

# Abstract Information Appliances

METHODOLOGICAL EXERCISES IN CONCEPTUAL DESIGN OF COMPUTATIONAL THINGS

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## ABSTRACT

The decisions we make when designing computational things cannot all be reduced to questions about functionality, usability testing, user requirements, etc. In HCI-related research and design, other fundamental aspects of design, such as the basic aesthetical choices involved, have a tendency to be hidden and seemingly forgotten. To support awareness and understanding of such basic aesthetical choices, we propose two methodological exercises that take the expressions of computational things in use as their starting points: i) to discover functionality in given expressions; and ii) to rediscover “expressionals” in given appliances. The aim with i) is to encourage reflection on the way in which functionality explains the expressions of things. With ii), the aim is to expose the more or less hidden aesthetical choices by means of re-interpreting them in given appliances. We present examples of the exercises and discuss more general issues, such as the central role of temporal gestalts and the art of using computational things.

## Keywords

Aesthetics, interaction design, design methods.

## INTRODUCTION

Aesthetics concerns the formal reasons explaining and describing the appearance of given things. We ask questions concerning structure and composition, use of material, overall consistency, etc. Using such questions as a basis, we may try to describe and analyse both genres and individual works on basis of how we think these choices have been made and for what reasons.

When we restrict our perspective on computational technology to only being the means for implementing some practical functionality, many aesthetical decisions will be hidden (cf. [4]). Not because they are not made, but because the expressions of the things we design become mere consequences of other concerns. Consider, for instance, the differences between a traditional phone, a mobile phone and a mobile phone equipped with a hands-free set. Although their basic functionality is almost the same, their expressions in use differ enormously.

Even though our *only* concern is to support a person communicating with someone at a distant place, the appliance we design will have certain expressions as such. And since we are not only going to use all these new technological devices once in a while, but actually

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live with them as they surround us at all times [11] and condition the way we live (again, phones and especially mobile phones provide good examples), these expressions are important as they form the basis for the presence of these things [7]. The basic aesthetical choices regarding the concrete appearance of a thing can never be avoided, only neglected.

To some extent, human-computer interaction has borrowed rudimentary aesthetics from areas such as graphics design. This helps us design proper screen layouts, use fonts and other graphical elements, etc. Such aspects of interaction design are obviously of great importance in screen-dominated interaction, but the aesthetics of disciplines dominated by design-by-drawing tells us very little about the computational aspects of this new material we are working with. And, after all, it is precisely what makes something computational in appearance that is the great challenge in developing an aesthetics of computational things.

In our view, these two issues – i.e., that the aesthetical choices tend to be hidden by concerns for usability and practical functionality, and that the aesthetics of areas of design dominated by design-by-drawing tells us little about how to craft something that is computational – motivates an investigation of computational technology as a design material where we try to expose basic aesthetical issues by focusing on the expressions rather than practical functionality, and where the aesthetics of computational things in *use* are in focus.

### **COMPUTATIONAL TECHNOLOGY AS DESIGN MATERIAL**

Material is what builds things. Form is the way in which material builds the appearance of a thing. According to this basic distinction, computational technology is a material since it is used to build the appearance of a certain kind of things, namely, “computational things”. Computational technology as a design material can, therefore, not only be a matter of computer hardware, but our notion of this “material” has to involve all the things it takes to make something “computational” in appearance, i.e., programs to be executed, interactive surfaces to enable control of them, hardware to run them, etc.

What characterises computational technology as a design material, then, are the temporal structures that are generated when programs are executed. This is similar to how temporal gestalts are created when musicians perform a piece of music. However, these temporal structures have to be manifested in space in order to be perceivable. In the case of music, the temporal gestalts are manifested as sound that is generated as musicians play their instruments. In the case of computational things, we can choose different ways of manifesting the temporal gestalts generated by computations, by creating various kinds of “displays” (in the widest notion of the word).

