The Analogue strikes back:

freshly squeezed touch into bits

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Abstract

Haptic interfaces are felt by many to have the potential to enhance communication and interaction via the computer - enabling affective expressive interpersonal communication and enriching interaction with virtual worlds by haptic feedback.

Still, what exactly this potential is and how we can design in order to fully appreciate it is topic of contemporary debate. My contribution to this debate shall be to place some of the current developments into a philosophical and cultural context, to introduce social science based methodologies which will hopefully help broaden the discussion, resulting in a greater scope of input (from other disciplines). Through semiotic analysis we can predict meaning making in haptic communication. The Haptic Box study demonstrates our cultural associations with textures. The PinKom study investigates spontaneous forming of communication codes with a low-tech haptic device.

Haptic, Communication, Semiotics, Affect, Social, Culture

Introduction

Haptics: a Philosophical Perspective

When designing and reflecting on our designs for the Haptic sense, it is important to consider philosophical implications and precursors for our efforts. The way we approach a subject can tell us a lot about our general ideas about our place in the

universe. Becoming aware of our boundaries might enable us to push them outwards or even step outside of them.

As we all know the sense of touch is incredibly complex and there are not many explicit philosophical writings on the subject. Renee Weber [1] has attempted this in a chapter dedicated to the philosophy of touch, by drawing on more general ideas about the human mind, body and soul. She introduces three models that are generally used to define the human being and applies them to touch: the physical-sensory model, the psychological-humanistic model and the field model. After introducing her mappings, I would like to place different strands of developments in Haptic research as I see them fit into her descriptions.

Physical-Sensory Model

The physical-sensory model as Weber puts it "fits the aims and assumptions of Anglo-American philosophy" and is mainly interested in touch as pure contact, made up of sense impressions. In this model, touch is used for contact information and functions cognitively, like sight or hearing would.

This utilitarian approach can be found in Haptic tools designed for sensory substitution. Here, the haptic device acts as a replacement of eyes, hands and ears to provide information to us - for example when working in hazardous or hard to reach environments (e.g. drilling under the sea, performing minimally invasive surgery, digging on the moon). Also, haptic assistive technologies for people with disabilities can be classed in this category. Another example for devices using touch as "sense-impressions impinging on sense-impression, mediated perhaps by some neurologically complex mechanism for registering and encoding them" are haptic tools for sensory augmentation, which help improve usability factors like effectiveness, efficiency and satisfaction (e.g. adding vibrotactile feedback to reduce task completion time and errors, helping user navigation). The design materials available for this approach are usually based around simulation and a reproduction/carbon-copy of reality: realistic attributes and multiplexing of information are key features. At the moment, it seems to me that projects that fall into this group are less appropriate for semiotic analysis.

Psychological-Humanistic Model

Weber classes the second model, the psychological-humanistic model, as expressing "the concerns of contemporary European philosophy, especially phenomenology and existentialism" and it assumes that we can use touch to reach and communicate with another person. In this case touch functions to create a connection, a trigger for emotions, ideas and images. This approach can be found in projects aiming to facilitate communication of affect, presence and personal expression. The designers here usually work with symbols, metaphors and intuition.

Field Model

The third model, the field model, is thought by Weber to "harmonize with Eastern philosophy and its holistic world view". Gradually, as western science is moving from empiricist, dualistic standpoint to accept theories of unity and interconnectedness like relativity theory and quantum mechanics, this can also be felt in the design of human machine interfaces - moving away from a limited and reductionist interaction to an integrative and synthesizing, embodied one. The field of Haptic research is one such pointer supporting this development.

> "To treat a holistic sense such as touch within a reductionistic framework seems problematic to me; to see it as an expression of a general holistic framework is more consistent and philosophically more appealing. On these grounds, as well as others, the field model of touch strikes me as the most interesting and promising one" [1, p. 15]

So, among a more general urge in Human computer interaction research for embodiment and added sensuality, among the philosophical conclusion, once again, that the mind and the body may not be separated, and one may perform better in a holistic manner, we find attempts to investigate and create the possibility of communication and interaction via (computer-mediated) touch.

