

Design and semantics of form and movement

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Semotion: mediating urgency through mechanical movement

Abstract

In this paper we explore movement as an alternative mediator of gradients of emotion. It is studied in a case in which four different mechanically moving objects express different levels of urgency related to catching a plane. We discuss Move Boards, Acting out, tinkering and 4D sketching [1] as relevant design tools in addition to traditional idea generation tools. From the user-test we conclude 3 out of 4 robots created a highly consistent result in the recognition of the intended communicated emotion without context and within context.

1 Introduction

Industrial Design at the Eindhoven University of Technology is concerned with the (technical) design of product functions, product meanings, and with product aesthetics of intelligent, interactive products. The majority of present interactive products focus on our cognitive abilities in interfaces that offer screens and 'binary' buttons as interaction mediators. As pointed forward by Djajadiningrat et al. good interactive products needs to include the user's cognitive, perceptual-motor and emotional skills, to go beyond interaction that feels 'stuck on' and PC-like, in order to realise products that offer appropriate interaction styles [2]. When adding emotions to interactive products we can increase its usability [8]; it could also play a key aspect for genuine intelligent behaviour that is able to adapt and

interact with the user naturally [4].

For the convenience of this paper we distinguish emotional design in three aspects: the measurement of users' emotions (input), the product's handling with emotion (processing), and the product's mediation of emotions (output). In product design, the latter is often associated with the expression of behaviour.

While static physical objects only refer to three dimensions and only have an appearance, 4D refers to the addition of a (temporal) fourth dimension, time, which translates in active behaviour expressed through movement of the object. By using designed movement added to an object, one can increase the strength of its intended emotional message compared to its non-moving counterpart [4].

The scope of our design project was to understand how movement can be used as mediator of emotion (output) and explore the possibility to mediate different emotions with its gradations through movement to realize an interaction that is alternative to current PC-Type interactions and more appropriate (to its context and humans in general).

The context of the investigation is the airport, in which the designed movement is a mediator of the levels of urgency to catch your plane (i.e. relaxed, start thinking about it, get on your way, start rushing NOW).

In order to gain empirical insight in this case, four robots were built to be mounted on the hand-luggage trolley of Schiphol Airport. Each robot uses different states and

approaches the problem with its own 'language' but all with same purpose: expressing levels of urgency to catch your plane. To test the designed movement to its meaning, effect and whether it is possible to communicate different levels of urgency, a user test was conducted. The results are used to argue our view on movement as mediator in product design.

In this paper we will discuss our design process, our results and recommendations in respect to movement in (emotional) design.

This design research project was done by a team of 4 second years' Industrial Design students who each individually designed a working, moving prototype. It is the fourth in the Semotion (Semantics of Movement) project series. The project took a time span of 16 weeks, its learning goal was to get more empirical insight in alternative interfaces and the use of emotion in product design. The project 'restricted' us in the use of movement for the expression of urgency in the context of the airport, no GUI's were allowed.

2 Methods

In order to be able to design meaningful motion, several interesting methods can be added to the traditional static product design process. In this section we describe the additional methods we used. The first two methods that are described here are explorative, used in the idea-generation process. The latter two are meant for translating meaningful movement to mechanic constructions.

We would like to stress the importance to work throughout the design process with tangible, little working models as motion perceived in 2D (designed on a computer screen) cannot be compared with its 3D counterpart as the latter offers the possibility to walk around them, have influence of lights and more important have another emotional impact.

2.1 Move Boards

To get insight in the meaning of movement, people were asked to judge static objects on valance and arousal in the abstract expressive space [6]. It is a method to quantitatively rank emotion in a user test [7]. Another judgment on these same parameters by the same test participant was done when the object was showed in motion in a video. Insight was created by means of the impact of movement added to static form. From this

exploration we realised that movement in combination with form has a higher consistency in association then static form (e.g. a static tree form might be associated with pleasance or stress a slowly moving tree is immediately associated with 'calm' and 'rest'). It proved to be a good method to understand the power and several characteristics of motion and how it can affect the form's semantics. This method can be used in the explorative stage of a process concerning motion.