To create a display, we combine computational technology with some other material capable of manifesting the temporal structures as spatial structures. For instance, we can manifest these temporal structures as patterns on a cathode-ray tube screen, or as sound coming from a speaker. However, we can also manifest them in less conventional ways, e.g., as a feather being blown around in a glass pipe [10], as patterns of moving fabric [6], or by means of a “dangling string” [11]. Computational things have both temporal and spatial form elements. Thus, at least two kinds of design materials are necessary to build such things: i) computational technology to generate temporal structures by means of executing programs and ii) some other material(s) to manifest these structures in space.

### **Implications for the Aesthetics of Computational Things**

Given that computational technology can be considered a design material, a material with which we can craft certain kinds of things, it seems reasonable to ask the same questions about this “new” material as designers and artists have been asking about other materials. For instance, we can ask what things can be created with it, or about how it combines with

other materials. As any new design material, it will challenge existing ideas about aesthetics and design as it opens up new possibilities.

One implication of a having temporal gestalt as a central form element, is that the aesthetics of computational things will have to deal with how to design in time, or how to “compose” temporal gestalt, as one of its main elements. Of course, computational things depend on spatial gestalt as well, but what makes them “computational” is, after all, that which depends on computation.

## TWO METHODOLOGICAL EXERCISES

When designing computational things, we often start with some basic functionality, e.g., we intend to design some kind of digital notebook, calendar, organizer, communication device, etc. We then want to assure that it meets some user requirements – be it general objective ones or particular subjective ones. Starting with a general notion of function and some general usability criteria, we use stepwise refinements that finally result in a concrete design, which then can be subject to test using prototypes. Now, these concrete things have appearance, their expressions in use talk to us as we live with them. This expressiveness is a result of more or less explicit design choices. Where do these design choices come from and how are they related to functionality and usability? Question such as these call for a program for experimental design of computational things where we try to visualise, conceptualise and question relations between expressiveness, functionality and usability.

The expressions of things in use seem to define functionality just as much as functionality seems to explain design expression. We can think of this as a *function-expression-circle*:

(A) Expressions bring forth functionality and thus define given functionality in a certain sense. For instance, we visualise “sitting” through the expressions of sitting down in various chairs, on benches, etc., or “opening” through the expressions of opening doors, hatches, cans, etc.

(B) Functionality explains expressions and thus defines given expressions in a certain sense. For instance, we do not only see a chair or a bench, we see *that* it is a chair, a bench, etc.

This circle suggests complex and intricate interrelationships between function and expression in design. The utopian functionalist *leitmotif* “form follows function” is, of course, just a leitmotif that emphasizes functionality and where we start at the “function” side of the circle. Now, we can turn the functionalist leitmotif upside-down and try to work with the seemingly forgotten issues regarding basic aesthetical design decisions from the other end of the spectrum (cf. [4]). To guide such an investigation, we can use the following leitmotif: *function resides in the expression of things*.

Whereas “form follows function” suggests that design expression somehow is “derived” from functionality, the idea that “function resides in the expression of things” suggests that we could try to discover functionality in expressions and rediscover the hidden aesthetical choices in the expressiveness of things in use. Below, we describe two methodological exercises in rediscovering and redefining the role of aesthetics in the design of computational things; two exercises giving a methodological interpretation of the function-expression-circle.

### Appliances and Expressionals

The exercises bear on a distinction between two basic ways of looking at a (computational) thing: on one hand, one may focus on what one can do with a given thing, and, on the other,

one may focus on the pure expressions of a thing in use. We can see a given (computational) thing as an *appliance* or as an *expressional* (cf. [7]):

- An *information appliance* is a computational thing designed to perform certain information functions, e.g., something to write letters with, to take pictures with, or to communicate with people at distant places with (cf. [9]).
- An *information expressional* is a thing designed to be the bearer of certain expressions related to elementary information handling acts without any reference to specific applications.

The exercises described here implies moving back and forth between these two ways of thinking about the design of a computational artefact. The two exercises are:

- (i) Discovering functionality in given expressions.
- (ii) Discovering “expressionals” in given appliances.

In (i), we try to discover appliances inherent in given expressions. We try to think: if these are the expressions of use – what might be the possible functionality? In other words, we train ourselves in finding functionality that explains given expressions.

In (ii), we try to give an interpretation of the aesthetical choices hidden in an information appliance or application. We try to discover “expressionals” inherent in a given design of an appliance, i.e., we try to revisit and reformulate inherent aesthetical choices in given appliances (cf. “interaction relabelling” [3]).