Search for Design Guidelines

There is a general search for classification and coding systems in order to utilize this third sense to be added after the visual and aural. I would like to discuss the possibilities of such outcomes and in which ways we may proceed. Reflecting on my own review and research sums up the problem: everyone seems to have a good "feeling" about this but no one can seem to put their finger on exactly what it is. In other words, it makes sense to everyone that there is value to be added by touch, but why exactly that may be escapes our words so far. The articulation of this paragraph is interesting in itself. It is driving me to think whether this sense can be put into words at all.

In order to design successful messages or message transmitters, it has been said that we have to be able to classify how messages are communicated and split them up into small segments that can be reproduced digitally and mechanically [2]. The question that is now arising for me is whether in an affective analogue design space, it will be possible to identify and reproduce small units or whether it might be more successful to approach the problem in a holistic, rather than a reductionist, manner. The separation of our senses and sense impressions in order to study their workings seems essential in order to consider them as design elements, however sometimes we might consider the person as a whole, sensory apparatus unified and located in a social and cultural context.

Indeed, the current interest in enabling the haptic channel in computer-mediated communication is often centred around the desire to feel "presence" and "affect". Are these social, learned reactions we are trying to arouse - in which case they would be in reach of being classified - or are we, as also often mentioned in research papers, longing for a natural, intuitive, universal language - a lot more primary. This would make the effect more powerful, but it would also mean for the design process that we need to adapt an approach built on personal experience, something like a haptic sketchbook, similar to what set designers, architects and fashion designers are successfully utilising in their work. In addition to that, if we take the "personal" approach, the design paradigm to strive for would be a dynamic range rather than prescribed experiences, a palette of sensations that is individually variable and under the control of the communication partners.

A successful haptic communication device would allow the person using it to evolve their own language and harvest the amazing capabilities of the human

imagination to fill gaps with their own interpretation, built on their own experience.

As we are developing the haptic research and broadening its scope, we are moving from the purely physical-sensory model to the psychological-humanistic and even field model, which will lead us to consider and bring in many other research disciplines that are already dealing with the inherent issues of communicating and relating, of meaning making and intent, attitudes and context.

Haptics: a Cultural Perspective

"Saussure [...] concluded that meaning is not inherent in things,
but is constructed through a social contract" [3, p.119]

Consideration of signs, codes and culture can help us analyze current haptic communication projects and from there develop design paradigms. In my research I consider how we can utilize semiotic theory to help us design and enable meaningful haptic communication. Semiotic theory as one way of analyzing communication assumes a 'self 'and an 'other' who successfully encode and decode messages and create meaning between them. It may not be useful to projects of purposes that fit strictly into the physical-sensory model. Developing a sensor and a tactile display to replace the human hand performing surgery inside the body (which is physical-sensory) must follow the restrictive rules laid out by psychophysics in order to be accurate and trustworthy. Even though the person performing the surgery still has to create meaning for himself based on the sense impression received, this meaning should at the most fit into the logical codes, for which only one way of decoding is possible. For this purpose, no room for different interpretation shall be given and design should orientate itself on the physical reality as much as possible. However, entering the realm of the psychological-humanistic and the field model, we encounter a world of communication where intent and attitude of communication partners is integral to the meaning making process on both sides.

Semiotics

Semiotics is the study of signs and sign systems. Within this theory we as social actors can interpret codes not just limited to language, but apparent everywhere we look. At lot of the terminology is borrowed from linguistics, however it is not limited to this model. A picture, film, object would be a "text" that is analysed by us, the "reader". Cultural theorists speak of the "vocabulary of film" or the "grammar of TV documentaries". Semiotic theory envelops considerable breadth of scope in that it can be used to analyse almost everything, especially in the realm of communication.

