Consequences for Design
A framework to couple user’s actions and the product’s function
6.1 Introduction

A research-through-design approach cannot stop at testing the designed prototype, it should generate new knowledge that goes beyond the tested design.

In this chapter I present a framework that can be used to answer the all important question: How can designers create ‘freedom of interaction’ and how can they ‘couple the product’s reaction to the user’s action’ to communicate understanding? The framework that is presented is not restricted to the design of emotionally intelligent products but can also be used for the design of other interactive products to provide intuitive and aesthetic interaction.

In chapter three I argued that freedom of interaction is an essential condition in my approach to emotionally intelligent products. Without freedom of interaction the user cannot express his emotions to the product while trying to achieve the intended functionality. However, it is important that the user does not get lost in unlimited action possibilities. To prevent this from happening the user needs information to guide his actions towards the intended functionality.

In this chapter I explain how action and function can be coupled to generate this information.

I start with an analysis of a mechanical product which allows for freedom of interaction and where the user’s action and the product’s function are naturally coupled. I identify six aspects of action and function i.e. time, location, direction, modality, dynamics and expression. When action and function are unified on each of these aspects, they appear naturally coupled.

In contrast, in electronic products action and function often are not unified on these aspects. Whilst this brings many advantages for new functionality (i.e. remote control, programming) it often results in non-intuitive interaction. To restore intuitive interaction in electronic products the user needs information to guide his actions towards the intended function.

Therefore I focus on the creation of information through feedback and feedforward and distinguish three types of information: functional, augmented and inherent. These different types of information are the elements that can bridge action and function together by making couplings on the six aspects. I present a framework that illustrates these different coupling possibilities and explain how different interaction styles fit into this framework. Based on this analysis of interaction styles I argue for a more tangible approach. This approach aims to enrich both the action possibilities and the related inherent feedback and feedforward to allow for richer couplings between action and function. The approach is illustrated using product examples.

6.2 Freedom of Interaction

In chapter 3 I concluded that expressing emotions presupposes freedom of expression and thus freedom in interaction. In my approach this freedom of interaction is based on the exploitation of the rich perceptual motor skills of the user.

Two other issues for freedom of interaction are those that Dourish touches upon. Although he presents these issues in the context of traditional interfaces opposed to tangible interaction (Dourish, p.50-51) I believe they are also applicable to the concept of freedom of interaction. He says: “Traditional interfaces of electronic products have a single center of interaction. To access the product’s functionality the focus of attention is on one button, window or cursor. (…) The single point of control that traditional interfaces adopt leads naturally to a sequential organization of interaction—one thing at a time, with each step leading inevitably to the next.” (Dourish, p.50-51). From his analysis of traditional
interfaces I take the following two points as being important for freedom of interaction:
- no single point of control or interaction
- not a necessary sequential order of actions

Next to these two points Dourish mentions, I believe that in order to design for free and playful interaction, actions need to be reversible, so the consequence of an action can easily be undone [reference].

In conclusion I state that in order to achieve freedom of interaction designers need to offer interaction that:
- takes full advantage of a person’s perceptual motor skills
- allows the person to act at multiple points at once
- offers a myriad of ways to achieve a product’s functionality
- allows for easily reversible actions

Freedom of interaction is of course not unlimited. We should realize that freedom of interaction is more than freedom of action. While unbounded action possibilities might allow for freedom of expression it is useless without the proper reaction of the product. To avoid the user is getting lost, he needs information on how his actions and the product’s function are coupled.

**6.3 Coupling action and function**

Before I go into the coupling between the user’s action and an electronic product’s functionality I use the example of a mechanical product to see what we can learn about that coupling.

In most mechanical products the appearance, the action possibilities, the action and the function are all naturally coupled which allows for intuitive interaction.

To illustrate the issue of acting at multiple points at once and a natural coupling between action and function, I use the example of a pair of scissors.

