INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
3 & 4 SEPTEMBER 2015, LOUGHBOROUGH UNIVERSITY, DESIGN SCHOOL, LOUGHBOROUGH, UK

DESIGNING FOR MULTISENSORIAL INTERACTIVE PRODUCT EXPERIENCES

Bahar SENER[1, 2] and Owain PEDGLEY[1]
[1]University of Liverpool, UK
[2]Middle East Technical University, Turkey

ABSTRACT
This paper presents a methodology and case study of designing for multi sensorial interactive product experiences, within the context of postgraduate degree level Industrial Design education. Building on literature spanning product and interaction semantics, and multimodal product experiences, the paper establishes a stepped approach to integrate up to six different sensory modalities (sight, touch, presence, sound, smell, taste) into a user-product interaction scenario. A product design project (bedside alarm clock) is then introduced, for which nine postgraduate students were guided to design to a certain characterful interaction (e.g. charming, helpful, amusing etc.) using multiple sensory modalities. Each of the nine resulting product designs are scrutinised for the sensory modalities that are activated, making use of a storytelling (product usage scenario) analysis. The specific sensory attributes that were harnessed are compared across the product designs and the frequency of their implementation is charted. Conclusions are reached on (i) strategies that designers employ to reach intended multi sensorial UX for their products, and (ii) the effectiveness of the educational methodology adopted for encouraging student designers to think beyond the dominant visual domain of design.

Keywords: Senses, aesthetics, interaction, UX.

1 INTRODUCTION

User experience (UX) of products - sometimes referred to directly as ‘product experience’ - is a complex area of work falling within the remit of industrial design. Proper attention to UX requires designers to apply investigation, empathy and creativity to understand and shape the varied ways in which target users will preferably perceive and process their experiences of a new product. One of the significant factors in UX and contemporary 'design for interaction' (DfI) is multi-sensory engagement during product contact and interaction, for the purposes of affecting an interesting, coherent and positive overall experience [1]. However, relatively few case studies of how to design for multimodal product interaction exist, and even fewer studies offer insight into how such an important competence in industrial design may be nurtured in a tertiary education environment.

In the context of physical artefacts, user-product interactions are fundamental to shaping people’s experiences. The conceptualization of interactions at the front end of a project is a critical design step. DfI is a multifaceted and complex activity, requiring understanding of various characteristics of products, users and usage. Its basic premise is to design a product such that it leaves a trail of positive impressions on people through a series of definable interaction ‘events’.

Carefully thought-through interactions are seen as a powerful tool towards adding value to a product and positively influencing people’s experiences of that product [2]. Let us take for example two competing smart phones: one Apple, one Samsung. As with many A-B product comparisons in the current era of high-quality consumer goods, the functionality of both the Apple and Samsung products are similar, their retail prices are comparable, their brands are arguably equally prestigious (although invoke their own brand loyalties), their country of manufacture for the most part are likely to be the same, and both products are readily available in stores. Most of these factors are long established as central to people’s evaluation of product quality and influential on purchasing decisions [3,4]. However, with these factors becoming less differentiated, increasing importance is placed on product styling, materialization, DfI and semantics.

In this paper, we concentrate our efforts on an approach we term 'meaningful interaction', which seeks to make use of meaning concepts (usually expressed as adjectives or phrases) to steer intended interaction experiences in a characterful and multisensory direction. 'Meaningful interaction' is seen as an especially useful approach to DfI because it can be used to shape the qualitative experience of user-product interaction in a direct and comprehensible manner.

2 MEANINGFUL INTERACTION & AESTHETICS OF INTERACTION

Before we define 'meaningful interaction', we will first explain the phrase 'aesthetics of interaction' [5, 6]. In its contemporary setting, the term 'aesthetics' is used to catch multiple senses, in contrast to its traditional use tied only to visual product attributes. For example, the *purring sound of a dishwasher* or the *squashable grip of a toothbrush* are as much aesthetic experiences as the *shimmering finish on a digital camera* or the *sleek lines of a motorcar.* During interaction with a product, we may gain pleasure or displeasure from whichever of our six senses (sight, touch, presence, sound, smell, taste) are activated at any given time. Designers who seek to define such aesthetic experiences are said to be concerned with *how* an interaction is experienced, or with the *aesthetics of interaction.* They may be concerned with, for example, the *smoothness* of a gear change on a car, the *sharpness* of a knife as it effortlessly slices through fruit, the *comforting softness* of a sofa, or the *slickness of navigation* around a touchscreen operating system. 'Aesthetics of interaction' plays to our hedonic needs [7], since in its absence a product may still provide acceptable functionality albeit with far less pleasure and panache.

Meaningful interaction applies the principles of *product communication theory* and *aesthetics of interaction* into an actionable approach to DfI, centred on achieving a coherent interaction vision.

- Product communication theory: product designs where people are persuaded to interact in particular ways to achieve certain tasks, whilst being blocked from interactions that are considered detrimental [8, 9]. Krippendorff [10] provided the invaluable insight that: "... one always acts according to the meaning of whatever one faces...".
- Aesthetics of interaction: product designs for which the quality of user-product interaction is appreciated, found pleasurable, irresistible, etc.