Signs

"Briefly, a sign is something present that stands for something absent, as a cross represent Christianity; a sign system, also termed a code, is a collection of signs and rules for their use " [4, p. 16]

A sign, more specifically, is a creation of any sort - poetry, a traffic signal, a gesture - that conveys meaning into the mind of the interpreter. It has two parts - the signifier, the visible, present part and the signified - the invisible, absent, associated part. Signs come in different varieties; three of the most common are the icon, index and symbol. An icon generally resembles the object it points to, the index is part of a larger object and thereby connected and a symbol is arbitrarily chosen or assigned - it doesn't have to have resemblance or any connection to the object. This latter one is often mentioned synonymously with the word 'sign' and is considered as a uniquely human ability - chimps have been known to use symbols, but not to make them. Symbols are also more likely to create emotional responses.

System of Signs - Codes

According to Leeds-Hurwitz we can assume three types of codes that can be classified: logical codes, aesthetic codes and social codes. Later we can apply these ways of analysing to actual examples.

Logical codes

Examples of logical codes (codes used by science) are mathematics, Morse code and interestingly, Braille. Decoding is made possible by explicit agreement, which was evolved deliberately in the community the code is known in. It uses symbols, arbitrarily ascribed and is considered digital as it can be divided into discrete units and monosemic, stands for only one signified and it has only one single decoding. It is denotative as it has a literal meaning.

Aesthetic codes

In contrast to that are the aberrant aesthetic codes (codes used by art) which painting, architecture, sculpture, literature and photography are considered examples of. Here, signs are iconic, based on similarity and the codes are connotative and analogue: the meaning cannot be divided into discrete units. Codes are chosen by individuals and subject to change. Decoding happens by clues that have to be sought out by the interpreter.

Social Codes

Thirdly are the social codes (codes used by society), the ones most interesting to semiotics as they include trademarks, clothing, greetings, food, furniture, objects, games sports and so on. They are also considered connotative, analogical and aberrant, they use symbols with an arbitrary relationship between signifier and signified and they are formed by social interaction. Decoding is made possible by the "unwritten expectations based on shared experiences" [4] or conventional use in other words.

Codes in Haptic Communication

The logical codes are precise and the recipient should always understand exactly the message as it was intended. With the aesthetic and social codes there is always a possibility that something is learned that was never intended or indeed that something is missed. So, it would seem at first that to build a logical coding system for Haptic communication is the best option. This may be the case for

circumstances call for a transmission of messages without loss or interference. However it will lend itself less well to allowing a communication system to evolve and to the sort of communication that has to allow for analogical and connotative content - feelings. Non-verbal communication would be placed in the social coding system.

So, looking at the current attempts to create a logical system for Haptic communication and the struggle to fit this arbitrary, imprecise world into a linguistic model maybe it is of benefit to consider the aesthetic and social codes which some projects undoubtedly already integrate intuitively.

"An important consequence of the theory is that it would be easier to externalize verbal representations through verbal responses [...] similarly, it would be easier to externalize non-verbal representations in a non-verbal way than through verbal responses" [5, p.150]

We can see how logical codes were formed in the development of Braille, Vibratese, the Optohapt and the Optacon. They all aim to discover a set of tactile patterns that can be discriminated, rapidly processed, and easily learned. They either transmit letter shapes directly via vibration or mapped letters to vibration patterns. This, really, is the creation of an artificial language. The real advantage of touch as I see what attracts people to it is the potential of harvesting a 'natural', intuitive language.

Haptic communication researchers often refer to aiming to establish semantics, syntax and grammar for communication. Apart from developing a vocabulary to help subjects describe their experiences [6], the linguistic model might not be as helpful as a semiotic model in what seems mainly a communication of non-verbal cues. If we do need to break down the atoms of communication in order to define building blocks, we might turn to the science of signs. It seems that although people voice their desire to establish logical codes, they naturally draw on aesthetic and social codes that help them design meaning successfully.

Semiotic Analysis of Case Studies

In the next section, I will by examine haptic communication designs that seem very successful in their chosen mappings. By analysing projects that are working

well, assumptions can be made about general guiding principles. The first two case studies looked at are devices for haptic interpersonal communication and the last two are attempts to create structured messages (icons) transmitting haptic information in computer interfaces.