In these exercises, it is essential that we go back and forth between the two “modes” of thought, i.e., between thinking about a thing in terms of being an appliance vs. in terms of being an “expressional”. For instance, we may start with discovering an “expressional” in a given appliance and then, so to speak, go back to the appliance “rediscovering” its functionality with a new understanding of its use. Starting with finding some functionality in a certain expression we may then “rediscover” the given “expressional” with a new understanding of its expressiveness.

Thus, this is a methodological circle where the two exercises complement each other. The purpose with this circularity is to increase awareness and understanding of the interplay between functionality and expressions of use in the design of computational things.

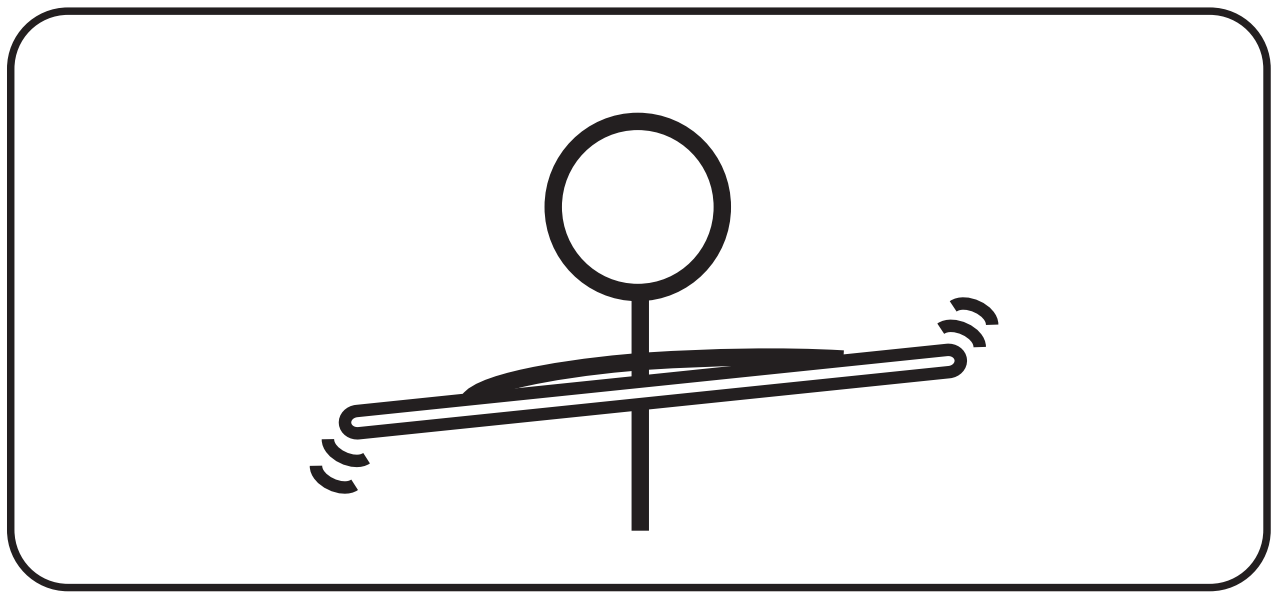
## EXAMPLES

Although both exercises described here are applicable in other areas of design as well, the focus lies on the combinations of temporal and spatial gestalt typical to the appearance of computational things. It is important to note that the idea with these exercises is that we should train our ability to “see” the aesthetical choices more clearly in the process of designing computational things. The examples we work with do not have to be “realistic” – on the contrary, to paint a clear picture it may help to exaggerate and work with examples that reach far out in the design space of present and future information appliances (cf. [5]). We can compare this to what happens in sports and art when we in pure fascination reflect on the powers of expressions: just compare a downhill race with skiing as a means for transporting oneself down a mountain, or a Wagner opera with traditional work songs.

### Discovering Functionality in a given Expression

#### A Waiting Tube

*Expression:* Consider a 2 m long tube, about 10 cm in diameter, open at both ends. We then place a marble inside the tube and hold it horizontally in front of us. Trying to keep the marble inside the tube, we carefully balance the tube and listen to the sound of the rolling marble (fig. 1).