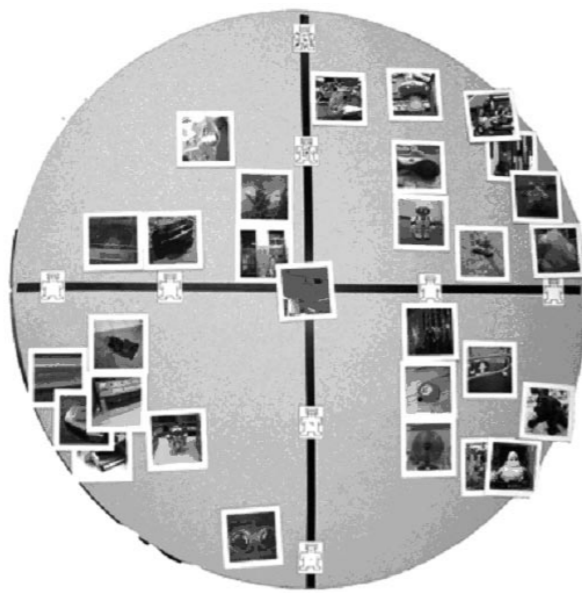


Fig. 1. The abstract expressive space; the x-axis represents valance and the y-axis arousal. The two combined represents emotion, e.g. Low Valance and High Arousal might represent Stress.

2.2 Acting out

The next step is to actively translate emotions and/or meaningful messages through bodily movement. The designer acts out the behaviour of the object to understand relevant expression and communication from the object's point of view. This works best when done in a small group and in a free-spirited way (i.e. no expectations of one another or of the session itself). Try to, step by step, reduce the degrees of expressive freedom: first utilizing the full body to do the movement, then just one or two hands and finally using an inanimate object in one hand. Trying to find meaning in motions that have just a few degrees of freedom makes it easier to translate these motions to mechanic constructions. Acting out has several advantages compared to static brainstorming: Firstly, the designer reaches an emotional state by his bodily expression, therefore he can better

emphasize with the *user* and the *product* from which he will realise the relevant expression the *interaction* needs. Secondly, because the bodily expression also includes movement, the observer designers can attribute several characteristics of movement in respect to certain behaviour.

2.3 Tinkering

Tinkering is a method of brainstorming, based on fast modelling. Using simple everyday materials like cork, cardboard and straws, ideas about form, combined with movements and mechanisms can be explored. The documentation of the previous methods can be used as inspiration sources. It is an extension of acting out applied to an object. The designer thinks of how the behaviour he acted out can be translated to form and movement.

2.4 4D sketching

This 'sketching' technique takes tinkering one essential step further: electronics & (servo) motors are added to the models. With the same basic materials (cardboard, hot glue gun etc.), but with the addition of a micro controller and servo motors, it is easy to iteratively 'sketch movement' by uploading different sets of software to the microcontroller. Using tinkering materials enables the designer to quickly change designs and improve the motions, without spending too much time on visual modelling. The designer can focus on the essential after the somewhat explorative methods of Move Boards and Acting Out in applied Tinkering; the design of relevant movement.



Fig. 2. An example of a 4D sketch

3 Objects

The airlines suggest we pass customs three hours in advance for boarding time. The airport supports a number of activities and services to make sure the travellers have a comfortable and carefree stay. We built four robots that used movement as a more pleasant, natural, powerful and relevant mediator of different levels of haste in respect to traditional cognitive mediators. The objects communicate different 'states' throughout time, e.g. "Think about going to the gate" and "Start Rushing Now!". The objects focus on the mediation of urgency, the input and the processing of the system is not considered but probably needed and feasible. Example inputs of the system might be GPS or the user's stress level.

The different approaches explained in the next section is the designer's intuitive result of the design process described earlier.

3.1 Wuddy

Wuddy is based on the power of human expression; the movements are inspired and closely related to human movements. The robot has three degrees of freedom: it can turn, tilt and open its 'mouth'. At key moments in time, a new state such as e.g. "start rushing now" occurs; it tries to attract the attention of the user in an anthropomorphic manner with in this case as goal to send him to board. In time between those key moments, Wuddy appears to be dancing. As time progresses the dancing differs to express the urgency. The dance starts very slow, with low amplitude, and in harmony. Next the dance becomes faster with higher amplitude, but still in harmony. In the final state the dance becomes random, utilizing fast movements with the highest amplitude and no harmony. By doing this Wuddy expresses panic.



Fig. 3. 'Wuddy' uses anthropomorphic expression in his mediation of urgency.

3.2 Licium

Licium is a robot built on abstract movements as well as abstract shapes. The robot consists of a frame containing beaded strings, it forms a planar, which is moved both vertically and horizontally to create a wave-like effect. The movement is directly triggered by two servo-motors, but is also influenced by gravity and oscillation as well. These additional factors cause the beads to follow their own path which is indirectly controlled by the behaviour of the user. The variations in urgency are mediated by varying the speed and amplitude of the moving beads. By increasing these parameters three predefined states are communicated with the following goals: the first state is meant to be very low-key, relaxing; the second is aimed at encouraging the user to go to the gate; the last mediates there's no time to waste, like a final call.