The *Vibrobod* and *What's Shaking* [7] are both handheld devices that were developed to communicate the non-verbal cues that are often lost in computer-mediated communication by adding haptic feedback. The Vibrobod translates squeeze force of the hand to vibration patterns and in What's Shaking the designers map active newsgroups to a vibration buzz, populous newsgroups to warmth. They found that users of their systems "intuitively" interpreted meaning correctly. This "intuition" is determined by a learned system of codes that can be analyzed with semiotic theory.

WHAT'S SHAKING		
Stimulus:	Vibration	
Percept:	Vibration buzz (*more/less*)	->*SIGN*
Concept:	Activity	->*SIGNIFIED*
Stimulus:	Temperature	
Percept:	Warmth *(more/less)*	->*SIGN*
Concept:	Presence/Body Heat	->*SIGNIFIED*

fig 1: Semiotic analysis of *What's Shaking*

In this system, the designers used their intuition and experience to create a coding that can be "read" (interpreted) by others. Following are other examples where researchers have successfully created readable signs.

Tactons [8] and *Haptic Icons* [9] are both attempts to deliver meaningful information in computer interfaces via the haptic channel. These are structured stimuli designed to represent content. The *Tactons* were designed to deliver information about the urgency and type of call on a mobile phone or pager.

TACTONS		
Stimulus:	Amplitude modulation	
Percept:	Roughness (*more/less*)	->*SIGN*
Concept:	Urgency	->*SIGNIFIED*
Stimulus:	Rhythm	
Percept:	Pattern *(a, b, c)*	->*SIGN*
Concept:	Type of Call	->*SIGNIFIED*

fig 2: Semiotic analysis of *Tactons*

Apart from some fine-tuning the researchers reported as necessary in order to make types of stimuli distinctly recognisable and distinguishable from each other, users were mostly able to read the mappings correctly, given an initial familiarization period.

The *Haptic Icons* were designed to facilitate turn taking in a collaborative task over a shared network - something that in face-to-face conversation is usually regulated by non-verbal cues. Three icon families were created for the purposes of indicating who is in control, a request to gain control in different urgency states delivered to the person in control and signalling to the person who requested it. Altogether there are seven icons that had to be learned and identified under workload, delivered via a vibrotactile feedback mouse.

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HAPTIC ICONS


Family 1: Change of Control - The designer's metaphor here was a sound that indicates a
device being inserted into a PC / a device being extolled respectively

Stimulus:       weak buzz, then STRONG buzz
Percept:        Contrast /Order (Hierarchy of stimulus)      ->SIGN
Concept:        Gained control                                ->SIGNIFIED


Stimulus:       STRONG buzz, then weak buzz
Percept:        Contrast + Order (Hierarchy of stimulus)      ->SIGN
Concept:        Lost control                                  ->SIGNIFIED



Family 2: In Control - Designer's metaphor: Heartbeat

Stimulus:       periodic vibration, varied strength
Percept:        gentle (low stress)                           ->SIGN
Concept:        In control                                    ->SIGNIFIED

Stimulus:       periodic vibration, varied strength
Percept:        noticeable, not unpleasant (medium stress)    ->SIGN
Concept:        In control but might lose it                  ->SIGNIFIED

Stimulus:       periodic vibration, varied strength
Percept:        noticeable, unpleasant (high stress)          ->SIGN
Concept:        Another user urgently requests control         ->SIGNIFIED



Family 3: Waiting for Control -Designer's metaphor: tapping of fingers while waiting for
something

Stimulus:       periodic tap, varied strength
Percept:        light, gentle tap                             ->SIGN
Concept:        gentle request                                ->SIGNIFIED

Stimulus:       two quick taps, varied strength
Percept:        gap between taps draws attention to them      ->SIGN
Concept:        urgent request                                ->SIGNIFIED
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fig 3: Semiotic analysis of *Haptic Icons*

What has happened in the projects reviewed here is that although it seems users of
the systems grasp meaning intuitively, it is more true that the designers used their
intuition to create an association and the users read these signs correctly - in other
words constructed the meaning they were supposed to. Even though the icons
would require training, they are so cleverly harvesting a common system of
associations that makes them easy to learn. To associate a "rougher" vibration
buzz than the one before with a more urgent message surely needs to be learned.