**Figure 1:** A Waiting Tube

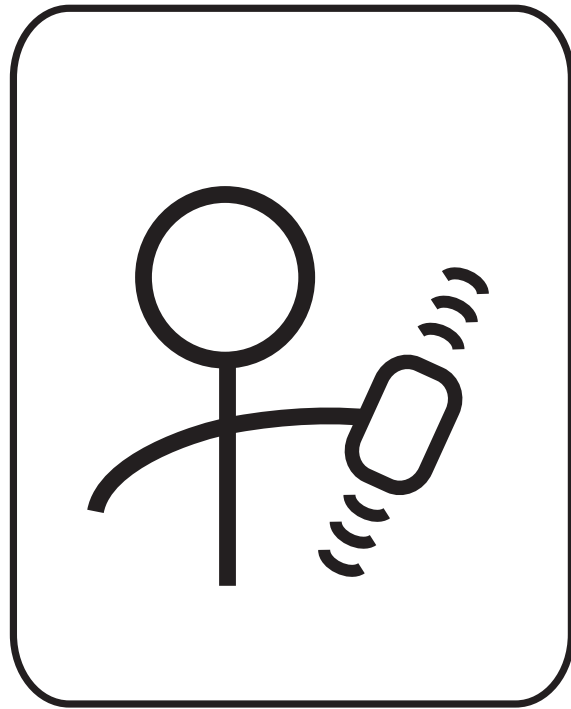
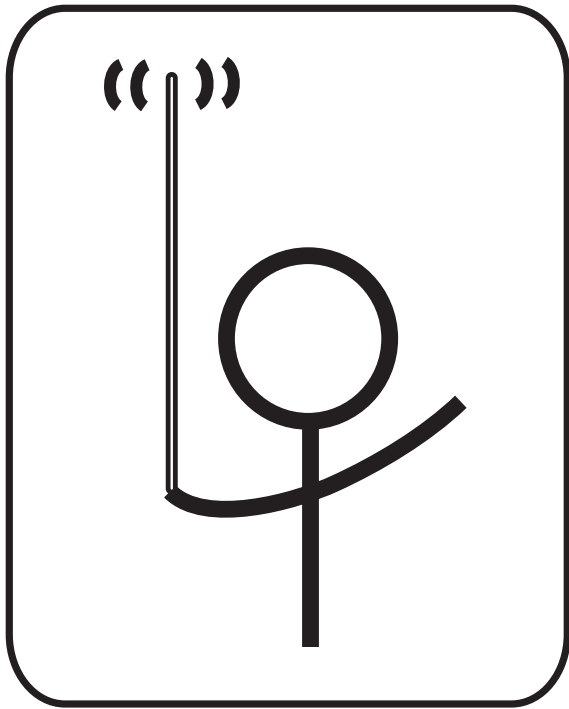
*Function:* What is this? We can imagine using the tube to “wait” for information: we indicate that we are waiting by keeping the marble in constant motion producing a continuous sound from the tube. This turns waiting into an act of intense concentration, as the sound will stop as soon as the marble is in rest or falls out of the tube. The sound of the rolling marble means we are waiting. As soon as the sound stops – through complete equilibrium or through imbalance that force the marble outside the tube – the waiting stops.

*Appliance:* If we equip the tube with microphones sensing the movements of the marble and some wireless communication device for transmitting information to a network, it can be seen as an information appliance we may use to wait for information. It can be connected to other appliances we use. This “Waiting Tube” amplifies and redefines waiting icons such as the hourglass. Instead of watching the screen, we take it out of the computer and put it in our hands, thus redefining waiting from passively watching something to becoming something we actively do. All this network communication has introduced frequent “waiting” of a partly new sort, a type of “waiting” that is rather annoying. The Waiting Tube does not solve this problem in a very efficient way, but if used properly, it will certainly slow things down turning waiting into something where the machines have to pay attention to what you are doing thus reversing the present situation.

#### A Free Antenna

*Expression:* A 1,5 meter long stick The basic expression here means balancing the stick on the palm of our hands in constant motion (fig. 2).