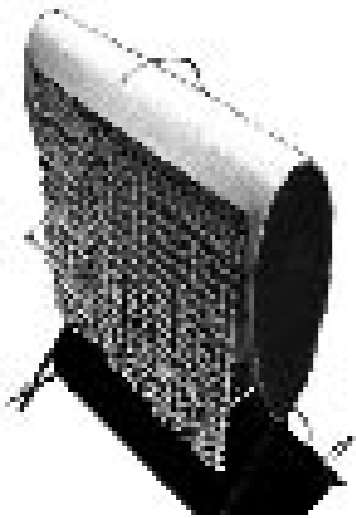


Fig. 4. 'Licium' uses a wave-like effect to express urgency.

3.3 Forest

Forest uses an abstract appearance to express urgency; no association was used in the design of the shape and movement. To create behaviour for Forest that is cohesive, consistent, perceivable and in the context of the airport, a personality [8] that resembles a travel agent is used to translate behaviour to movement. Forest expresses multiple emotions such as pride, politeness and dominance. The movement, caused by three rotating blades, expresses emotion by varying the relative rotation of the blades, the speed of the rotation and the stability of the rotation. A fast smooth synchronic running program communicates enthusiasm and pride ("Welcome to the

airport!, there is plenty of time") while a slow stuttering a-synchronic movement expresses dominance ("I really insist you board now!"). Although the movement is modelled after a travel agent, neither shape nor movement is anthropomorphic. The unit becomes part of the handlebar of the trolley, it is placed between the hands so that the movement takes place in the private zone of the user. This was done to create a feeling of trust with user.

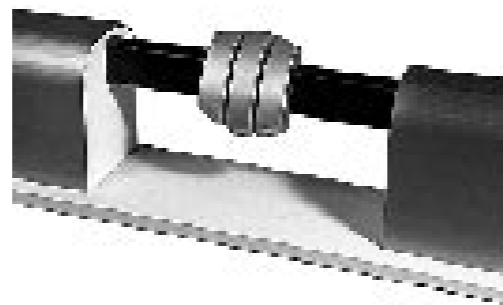


Fig. 5. 'Forest' expresses a combination of emotions by speed of rotation, the relative rotation of the blades and the stability of the movement

3.4 Squabbles

Squabbles consists of three similar looking objects, positioned in a row. Instead of mediating the level of urgency through a single object, this task now becomes a group effort. Two types of movement sequences can be distinguished: movement suggesting discussion between the three objects themselves and movement addressed to the user, in which the objects try to communicate a state of urgency. There are three states of urgency, 'relax/stand-by' (low urgency level), 'activating' (medium urgency level) and 'stressing' (high urgency level). The purpose of the intermediary 'internal discussions' is to raise the trust of the user regarding the correctness of the next level of urgency that is displayed.

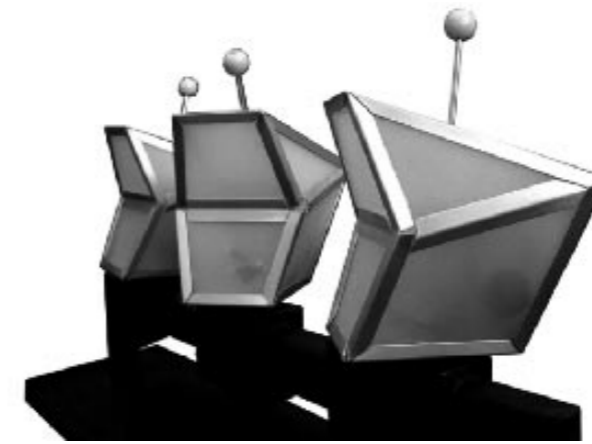


Fig. 6. 'Squabbles' communicates urgency by means of their internal communication and their collective efforts to help the traveller

4 User test

The user test was set up to test whether the robots are capable of communicating the correct message to participants, thus to verify if movement can be used to mediate different levels of emotion.

The user test consisted of two methods; the first method was used to understand the meaning of the designed movement without context. The participants were asked to judge the movement in the abstract expressive space (Valence, Arousal) extended with "Dominance" by filling in a form after they watched a state of the program of the object (e.g. state "you have enough time"). The participants were told neither about the purpose of the object nor the setting of the object. The order of the states throughout time was randomized to eliminate relative judgment. The focus of this method was only the movement. A typical test lasted around 5 minutes a robot with an average of three judgements (there are multiple states throughout the program).