But it seems like the more the user can relate to conceptual models already present and learnt, the more likely the "intuitive" handling of an interface can be.

"Natural mapping, by which I mean taking advantage of physical analogies and cultural standards, leads to immediate understanding." [10, p.23]

"When things make sense, they correspond to knowledge that we already have, so the new material can be understood, interpreted, and integrated with previously acquired material" [10, p. 68]

There have been concerns raised regarding the recall ability of not differing haptic stimuli, but of the different exact states of the stimuli (i.e. we can relate a buzz to activity, but can we identify whether it is a low, medium or high activity buzz?). We may have to consider that touch might not be infinitely separable into discrete units which are digitally reproducible, but still celebrate the fact that if treated analogously and allowed to respond dynamically, the potential for the communication of an affective and expressive nature is tremendous.

Forming of Codes

Finally I would like to look at the project *ComTouch* [11]. It is different from the other projects in that the designers did not just provide prescribed codes to be read, but allowed space for the social actors using the device to create their own system between themselves. This approach is interesting in that it can tell us more about the potential and the process of meaning making in haptic communication. *ComTouch* is designed to augment audio communication via a mobile phone by adding vibratory feedback that can dynamically express squeeze pressure of the hand holding the phone. It was hoped this would enable the communication of non-verbal cues. Subjects were given a chatting task where the touch channel was complementing the audio, and a negotiation task, where audio communication was discouraged.

The subjects knew each other before the experiment and all established and formed communication codes between them successfully. In the chatting task, the added tactile channel was mainly used for emphasis, turn taking and mimicry.

ComTouch	
Sensing/Self-stimulus:	squeeze force + duration of force
Percept:	intensity of vibration
Concept I:	Emphasis
Concept II:	Turn taking
Concept III:	Mimicry - presence, attention, bonding

fig 4: Semiotic analysis of *ComTouch*

ComTouch differs from the other projects in that it investigates social uses the subjects were putting their haptic mappings to. It is an open system in that is allows the users to form their own system of codes which do not necessarily have to have a clear meaning outside this small social group, but if proven successful could develop into conventional use. An example of users shaping their own conventions are the so-called emoticons, which were derived from countless attempts by online community users to convey emotions in a textual/visual form. The emoticons that were the most accepted and therefore most widely used became convention. ;-)

Tactile Semiotics - Haptic Box

With the Haptic Box I am investigating whether we associate certain emotional values with tactile experiences. Investigating attitudes and intention, can inform assumptions about the kind of meanings that will be constructed.

The box contains ten different textures, presented in a random sequence. They can be felt (not seen) with one hand while the other hand fills out a semantic differential scale - a set of 12 polarized word pairs rated from one to seven - to show the semantic link between the tested object and the subject's mental imagery. A semantic differential scale is made up of adjectives which serve as measures of the dimensions evaluation (good-bad), potency (powerful-powerless) and activity (fast-slow) and therefore gives us information about how we judge objects, words, concepts or whatever the item to be analyzed might be, along those dimensions. It is particularly useful in obtaining information about affective

responses to a particular object. All the word pairs are taken from established scales for each of dimensions, rather than intuitively chosen. However, some of them were chosen deliberately to not be obviously relevant to textures - like sweet and bitter for example. I was interested whether a cross modal effect might be detected. A questionnaire about touch memories and associations was filled out afterwards, to gain insight into the subject's touch awareness.