Imagine sitting at your desk cutting several images from a page of a magazine. The cutting comes about through the coordinated use of scissors, paper and your desk. You might use the scissors with your dominant hand, while your non-dominant hand is used to orient the page appropriately and you use the desk as a support to handle the size of the page. These are all brought together to achieve the task; you act at multiple points at once. The design of a pair of scissors (appearance) fits our perceptual motor skills. And, when using them to cut paper, moving your thumb and finger towards each other (action) is naturally coupled to a change of orientation of the blades (reaction) and the incision these blades make in the paper (reaction). When the blades are dull or the paper is too thick the resistance of the action also informs the user about the failure of making a proper incision.

![Figure 1: In a mechanical product the appearance, the action possibilities, the action and the reaction are all naturally coupled.](image)

This example shows the direct and natural coupling between the user’s action and the product’s functional feedback. Analyzing this natural coupling reveals an unification of action and reaction on the following six aspect; time, location, direction, dynamics, modality and expression.

Unifying action and reaction on these six aspects can be seen as an operationalization of intuitive interaction. In the following section I explain the six aspects.

**6.3.1 The six aspects of natural coupling**

I identify six aspects taken from the physical world, i.e. time, location, direction, dynamics, modality and expression,
which describe characteristics of both the action and the reaction. Unifying action and reaction on each of these aspects makes the interaction intuitive. The example of cutting paper with a pair of scissors is used to introduce and explain the six unification aspects.

**Time**

The product's reaction and the user's action coincide in time. There is no delay in time between moving your thumb and finger towards each other (action), the change of orientation of the blades (reaction) and the incision these blades make in the paper (function).

**Location**

The reaction of the product and the action of the user occur in the same location.

The paper is cut where the scissors touch it. One can argue that the location of your fingers and your hand do not coincide with the cut of the paper. But because the scissors become an extension of your hand when cutting the paper (Heidegger's concept of 'ready-to-hand' or 'zuhanden') [Note: further explain the concept], you act through the scissors at the same location as the paper is being cut.

**Direction**

The direction or movement of the product's reaction (up/down, clockwise/counterclockwise, right/left and towards/away) is coupled to the direction or the movement of the user's action.

The direction of the incision is the same as the direction of the blades following the orientation of the cutting hand or the paper. Moving the scissors further into the paper makes for a longer incision.

**Dynamics**

The dynamics of reaction (position, speed, acceleration, force) is coupled to the dynamics of the action (position, speed, acceleration, force).

The speed of the cutting action determines the speed of the incision being made. A smooth and continuous motion of cutting and orientating the paper results in a smooth and flowing incision. Likewise, a consecution of discrete cuts and reorientations of the paper results in an accordingly choppy incision.

**Modality**

The sensory modalities of the product's reaction are in harmony with the sensory modalities of the user's action.

When the blades touch and cut the paper this can be seen and heard. In nature the touching of two objects can cause a sound. Moving an object can be visually perceived... these relations between the different modalities are natural...

**Expression**

The expression of the reaction is a reflection of the expression of the action.

The user can express himself in the cutting of the paper. For example when the user is in a hurry, it probably results in imprecise and hurried actions. This is reflected in the incision in the paper. In mechanical products this aspect is often strongly related to the aspect of dynamics.

The previous six unification aspects are not limited to mechanical products but can also be used to couple action and reaction in electronic products.

### 6.3.2 Reality hits back

Unlike in purely mechanical products, in which action and reaction are naturally coupled, in electronic products this does not have to be the case. This is fortunate in the way that electronic products do not have to follow the tight coupling laws of the physical world, which allows for programmable products, remote controls...
and enjoying music without constantly having to touch the strings of a guitar yourself. Electronic products can introduce elements of magic and surprise, that seem to go beyond the laws of nature.

It is unfortunate, on the other hand, that an interface is needed to mediate the user’s action to the product’s function. This mediation hinders an intuitive interaction, because there is no longer a natural and direct coupling between action and function.