In method 2, participants had to judge the different 'emotional' states of the object in relation to an urgency level on a scale from one to six. Beforehand, they were informed about the purpose and were placed imaginarily into the scenario of the airport. To gain more insight in their motivation of their choices we asked them to think out-loud about the expression and the association they made. The states were presented in a logical order, from not urgent to very urgent.

The total number of participants was 40 of which 8 participated in method one. The rest participated in method 2. The participants were a mix of students and employees of the university who weren't acquainted with the project.

5 Results

The test results show that the participants ranked the amounts of urgency displayed in relation to the other states with fairly high accuracy regarding the robots Wuddy, Licium and Squabbles. De-contextualizing and randomizing the order of the states shows no significant effects on the perceived relative levels of urgency regarding these robots (the final, most urgent state, is ranked lower on urgency compared to the test with context, however it is still recognized as the most urgent state). The fourth robot, Forest, had less consistent results. While the intended meaning of some movements of Forest were clear, the meaning of others failed. Randomizing the order of Forest's states had no effect on the ranking of the levels of urgency and only resulted in less explicit ratings.

6 Discussion

We start by discussing the results of our objects in respect to its intended purpose: mediating levels of urgency. We also compare mechanical moving objects with its cognitive counterpart as mediator of emotional expression based on our empiricism. We end the discussion by recommendations and our experience in the design of movement in product design.

6.1 Results of the 4 robots

- There seems to be an apparent relation between the level of arousal of the object and the level of urgency as perceived by the participants. This could be explained by the fact that humans tend to get more stressed (i.e. increasing arousal) when the urgency-level increases. This human characteristic might be projected on the robots by the participants. Forest did not have such a strong relation between the intensity of arousal of the movement in respect to the level of urgency, because its focus was on mediating urgency-related emotions (the slow, stuttering movement was perceived as relaxed instead of stressed). This lack of a single clear parameter might explain the inconsistent results of Forest.
- Two of the robots (Licium and Forest) used mostly abstract movements and shapes, whereas the other two (Wuddy and Squabbles) based their movements more on associative movement. The linguistic motivation of the participants showed that associative movements offer many possibilities to add (complex) meaning to movement, but also shows an important pitfall:

associations can have completely different meanings to different people (e.g. the 'activating' state of Squabbles was both perceived as a happy dance and a militaristic parade). On the other hand, the exploration of the meaning of more abstract movements might give us more insight in the universal properties of movement determined by the visceral part of our brain (just as bright colours and rhythmic beats have an automatic positive affect [8]).

6.2 Mechanical Moving Objects versus its cognitive counterpart

One might wonder why our approach is different compared to its cognitive counterpart (reading from a watch or a screen) since both involve the 'reading' of information.

Instead of rationally telling how much time the user has left we use the emotional capabilities to mediate an equivalent emotional message: E.g. relax, you have enough time (considered the time left and the position you are). From the user test remarks we witnessed 'people' are capable of recognizing the intended emotional messages expressed through mechanical movement without knowing any rational data such as time and location. We feel that by presenting (emotional) information by using the interfaces we proposed, we created an alternative interface method compare to PC-Style screens and buttons, that is more pleasant, richer, fun, relevant and more closely related to people.

Since our proposed designs deals with emotional information we also feel that a screen showing movement cannot replace the mechanical moving objects. A screen is more related to our cognitive abilities because it is not 'real'. It also has a lower 'impact' because movement is closely interlinked with the third dimension and because physical objects share the same physical context with the user. Beside those conceptual reasons, it also has some functional benefits: one can walk around them and it could be used for tangible manipulation in future projects.

6.3 Recommendations & Experience

As reminder for the paper we state our beliefs around the use of movement as mediator of emotion based on the user test, informal user remarks and our design experience:

- Movement can be used to express emotion and gradations of emotions that can be recognized by different users.
- Motion added to static products immediately expresses behaviour, whether it is intended our not. One must realise this when movement has a functional character such as the opening of a cd-tray.
- Interaction based on movement is experienced as more natural, it is a more instinctive interaction that can take places on a visceral level instead of a cognitive level.
- We think that both the possibilities of abstract and associative movements (e.g. anthropomorphic) should be further investigated in the future, for both seem to have great potential.
- (Emotional) Information can move subtly from the background to the foreground and vice versa when using movement as interface.
- Movement as alternative interface is an enrichment to aesthetical interaction.

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