The chosen word pairs for this experiment are as follows, and subjects were asked to rate them on a scale from one to seven:

Pleasant	••••••••	Unpleasant
Active	••••••••	Passive
Rugged	••••••••	Delicate
Foul	••••••••	Fragrant
Heavy	••••••••	Light
Hot	••••••••	Cold
Sweet	••••••••	Bitter
Young ••••••••	Old	
Relaxed	••••••••	Tense
Strong	••••••••	Weak
Valuable	••••••••	Worthless

fig 5: Semantic Differential Scale for *Haptic Box*

37 people have completed the Haptic Box experience, 21 male, 16 female in the age range 21 to 60, most of them staff and students from the University of Portsmouth. Some interpretation can be made from the results.

Association to Physical Nature

A lot of overlap on the collated scales was probably often due to the physical nature of the object, and the fact that some of the word pairs can be taken very literally - e.g., almost everyone associated *rugged* rather than *delicate* with the Tree Fungus (whereas no one could agree whether the Fungus was *pleasant* or

unpleasant to touch for example, which does not relate to any actual physical reality). The problem here is that the word pairs are taken as denotative, describing the physical object, rather than the connotative meaning that was to be investigated. *Hot* and *cold* would be a metaphorical way to describe a person, but in association with a texture it becomes literal.

Common Association with Natural Materials

Noticeably, it seems that the most correlation between subjects is over the materials that are the most organic, natural. It appears the more artificial the material, the more associations diverge. This could be because the settings in which we meet organic materials (Tree Fungus, Bark) are usually similar, so we share the same experiences and associations. The experience of synthetic materials on the other hand is manifold and it is more difficult to describe a common denominating experience or association.

Tree Fungus	*Fur*
Unpleasant	**Pleasant**
Active	**Active**
Rugged	**Delicate**
Foul	
Heavy	**Light**
	Hot
	Sweet
Bitter	
Old	
Tense	**Relaxed**
Strong	**Weak**
Worthless	Valuable
Brave	Brave

Stone Tile	*Silk*
	Pleasant
Passive	**Passive**
Rugged	**Delicate**
	Fragrant
Heavy	**Light**
Cold	Hot
	Sweet
Old	**Young**
	Relaxed
Strong	**Weak**
	Valuable
Brave	

fig 6: Semantic Profiles for *Tree Fungus*, *Fur*, *Stone Tile* and *Silk*

Some results of the Semantic Differential analysis can be seen in fig. 6: a lot of agreement on one adjective rather that the other (i.e. if most people chose 'foul' rather than 'fragrant') is represented by the favoured adjective printed in bold. If there was only some agreement on one adjective, it is printed in grey and if no agreement was apparent, the adjective was left out. We can see a profile emerging for each of the textures.

Conclusion Haptic Box

Statistical evidence about a link between semantics, tactile sensation and values is being generated. Correlations are happening especially where people recognise the texture and therefore associate an object rather than a texture. There are two of the textures investigated, which are especially obvious in the way that most subjects had a clear impression of them and seemed to have similar response. This result is in line with my enquiry of social codes in communication - the mere texture may not necessarily produce a coherent mental image, but it might be associated with an object we have experienced before and that is associated with a certain mental concept.

For example, when we touch the silk we may all have more or less the same receptors stimulated which deliver their sense impressions to the brain. It was not systematically recorded in this experiment so far, but a lot of people actually commented when they thought they had recognised a texture. In the case of silk, people were invariably often right. Then, after forming a mental image, a whole different set of associations is possible.

Once we have recognised it to be silk, because we have experienced it before, we associate all the cultural connotations that come with it: precious (expensive, rare), glamorous, feminine. These connotations are dependent on the environment we have grown up in and the context in which we encounter the object - some cultures may use silk for both genders equally, to show off wealth, whereas in others it may be used for seduction. They are also subject to change over time - for example, with new manufacturing methods, silk is not as rare and therefore not as precious as it once was. The other example texture that produced an almost unanimous reaction to the word pairs is the tree fungus, which was also

easier to recognise than the other textures as it was more of a relief than a flat structure, which gave subjects another parameter to explore. If you look at its profile and compare it to the silk's profile, one can clearly begin to see a contrasting semantic image. The rotten tree parasite is old, bitter, foul and worthless - the silk is young, sweet, fragrant and valuable.

