situations for themselves, it encourages them to start grappling conceptually with systems and their contexts, and thus to establish deeper and more personal relations with the meanings offered by those systems."* [15] Their rationale is also based upon the observation that digital technologies are increasingly used beyond the workplace in everyday life where efficiency and usefulness are not primary concerns. They conclude: *"Ambiguity of information impels people to question for themselves the truth of a situation. Ambiguity of context can question the discourses surrounding technological genres, allowing people to expand, bridge, or reject them as we see fit. Ambiguity of relation, finally, can lead people to consider new beliefs and values, and ultimately their own attitudes. In each of these cases, ambiguity frees users to react to designs with scepticism or belief, appropriating systems into their own lives through their interpretations."* [15]

To an extent design is taking on methods traditionally associated with the arts. Art often gains its power through its ambiguity and openess to different interpretations, while design mostly strives to be clear and intuitive. While art asks questions, design provides answers to clearly defined design problems.

2.2 Case study: Design semantic's & ambiguity of information in Webpresence

In 2008 I began research on "Webpresence" [16][17], a project that indicated visits

to the project website through a physical display in the office space. It was thought to add an experiential quality that would add a sensual dimension to otherwise abstract asynchronous website statistics. Three different displays were tested with varying results. An LED as display provided an unambiguous indication of a new visitor to the website but quickly lost its quality to delight within hours of installation. Additionally its semantic mapping of a blinking light was perceived as too haphazard and unrelated to the event of a visitor arriving. The second display, a miniature vibration motor, reminded of a doorbell. Semantically this was more appropriate yet the resulting sound was perceived as too disruptive and interfering with primary tasks at the workplace. The most felicitous mapping consisted of a curtain actuated by a silent fan. Semantically it evoked a visitor opening the door and causing a draft which in return would gently billow the curtain. Conceptually this approach mapped the virtual location of the website onto the physical location of the office, thus merging both formerly disconnected spheres in a one-way connection. Surprisingly this poetic display did not loose its appeal over time. It avoided the effect of adapting to it through exposure. Which properties of the display prevented this effect?

As the motion of the curtain was perceived as very natural and the fan was completely soundless, its function as a display was ambiguous. It was necessary to distinguish if it billowed as a result of a natural draft or a draft caused by the fan. This required to reconfirm its cause by a quick glance if someone had entered the room. In these properties it resembled the ambiguity of information described above. Gaver (et.al.) write that *"they require users to fill in the gaps in information that is purposefully imprecise. When successful, such interfaces are not only aesthetically attractive, but conceptually appealing as well."* [15] As a result it is almost impossible to adapt to the billowing curtain indicating a new visitor to the project website.

Discussion and conclusions

As this investigation has shown the relation between perception, numbing, learning and the semantics of artefacts can be seen as a dynamic and paradoxical one. To numb, to learn and to adapt can be regarded as related aspects for human ability to successfully adjust to a continuously changing world. One way of viewing the overly negative association with "numbing," is that we are very successful in learning and adapting to change, to integrate one experience and thus be ready for the next salient event.

The text introduced several design research examples that can stimulate users conscious awareness and thus may prevent numbing, among them: Opportunities for reflective choice, opportunities for change of behaviour through information and communication, a combination of features and obstructions, slowness and aesthetics, radically limited exposure while performing primary activities, radical over-exposure excluding any other activities, and finally three ambiguities as design resources: informational ambiguity, contextual ambiguity and relational ambiguity.

By expanding these strategies to involve users and capture the ways of how people create meaning, this could provide valuable contributions for a better understanding of

the semantic dimensions of artefacts. This knowledge could again prove useful to inform the semiotic model of design theory.

Additionally we need a better understanding of the process of perception. This includes processing and memory: How we process our environment and how we remember experiences, as both are intrinsically linked to how we create meaning. This knowledge could be used to inform or analysis of own empirical data gathering in combination with bottom-up iterations of artifacts, created in participation with stakeholders and their needs.

Nevertheless, the ease with which we become accustomed to new artefacts may also have aesthetic dimensions determined by designers, and, not restricted to safety critical processes, these dimension may benefit under certain conditions, from a conscious awareness expressed through their design. The need for this could be seen in the designerly dilemma of people overly trusting technology against common sense, or frivolous behaviour, which again may have an appropriate design solution.

Perhaps it would be worth investigating some of the strategies above, such as ambiguity, in devices that have safety critical roles, as, for example, a car's accelerometer, this would not render the device 'unreliable' but require regular confirmation of their accurate operation. A state in which the perception of an artefact shifts between ready-at-hand (zuhanden) and present-at-hand (vorhanden) depending on the circumstances – yet without adding another layer of complexity.

Informing the critical empirical design explorations by theory of the cognitive sciences could help to create better design research methods, inform design theory and may also benefit design education.

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