In product design, designers striving for intuitive interaction can reinforce a natural coupling by unifying action and reaction on as many aspects as possible. But as more functionality is added to electronic products full unification on all the aspects may be difficult or even undesirable to achieve because intuitive interaction needs to be balanced with technology, ergonomics, production costs or aesthetics.

For example, if we consider adjusting the volume in audio equipment we could strengthen the coupling between the action and function by uniting the location of the control with the location of the loudspeaker. From a comfort point of view, this may be acceptable for a portable audio-system but it would be rather awkward for a home stereo system in which the speakers occupy the corners of the room.

Another example is the making of coffee. Unity in time of the action indicating a need for coffee and getting the coffee is technologically possible for an instant coffee dispenser but not for an espresso machine.

When it is not possible for designers of electronic products to establish direct couplings between action and function information is needed. Information that can guide the user’s actions towards the intended function. This is the area of feedback and feedforward.

In the next section I focus on these issue of feedback and feedforward and distinguish three types of information: functional, augmented and inherent.

6.4 Feedback

Feedback is one of the most common used design principles in interaction design next to visibility, constraints, mapping, consistency, and affordances [Norman, 1988]. Feedback can be defined as ‘the return of information about the result of a process or activity’ [American Heritage Dictionary]. In interaction design this seems to be interpreted as ‘any type of returned information will do’.

The following example illustrates the different types of returned information.

When you push the on/off button to turn on the television...
...you feel it move inside the housing, you feel the resistance of that button, you hear and feel a click and release the button.

A red light next to the button lights up.

Slowly the screen lights up, you hear a voice and you can make out the 9 o’clock news.

In this example different types of feedback can be identified: the click of the button, the red light and the actual appearance of images on the screen and sound from the speakers. They are all forms of information the user receives about the effectiveness of his action. Usually when a subdivision of feedback is made, it is done on a sensorial basis, i.e. auditive, tactile, verbal and visual. Although this is useful when discussing sensory richness or multimodality, there is a categorization that underlies the sensory. I distinguish three other forms of feedback: functional, augmented and inherent feedback.

6.4.1 Functional Feedback

“...Slowly the screen lights up, you hear a voice and you can make out the 9 o’clock news.”

When the user receives this information from the television it is clear to him that his actions were successful, that his needs and desires to watch television are met. This
information relates directly to the function of the product, it is the actual purpose of the product. Functional feedback is therefore defined as the information generated by the system when performing its function, e.g. sound, light or motion.

As one product can have multiple functionalities and features, this form of feedback should be viewed in respect to the needs and desires of the user.

When functional feedback can not be naturally coupled to the user’s actions additional information is needed.

6.4.2 Augmented feedback

“...A red light next to the button lights up.”

In the television example, because there is not a direct coupling in time between the action of pushing the button and the appearance of an image, the designers opted for adding the red light.

The information that the user receives from this light is called augmented feedback. The term augmented feedback is found in the field of the psychology of learning [Laurillard (1994)] to refer to information not coming from the action itself (which is inherent feedback), but from an additional source. Since it is not coming from the action itself, but from an additional source, augmented feedback appeals more to the cognitive skills of the user instead of appealing to the perceptual motor skills.

In product design this kind of feedback is usually added to inform the user about the internal state of the system through the use of Light Emitting Diodes, Liquid Crystal Displays and added sounds. It can indicate ‘stand by’, ‘waiting’, ‘sleeping’ (see figure 2), ‘processing’ etc.

6.4.3 Inherent feedback

“When you push the on/off button to turn on the television... 
...you feel it move inside the housing, you feel the resistance of that button, you hear and feel a click and release the button...”

In the example of turning on the television the displacement, the feel and sound of the button when pushed is inherent feedback.

Inherent feedback is the information that is returned from acting on the action possibilities and therefore appeals to the perceptual motor skills of the user.