These findings about links of semantics and touch experience can help design haptic devices and expressions because it shows that there is a system at work, even though it may not be fitting into a purely linguistic model. The study is to be taken as a pointer to the cultural system of signs that is available to us.

Kinaesthetic Semiotics: PinKom

Building on the investigations into tactile semiotics, I have designed a study similar to *ComTouch*, where the actual user behaviour is hoped to inform design specifications. Researchers of Haptic Communication are concerned with studying the effectiveness of different mappings of touch parameters like vibration, force feedback, temperature [12]. Creating the technology for this is difficult and building functional prototypes takes up most of the research time. User studies often have to be reduced to pilot studies. To counteract this, I built a low-tech solution that could be useful in predicting how people will use personal haptic devices. It is designed to investigate how they will react to these new forms of expression and whether they will develop idiosyncratic languages - because it is a shape display, I would call this an investigation of *kinaesthetic semiotics*: we are looking at the subjects producing a system of signs, made up of movement and touch.

PinKom is a mock-up of an imaginary haptic communication device that will allow the spontaneous forming of communication codes via that haptic channel. It would utilize the potential of shape display and real time force feedback by a remote human being for personal, intimate expression and sense of presence. Couples in a love relationship use PinKom - which is basically a customized version of the pinpression toy - for at least a week. It is a visual and haptic display, which can be seen and felt two ways. Subjects are asked to imagine that this would be a remote communication device while interacting in real-time. They are asked to do two tasks over one week: a) use the device in an

asynchronous and gestural fashion, i.e. leave message for each other and record these with a digital camera they were provided with; and b) to communicate predetermined messages of an affective nature ("I love you", "I am angry") in real time, both touching the device synchronously. They are also given a notebook/diary in which to record their thoughts by written or visual means.

Qualitative data is generated and spontaneous forming of communication codes is monitored, providing a glimpse of the real uses people would put their new touch based communication devices to. Even though the prototype is not technically functional at present, it is allowing some results and pointers for future designs.

Real time communicating

The first couple using the device were a male and a female in their thirties, both professionals in the creative industries. Their written recordings showed they felt that a jabbing motion was very useful in communicating anger, but struggled in communicating happiness which they put down to happiness not often being expressed via the touch sense.

Message leaving

The other observation that was possible is the fact that when allowed to use the pins as a visual display, the resulting expressions [13] were almost unanimously 2-dimensional. This happened in an earlier study precluding PinKom, conducted with schoolchildren who were asked to communicate affective messages using play-doh - they tore it into strips and used it to make 2-D, flat images. So the next question to be asked would be whether our minds will have to readjust for the possibility of a three-dimensional haptic expression.

Conclusion PinKom

For the design incorporating a pin mechanism for non-verbal interpersonal communication, it seems that the dimension of the real time force will be more powerful to communicate than the shape display on its own. However, as in

ComTouch we can observe subjects appropriating the medium for their personal use - in this case producing figurative, visual messages. They are modelled on the natural world, and not abstract. Obviously, for the documentation of real time communication it would be useful to observe this in a lab setting, this may produce more information than letting subjects report themselves – but this method was discarded for the benefit of allowing people to experience their device in a familiar, intimate setting in their own time.

Whether the PinKom is feasible with current technology is irrelevant for this study, but as a user-centred design study of new ways of communicating via remote touch, it is my approach to ascertain useful future specification. However, it should be a future aim to build a functional prototype of building a remote communication device using a pin display.

General Conclusion and Discussion

My intention is not to distract from psychophysical considerations, it is obviously essential to establish which design parameters we can actually perceive before incorporating them. However, the way we construct messages from our building blocks leads us into a new realm of considerations. We will build on the sensory-physical knowledge that is being generated and add the psychological-humanistic layer, ultimately striving for holistic ways of designing and allowing evolution of the powerful elements of touch.