*Function:* What is this? Isn’t this something connected to acts of communication, a kind of antenna? Let, for instance, the antenna indicate that it is “free” when it is not touched along its sides, and “open” for communication when it is in motion. To announce that we want to establish communication we indicate that we are “free” and “open” for communication by balancing the stick on the palm of our hands in constant motion until communi-



ation is established. This turns passive waiting for communication to be established into an act of active concentration.

*Appliance:* If we equip the stick with accelerometers and touch sensors all over the stick except at its tips as well as some wireless communication device, it may be seen as an information appliance we use to announce that we want to communicate. Imagine, for instance, that we connect the Free Antenna to our mobile phone. This means that the phone only will be open for communication when I balance the Free Antenna in the palm of my hand. Among other things, this means that I bring some artistry to the rather boring fact that my mobile phone is connected to a network.

#### A Shaker

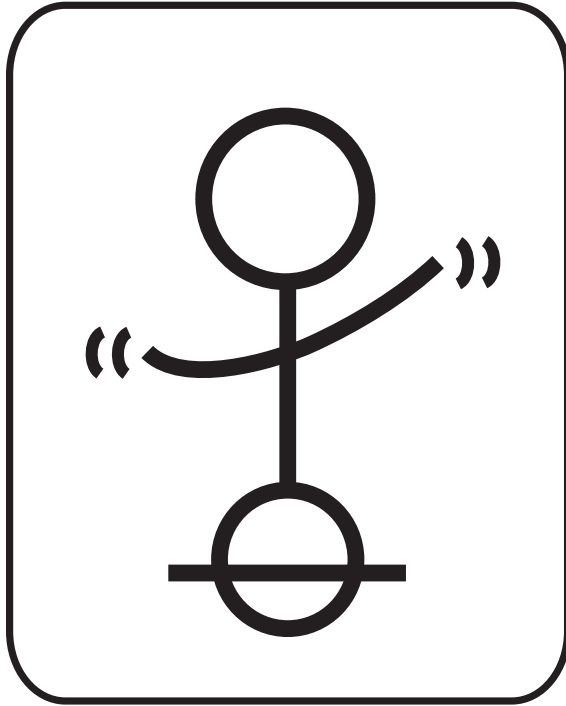
*Expression:* A “black box” the size of a small book that make a sound as it is shaken (cf. The musical instrument ‘shaker’) (fig. 3).

*Function:* What is this? Perhaps it is something we use to write information by shaking it in certain patterns? Besides being a device for writing, we can also imagine other basic information handling “functions” in the expressions of this device. For instance, we might start it up by shaking it lightly, similar to how we shake a person we want person wake up in the morning. Similarly, we can think of putting it into “sleep” as carefully placing it somewhere without any abrupt motions that will make it make a sound. We an also imagine trying to express slightly more complex things, such as “anticipation” or “frustration”. We might try to express “anticipation” as an accelerating rhythmical shaking with a crescendo, similar to the way we might applaud in anticipation before some artist will enter the stage. To use this Shaker to express “frustration”, the rhythmical shaking of “anticipation“ might be replaced by more irregular and aggressive shaking.

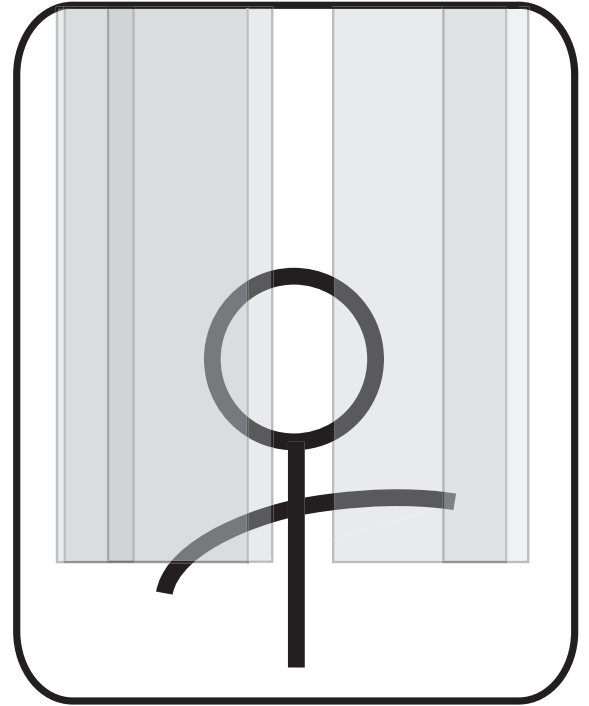
*Appliance:* If we equip the Shaker with accelerometers and/or microphones, we can use it as a keyboard to write information, instead of a set of buttons controlling various processes. Instead of having to hit the right keys or buttons in the right order, we will have to produce