A definition of inherent feedback can be found in the field of the psychology of learning where Laurillard defined it as “Information provided as a natural consequence of making an action. It is feedback arising from the movement itself.” [Laurillard 1994].

Figure 2:Augmented Feedback: The Light Emitting Diode of this Apple Powerbook is an indication of the sleeping state of the system. The light has the expression of a relaxed breathing pattern.
Figure 3: Inherent feedback; both buttons give inherent feedback during the action of pushing. One can see, feel and hear the button being pushed. Only the button on the right gives information about it being pushed even after the action has ceased.

In product design this form of feedback was usually treated as a by-product of the choice for the controls. But as the awareness of the multi-sensorial character of interaction grows, designers do not consider only the visual appearance of a control but also its sound, touch and feel.

6.5 Feedforward

Feedback is the information that occurs during or after the user’s action. But before the user’s action takes place the product already offers information, which is called feedforward. The same three division of inherent, augmented and functional can be applied to feedforward as well.

6.5.1 Inherent feedforward

Inherent feedforward, like inherent feedback is related to the action possibilities of the product and the perceptual motor skills of the person. It is the information that communicates what kind of action is possible (pushing, rotating, sliding) and how this action can be carried out (the amount of force that is possible, which parts of the body etc.). Inherent feedforward can be viewed as a dry interpretation of the concept of affordance [ref.], i.e. where action is considered regardless of function.

Figure 4: Inherent feedforward; the controls in the left picture affords pushing, while the ones in the right communicate the possibility of turning.

6.5.2 Augmented feedforward

When the user receives information from an additional source about the action possibilities, or the purpose of the action possibilities, it appeals to his cognitive skills (for example through words, pictograms or spoken words). This information is referred to as augmented feedforward. Examples range from on-screen messages indicating what to do (figure 5), to lexical or graphical labels communicating the purpose of the action possibility.

Figure 5: Augmented Feedfoward. The display of this Nokia mobile phone informs the user about the appropriate action that needs to be taken to unlock the
6.5.3 Functional feedforward

Functional feedforward goes beyond the action possibilities and their specific purpose and instead informs the user about the more general purpose of a product and its functional features.

Product designer can draw on concepts such as product semantics [ref.] and on making the functional parts visible [ref.] to inform the user about the functionality of the product (Figure 6).

The following section describes how the aforementioned issues of inherent, augmented and functional feedback and feedforward relate to the user’s action using the six aspects i.e. time, location, direction, dynamics, modality and expression.

6.6 Framework

In the previous sections I introduced the aspects of the framework. Figure 7 is an illustration of the different types of information the product can offer.

I also introduced the six aspects of a natural coupling between action and reaction. i.e. time, location, direction, dynamics, modality and expression.

How can this framework be used to restore natural coupleings between action and function and strengthen intuitive interaction.

Figure 6: Functional feedforward: The functional component of the television screen informs the user about the function of the product.

The idea is that if a direct coupling between action and functional information is broken because of technological, ergonomic, financial or aesthetic limitations new coupleings should be established in the design. These new coupleings should bridge action and function via the use of inherent or augmented information. Figure 8 is a schema which visualizes all the different coupling possibilities.

In many current electronic products the bridges between action and function are realized through the use of augmented information, which results in LCD displays and the lexical labelling of action possibilities. Guiding the user’s action towards the intended function therefore, puts a lot of effort on the user’s cognitive skills.

Another observation of current electronic products is that while the product functionality does offer differentiations on most of the six aspects, the bridges between action and function are realized mostly through the unification
of just two of the six aspects, i.e. time and location [Norman's concept of ‘mapping’], which results in the use of appropriately placed buttons.

Other interaction styles focus on ‘natural interaction’ by making use of gestural and speech interfaces. They exploit the cognitive and perceptual motor skills of a person. Although rich in action possibilities these interfaces lack inherent feedback and feedforward and completely rely on a direct coupling between action and function or on couplings through augmented feedforward.