With the work on tactile semiotics I have demonstrated how we can investigate the signs that are present in our culture. Being aware of this process of sign reading, which happens automatically for the cultural consumer, is important for any cultural producer. Utilizing the signs cleverly, which is what designers intuitively do, can construct a certain message/reality. All artists working with material culture (fashion, architecture, stage/production design etc.) use their intuition and personal experimentation to create meaningful artefacts, which can be 'read' by others who share the same cultural experience. Of course, there is a visual aspect to these and we are very fluent in visual signs - a red dress, a black and white photograph has certain connotations that can be deliberately conjured up. We "intuitively" associate a red dress with a sexually confident woman, and a

black and white photograph communicates nostalgia and past times. The origins of why that is so (i.e. in the beginning of photography, they used to black and white due to technical constraints) is maybe less important for semiotic analysis than what meaning the artefact constructs in the mind of the 'social actor'. In the same way, we "intuitively" associate a high vibration buzz with activity and a warming device with body heat and therefore presence of a remote being.

With touch a lot of responses seem instant and universal - however, there is a layer of abstracted meaning, which is not necessarily the same for everyone. A wearable vibrotactile device delivering a buzz as an alert seems intuitive - in its design, and our response seems obvious and automatic. Abstraction on top of the sensorial layer that most of us have in common, however, still needs to take place. After registering the sense impression through the body, my mind associates the fact that what I am wearing means it can buzz and when it does this, it means that something has happened which needs attending to. If I was not aware of the context and intent of the buzz, I might therefore construct a different, unintended meaning, which will influence my behavioural and emotional response. I might be startled and run away or try to take off the vibrating device.

What is interesting about the PinKom is the fact that with relatively simple means we can start to think about and study the potential of touch in remote and computer mediated communication. If we allow ourselves the space for artistic creation that may sometimes seem unrealistic at first, we can explore the field from different perspectives and push the boundaries of the field by asking unexpected questions. Tollmar [14] suggests combining blue-sky research with down-to-earth design methods in designing new interfaces. Mock-ups can be used to help users envision the kind of systems they need - and in turn inform the designers of exactly what will be required [15].

As well as Haptic Designers collecting metaphors from the real world (inspired by social codes) to inform our semiotic intuitions, it will be interesting to see what happens if access to haptic technology (like the Haptic Editor [16]) becomes widely available - will aesthetic codes, inspired by individual artists, be created [17]? We might see a development like in photography or colour theory, where artistic experimentation pushed technological development and led to a greater understanding of perception and therefore a more accurate usage and dynamic composition of (visual) elements. Because of the unique nature of touch,

design for Haptics will demand its own set of experimentation, haptic sketches and design iterations. A mere translation from visual to haptic (i.e. making *graphs* haptically explorable seems paradoxical) might not be fruitful. The elements for composition need to be explored and they may not always have a visual or verbal equivalent. Music and sound seems a more natural source of inspiration and analogy in its relation to vibration.

Interface design in general is moving away from a button culture to a search for true interactivity - looking to shift from the paradigm 'clicking a selection of pre-determined choices' to a more flexible, dynamic response system that better reflects the styles and preferences of human beings as users. This development is especially evident in the area of interactive installations and responsive environments.

"[Users] can truly gain an experience of agency, [...] their action pulls congruent reaction without them feeling they have merely stumbled across come pre-determined interaction sequence" [18]

Haptic interfaces, as part of the general move to appreciate the user holistically, as a discipline also incorporates this interest in more analogue structures. The *ComTouch* designers discarded the vibration motor of their first choice because its "dynamic range was too limited for adequate expression" [11], in favour of an acoustic speaker which could give the people using their system more control, i.e. the users were able to appropriate the range of responses available to their own preferences and personal use.

This enabling of the forming of social codes, rather than prescribing logical codes in form of a pre-set coded language, is another step towards a holistic interface. To establish logical codes will make sense where an explicit agreement between communication partners is wanted and needed in order to make communication successful. Where we want to allow for affect and personal expression, an emphasis on logical codes may neglect the potential for analogous expression and we may ultimately limit ourselves.

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