**Figure 2:** A Free Antenna

**Figure 3:** A Shaker



**Figure 4:** A Balance Plate



**Figure 5:** Curtains

the right rhythmical patterns, turning the act of writing on a keyboard into a more or less musical performance. Fortunately, we will also have the possibility to express our frustration when we fail to produce the right patterns because we do not master the art of using this device

#### A CD DisPlayer

*Expression:* Consider the expression of a CD player mistracking as we play our favourite CD.

*Function:* What is this? We can imagine using mistracking to display a possible mismatch between the given music and one's present state of mind. The CDs one listens to are all categorised with respect to listening moods. The amount of mistracking is used to indicate the level of mismatch.

*Appliance:* Sensors of various sorts in one's apartment record movements, how "heavy" one's footsteps are, etc. A program then "measures" one's state of mind on basis of the given information. The CD DisPlayer is connected to a large database with music files. Depending on the given measure of my state of mind and on the category of the given file, different amount of playback errors will be applied. For instance, the CD DisPlayer might only let me listen to one of Beethoven's late string quartets when I am in a reflective mood. Perhaps, this scenario might already be true – perhaps the idea that mistracking depends on a dirty or damaged disc only is a classified lie?

#### Discovering Expressionals in Appliances

##### A Balance Board

*Appliance:* An ordinary PC equipped with a trackball.

*Use:* Consider the ordinary use of a trackball to move a cursor in a graphical interface. If we for a moment try to forget about the functionality of trackballs and instead turn to the art of

using them, we see an act of carefully balancing and moving a ball, writing various patterns of information with our movements. It is as if the track ball where some kind of tool we use for balancing exercises.

*Expressional Interpretation:* A balance board is normally used for balance training. Consider augmenting it with accelerometers and some communication device, thereby turning it into an information appliance designed to express the communication of various balance acts. When equipped with sensors, e.g., accelerometers registering its movements, the balance board can be turned into a writing appliance: similar to how a trackball is used, one can write information by means of producing specific patterns of movements on the balance board. In the Balance Board we see an amplified version of the art of using a trackball, the entire person carefully balancing on the board instead of just using the hand.

#### A Talking-Loudly-To-Yourself Device

*Appliance:* An ordinary mobile phone equipped with a hands-free set

*Use:* When one uses a hands-free set, it appears as if one talked loudly to oneself. In a public place, this expression of a “talking-loudly-to-yourself-device” is very strong.

*Expressional Interpretation:* The device consists of an elastic plastic pipe of say 2 cm diameter. At one end, there is a microphone and at the other an earphone. The pipe is equipped with accelerometers, sophisticated recording/playback devices, colour displays and equipment for signal processing. We can affect the colour of the pipe and playback of our voice by topological transformations of the pipe (i.e., anything but tearing it apart), by our movements and by the timbre of our voice. It is a true instrument for listening to your own voice.

#### Curtains

*Appliance:* An ordinary graphical window managing system of a desktop computer.

*Use:* We try to set up the information view we want by arranging a number of windows on the screen. Since the screen estate is limited, some windows will occlude others, which makes continuous re-arrangement necessary.

*Expressional Interpretation:* In front of a window, several layers of fabric are hanging from the ceiling (fig 5). The layers, or curtains, are semi-transparent and can be moved horizontally. On each curtain, a unique, abstract and seemingly meaningless pattern is displayed using electronic ink, fibres that can change colour, or similar technology (cf. [8]). To view a certain piece of information, one has to move the curtains, setting up a specific combination of curtain positions. As the sun shines through the window, the combination of patterns on the curtains will, hopefully, result in the information view we desired.