Graphical User Interfaces (GUI) are poor in action possibilities and resort to the enrichment of augmented feedback and feedforward to restore the couplings between action and function.

In contrast to these different interaction styles I argue for the following tangible approach:

Through a combination of enriching the action possibilities which exploit the human repertoire of actions and the inherent feedback based in the richness of the physical world the quality and number of possible meaningful couplings between action and function are increased.

The following sections describe how this can be realized.

6.7 Coupling Action and Function: an alternative approach

The next three sections presents the issues of the tangible approach in the order of enriching the action possibilities first, followed by enriching the inherent information to end at the section where I discuss the coupling between inherent information and function. Of course in a design process these steps are iterative.

How to enrich the action possibilities?

*Enriching the action possibilities which exploit the human repertoire of actions...*

It seems that traditional interfaces of electronic products

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**Figure 8**: A schematic interpretation of all the different coupling possibilities between the functional information and the user’s action. The inherent information and augmented information can be used as ‘bridges’ when direct couplings can not be established.
allow for only one action possibility, touching with a finger or thumb. This action possibility only allows for an enrichment of coupling possibilities on the aspects of time and location. To take full advantage of a person's perceptual motor skills, the designed action possibilities should also allow for diversification on the direction, dynamics, modality and expression of the action. And to stay in line with the other issues of freedom of interaction, the interaction should allow the person to act at multiple points at once, for example by allowing for two handedness (like in the example of handling both paper and scissors). To prevent that the user can only reach the functionality through one sequential order of actions the interaction should allow for multiple orders of actions. The interaction should also allow for acting on different action possibilities simultaneously (for example allowing for diversifications on the aspect of direction; pulling and rotating at the same time).

Merely enrichment of action possibilities in person-product interaction is not enough. It should result in corresponding inherent information to bridge the action to the function.

How to enrich inherent information?

In traditional product design the power of inherent feedback has been limited to the look, sound and feel of the controls. The sensory aspects of inherent feedback improved both the visual aesthetics of the product appearance as well as the haptic and auditory aesthetics of acting on the action possibilities. The power of inherent information does not have to end at providing aesthetically pleasing feedback during the action. When an action possibility offers inherent feedback, even after the action has ceased, it can blend into inherent feedforward to guide further actions towards the intended functionality.

Inherent Traces of Action

Feedback can occur both during and after the action. During the action there is always inherent feedback, since acting on the action possibilities always offers tactile and/or visual feedback.

The possibility of offering inherent feedback even after the action has ceased, depends on the designed action possibilities. When acting on appropriately designed action possibilities and the modulation (Modulate: To adjust or adapt to a certain proportion; regulate or temper) of these action possibilities still exists after the action, new information is generated. In its simplest form it is evidence for the user that he has acted on the action possibilities, as if it were a trace of the bygone action.

Figure 9: In both alarm clocks acting on the action possibilities give inherent feedback during the action. One can see and feel the action. Only the action possibilities of the alarm clock with the sliders (bottom picture) give rich information about it being acted upon even after the action has ceased. The alarm clock carries a trace of the expression of the action. The modulated appearance of the slider alarm is evidence for the fact that it has been acted upon, as if it were a trace of a bygone action.
The trace in figure 9 is an example of inherent feedback where the modulation occurred on the aspect of expression. The modulation of inherent feedback can also occur on the other aspects. In nature traces can carry information from the six different aspects: the vapor trail of an airplane carries information about time, location and dynamics. The trail from a snowboarder reflects the dynamics and expression with which he carved down the mountain.

The conclusion of this section is that: Acting on the action possibilities should result in a modulation of the inherent feedback which in return becomes feedforward for new action possibilities.