#### An Information Sender

*Appliance:* An e-mail application.

*Use:* We use an e-mail application to send messages to other people. We click on some icon and watch some indicator to see if the message is successfully sent. Once this is done we might be hit by anxiety: what did I really write in the message?; was it really the right recipient?; was it the right file that was attached or was it that something personal with a similar filename?; etc. When we check the log to find out, there is no longer time to recover from any mistakes as the e-mail already has been sent. There is a strong expression of chance here; it is almost as if we are trying to control a very complex situation where things just seem to happen.

*Expressional Interpretation:* Each message is represented by a marble (cf. Bishop’s *Marble Answering Machine* [2]). To send a message, we place the marble inside a long tube and it slowly begins to roll. Beneath the other end of the tube, there is a large flat surface, e.g., a table, with a number of small holes in it, each hole representing a possible recipient. As the



marble comes out of the tube, it will drop onto the surface and before this happens, we must adjust the position of the table so that the marble hits the right hole. During this procedure, we reflect upon questions such as: Did I send the right message (the marbles are almost identical to each other making it difficult to select the right one)? Did I send it to the right person (there are so many holes on the table and moving it to the right position can be very difficult)?

#### A Fabric Closure

*Appliance:* A PC, PDA or mobile phone.

*Use:* On communication devices such as mobile phones and desktop computers, we use a button, click on an icon with a mouse, etc., to close down communication. The way this is done indicates how definitely we want this connection to be closed.

*Expressional Interpretation:* A large wooden box, e.g., 1 x 2 x 0,5 m, with one short side open. Different information channels are represented by small precision proximity sensors placed inside the box. To close down a communication channel, we hang a piece of fabric inside the rack to block the channel. The closer to the proximity sensor we hang the fabric the more definitely we close the channel. As we wrap-up communication, we choose fabric of various colours and textures to decorate our environment.

#### Digital Spillikins

*Appliance:* A mouse.

*Use:* The pointing device is used for drag-and-drop, i.e., to pick up, move around and arrange graphical objects on the screen.

*Expressional Interpretation:* We concentrate on the expressions of performing these precise movements with the mouse, of moving objects on the screen without making any mistakes. Consider a collection of spillikins augmented with fine tuned accelerometers and some wireless communication devices. Playing this spillikin game turns drag-and-drop into an act of careful reflection upon the movements – and the tools – necessary to move an object, what objects can be moved in relation to others, etc.

## DISCUSSION

The first step towards an explicit aesthetics of computational technology as design material, must involve awareness of the issues involved. To support this, we proposed two exercises that aim at exposing the expressiveness of computational things. Given this ambition we may ask what can be learned from doing these exercises: what is it that can be seen in these abstract information appliances?

### The Central Role of Temporal Gestalt

In the first exercise we start with an expression and try to find some hidden functionality. This is done in the form of an imaginary appliance that gives a functional interpretation of the expression in question. It can be seen as a functional analysis of an expression in which we find ways of relating functionality and expression.

Now, in what way can such analyses deepen our understanding of computational technology as a design material? Consider what can be seen when we turn back to the expression as we have given it a functional interpretation; what is it that, so to speak, carries the functionality? In the “Waiting Tube” the basic expression of a balance act is given the functional interpretation “waiting”. Turning back to the balance act, what carries this functionality is the temporal gestalt that is created as we balance the tube. The spatial gestalt of the tube itself cannot carry this functionality. Examples such as the waiting tube might at first seem a bit strange since waiting often is associated with, e.g., frustration. Still, waiting –and frustration for that matter – are aspects of the use of computational

things that we have to consider in design, be it waiting for a program to execute, a device to start, a communication line to open up, etc.

The central role of a temporal gestalt is evident in all the examples. In the “Shaker” we start with basic acts of shaking an object and interpret this as a rather general writing appliance where information is written and read as patterns of movements. Turning back to the basic expression, we see that it is the temporal gestalt that carries this functionality: it is almost as if we played an instrument as we shake the device, writing different pieces of information as we play different melodies or rhythms. It becomes a kind of distillate of the expressions of use of a traditional keyboard with focus on the rhythmical patterns of pressing down keys rather than on the spatial layout of the keyboard itself.