Inherent feedback in electronic products however, is often self-referent, it only says something about the interaction between the user's actions and the action possibilities. What does matter is that it is coupled to the functional feedback. When the inherent trace is coupled to the functional feedback it offers information about the current state of the product, i.e. in which functional mode it is in. More importantly, because the acting modulated the action possibilities, information is generated, it is feedforward for how to change the current state of functionality.

Again, like merely enriching the action possibilities is futile, enriching inherent information without coupling it to the functional information will not improve intuitive interaction. In the next section I discuss how the inherent and functional information can be coupled.

How to couple inherent information to the function?

To couple the inherent information to the functional information the same six aspects can be used. Functional information should be analyzed on the following:

- time: when does the functional information appear
- location: where does the functional information appear
- direction: what direction (up/down, more/less, left/right) does the functional information have
- dynamics: what are the dynamics (position, speed, acceleration, force) of the functional information
- modality: what modalities does the functional information have
- expression: what expression does the functional information have

The extreme stance to improve intuitive interaction, regardless of technology, ergonomics, production costs or aesthetics, would be the following: If the functional information allows for a modulation on one of the six aspects, it should be coupled on that same aspect to the modulation of the inherent information and the action possibility.

Since designing electronic products is not solely about the intuitiveness of the person-product interaction, other couplings can be used. The framework invites and challenges designers and researchers for the exploration of couplings. The decision of how to couple action and function is for the designer to take, not for the framework.

6.8 Conclusion

In this chapter I presented a framework to analyze person-product interaction in terms of the couplings between action and function through the use of inherent and augmented information. How can practitioners in different fields benefit from this framework? In the following I discuss how research and design can apply the framework.

Research

Researchers of person-product interaction can use the framework in two lines of research. One is a practical
approach to analyze and compare existing products, the other is a systematic approach to operationalize intuitive interaction.

**Analysis and Comparison of Existing Products**

The framework can be used to analyze and compare existing products. The different action possibilities, functionalities and the type of information that is used to bridge them, can be identified in successful and less successful products. Comparing them provides valuable insight in how they influence the success of products.

An example of how this approach can investigate the role of tangibility is by comparing two versions of the Apple iPod (figure 10).

![Figure 10: Two versions of the Apple iPod where one has a mechanical scroll wheel and the other a touch sensitive scroll 'wheel'. The older version has a mechanical scroll wheel, which is replaced by a touch sensitive control in the newer versions. This makes that the two versions differ in dynamics (the force of rotating versus rubbing) as well as in modality of the action and the inherent feedback, where the mechanical version is richer in modality. The mechanical scroll wheel also allows for a dynamic trace since the wheel continues to rotate, be it for a short while, even when the user’s action has ceased. An experiment can test if these differences influence the usability and the experience of aesthetic interaction.](image)

**Operationalization of Intuitive Interaction**

The framework offers six aspects of natural coupling, i.e. time, location, direction, dynamics, modality and expression. These aspects can be quantified and systematically varied to result in an operationalization of intuitive interaction.

The aspect of time, or more accurately the delay of time between action and reaction, has already been investigated by Michotte [reference] to research the perception of causality, which is an important issue in the intuitiveness of interaction. Likewise the other aspects should be investigated as well.

In the previous paragraph I argued that the designing of electronic products is not only about the intuitiveness of the person-product interaction. Other criteria, like aesthetics, require different couplings than unifying them as tight as possible unification. In a systematic approach variations in the coupling of dynamics for example can be explored to improve the aesthetics of interaction.

An example of a structural approach in product design research, is a project that is currently being realized by Djajadiningrat [reference]. He designed different variations of a programmable thermostat (figure 11) in which the couplings between the action possibilities and the different types of feedback are systematically varied.

![Figure 11: One of the variations of Djajadiningrat’s tangible approach to a programmable thermostat. The designs will be evaluated on criteria of usability (number of errors, time to success) and aesthetics (self report scales) to investigate how these criteria are being influenced by different couplings.](image)
Design

The framework can be beneficial for interaction designers in two different ways. One way to use the framework is to improve existing designs, the other is to use it to design for novel interactions.

**Improve existing designs**

Interaction designers can improve existing designs by strengthening the couplings on the different aspects. An analysis of the existing product can make them aware for example of the different locations where actions, inherent, augmented and functional information occurs. Relocating one or several of the source can improve the intuitiveness of interaction. Actions that are only coupled to augmented information can be enriched by offering inherent information and therefore meaningful action possibilities as well. Instead of only offering augmented feedback in the form of a display which states ‘INSERT DISC’ (see figure 12), the designer can enrich the inherent information and therefore a new action possibility by having the tray of the disc open at the same time.

**Figure 12:** The action of turning the power on of this DVD-player provides augmented feedback. Instead of the message ‘INSERT DISC’ the designers could have opted for inherent information where the tray would open. This communicates feedback about a disc not being present, as well as providing inherent feedforward through a new action possibility of allowing for the placement of a disc.

Other options to improve existing designs is to enrich the expression of the different types of information, which is illustrated in the example of the Light Emitting Diode of the Apple Powerbook (figure 2). The light is an indication of the sleeping state of the system and has the same expression as a relaxed breathing rhythm.

**Design for radically novel interactions**

Instead of starting with existing product interaction and go from there with small improvements, designers can also choose to design for radically novel interactions.

To take this route two existing creativity techniques, each taking a different angle, offer room to incorporate the framework.

The method currently applied in workshops given by the Mads Clausen Institute (Denmark) take the richness of people’s perceptual motor skills as a starting point for inspiration (Jacob Buur’s method [reference]). Participants of the workshop present to each other a non electronic object they are expert in handling. The handling of these objects are starting points for novel interactions.

The framework can be used to analyze how acting on the objects and the functionality are coupled on the six different aspects. Strong or beautiful couplings between action and inherent information can serve as inspiration for new designs.

Another creativity technique called interaction relabelling [reference] starts with the product’s functionalities.

“In this method, participants are asked to consider an existing product, and, pretending that it is the product to be designed, to tell and act out how it works. The two products need not be related; in fact, unrelated products may lead to more creative ideas. Using unrelated products helps designers to part with the interaction style that is prototypical for the product they are designing. By forcing a mapping between things with quite different functionalities, the focus shifts from the functionality to the actual
interaction possibilities.” [Djajadiningrat et al. page 66-67] After starting with this creativity technique the framework can be applied to analyze the to-be-designed functional features on the six aspects. Exploring how they can be coupled to the action possibilities and to the inherent information of the existing products offers valuable inspiration for strong and beautiful couplings.

**Summary**

**Action possibilities**

*Enrich action possibilities by allowing for differentiations in:*
- **time:** allow for simultaneous actions
- **location:** allow for different locations where one can act
- **direction:** allow for different translations and rotations
- **dynamics:** allow for differentiation in speed, acceleration, force
- **modality:** allow for actions that can be seen, heard, felt
- **expression:** allow for differentiations of expressive action; symmetry, balance, flow, rhythm, tempo

allow for one hand or two handed action

**Inherent information**

- **time:** actions that modulate the chronology of actions
- **location:** actions that modulate the location of the action possibility
- **direction:** actions that modulate the direction of the action possibilities
- **dynamics:** actions that modulate the dynamics (speed, acceleration, force) of the action possibilities
- **modality:** actions that change the modality of the action possibilities
- **expression:** actions that modulate the expression of the action possibilities, color, texture, shape, material, weight, symmetry, balance, flow, rhythm, tempo

**Coupling to functional information**

- **time:** when does the functional information appear
- **location:** where does the functional information appear
- **direction:** what direction (up/down, more/less, left/right) does the functional information have
- **dynamics:** what are the dynamics of the functional information
- **modality:** what modalities does the functional information have
- **expression:** what expression does the functional information have