As we look back at the basic expressions of use we started from, time as a design parameter is exposed, as it is temporal gestalts that carry the functionality of our imaginary abstract information appliances. This exercise helps us see and reflect upon central temporal aspects of computational technology as design material.

### **The Art of Using Computational Things**

In the second exercise, we try to rediscover and reinterpret the inherent aesthetic decisions of a given design. Starting with an existing appliance and its use in some particular situation, we focus on its expressions in use and form an “expressional” that represents our interpretation of the aesthetics of its use, i.e., an interpretation of what *the art of using* the device is.

The interpretation of the art of using a track ball as a balancing act, gives us a specific image of the important design choices related to this expression of use. All basic design choices somehow centre on the notion of equilibrium. The methodological circle is clearly visible here: we start with the use of a given appliance and through an expressional interpretation we “rediscover” its functionality. How should we, for instance, relate the notion of equilibrium to the act of moving a cursor using the track-ball? It is somehow natural to think of reaching equilibrium when we have successfully moved the cursor to the intended place. This could for instance mean that the art of using a track ball implies that we focus so intensively on an intended point of equilibrium that the whole act of using a trackball turns into a balancing act. This introduces explicit design variables, e.g., resistance when moving the ball, the sense of an equilibrium or of instability, the effort and movements required to reach the equilibrium, etc., that are directly related to the expression of use.

Interpreting the art of using a mouse to drag-and-drop as a digital spillikin game, exposes issues relating to precision, e.g., choice of path when moving, position relative to other objects, what objects can be moved in relation to others and how, how an object is picked up, etc. According to this interpretation, the art of using a mouse is a matter of carefully selected and very precise movements. Clearly, aspects such as the size of the spillikins, what tools we have to use to move them (imagine playing this game with log-sized spillikins using trucks and cranes), the number of sticks used, etc., are of importance to this art.

One may ask to what extent the idea of interpreting e.g., a trackball in terms of the Balance Board, is a metaphor, i.e., to what extent this exercise is related to methods of using metaphors in designing an interface. This is a subtle matter, but what is important here is that we go back and forth between appliances and “expressionals” in an attempt to rediscover and reinterpret basic aesthetic design decisions. Thus, it is – from a methodological point-of-view – not clear that the act or process of denoting one concept with a sign conventionally tied to another concept is what is important here.

When our focus shifts from efficient use of computers towards meaningful presence of computational things in everyday life, the *art* of using these devices becomes a central issue [7]. When designing a chair, we do not only think about efficient sitting, but about the art of

sitting down in a chair, the art of using chairs in interior design, etc. In this exercise, we use reflection upon, and “rediscovery” of, the art of using an appliance as a way of uncovering aesthetical aspects of the computational material used.

## CONCLUDING REMARKS

Thinking about the use of computational things in terms of being an art, is closely related to Borgmann’s notion of *focal things*. A focal thing is a thing that calls for engagement and attention. Borgmann states: “If we are concerned to revive engagement, we must try to recover the depth of design, that is, the kind of design that once more fuses engineering and aesthetics and provides a material setting that provokes and rewards engagement.” [1, p.16].

To design computational things as focal things is, in many ways, opposite to the idea that computers should become invisible and just act in the background, making our lives easier or more efficient. Some computational things will certainly become parts of the technological background, but it is important that we also develop a practice of designing meaningful things that can act as centres of attention and engagement in everyday life.

We believe that the kind of exercises described here can help us develop methods for a more systematic treatment of aesthetical issues in the design of new computational things. The process of innovative design starting with given expressions may benefit from exercises in giving functional interpretations of expressions. If, on the other hand, certain functionality is given, we try to imagine expressions of its use, and its appearance in everyday life. To find a solid aesthetical basis for design, experiences from extensive exercises in giving an expressional interpretation of use, may be of great help. But above all, the ambition with these exercises is to encourage reflection on how we use computational technology, thereby opening up for new perspectives on the design space of computational things.

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