In Desmet & Hekkert's affective framework of product experience [11], a triad of interrelated sub-experiences (comprising aesthetics, meanings and emotions) is used as an additive approach to defining overall experiences from user-product interactions. Their framework is relevant here because it is founded on sensory perception. They describe a progression through the sub-experiences, principally (though not exclusively) in an iterative manner, which importantly involves ever-increasing distance away from phenomena of products (e.g. sensorial information emanating from a product, aesthetic experience) towards phenomena of people (e.g. core affect, emotional experience). Benefiting from this perspective, 'meaningful interaction' essentially becomes the semantics of user-product interaction, or *interaction semantics* – where the subject of study is the meanings people attach to sensorial information experienced during interaction. In other words, we say that sensorial information (from an interaction) 'speaks to us' (semiotics, signs) and that we can 'tell something' from it (semantics, meanings).

3 METHODOLOGY

Designers are familiar with using adjectives or phrases to guide form creation in a particular direction, with a view to conveying intended messages through product form and expressive visual characteristics. The challenge in the work reported through this paper was to take the same thinking behind adjectival design approaches to form creation and apply it to meaningful multimodal interaction experiences. That is, to ask how to develop and apply an educational approach that focused not on, for example, generating an adventurous [looking] product but instead generating an adventurous multimodal interaction experience with a product? What kind of teaching and learning steps might be required? To do this, a seven-week research and design project was initiated as part of the elective course 'ID535 Design for Interaction', given to postgraduate industrial design students enrolled at the Department of Industrial Design, Middle East Technical University.

4 DESIGN FOR INTERACTION – A TEACHING & LEARNING FRAMEWORK

The purpose of ID535 is to provide students with an introduction to interaction design (IxD) and user experience design (UxD) within the specific context of materialized products. It therefore serves as a bridge between students' competencies gained through undergraduate industrial design training and more advanced studies in the field of product experience. Although the course is necessarily quite broad in its subject matter, a key principle is always that students must apply what they have learned through a half-semester long project.

In the most recent academic session, students used their course learnings to work on meaningful interactions for new bedside alarm clock concepts. This product was chosen because of its good potential for multimodal interaction, its relative simplicity in functionality and because its form need not be constrained by conventions. During the project, students defined an interaction vision, and then realized that vision through individual interaction episodes encountered along the path of interaction. To help navigate the possibilities of multimodal interaction, and to act as a source of idea inspiration, we constructed a taxonomy of sensorial information based on a literature review of sensorial terms (Figure 1). The taxonomy was inspired in part by the Kansei approach to product evaluation [12], in which a product is regarded as a transmitter of sensorial information across sensory modalities. Students were encouraged to consider how each of the sensory modalities could feature in their concept designs.

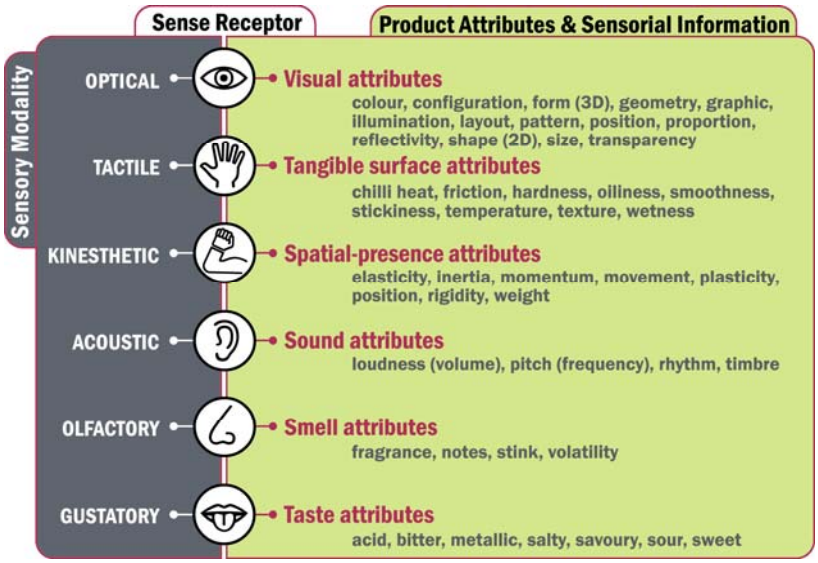


Figure 1. Taxonomy of sensorial information transmittable by physical artefacts

The project was managed across six stages, which in combination defined a method of ideation for meaningful interactions. Each stage is now described in detail.

Stage 1 – 'Visualized Connotations'. Students were individually assigned an adjective, which would later form the basis of a product interaction proposal (amongst: adaptive, amusing, calm, charming, cheerful, engaging, helpful, innovative, simple). The adjectives were chosen by the course tutors so as to stimulate considerable variety in interaction experience proposals. Students made a semantic exploration of their assigned adjective and prepared A3 posters to communicate the following.

i) By using <www.thesaurus.com> students decided on the particular 'sense' in which they would explore their adjective, and noted down synonyms for that sense.

ii) By using <www.dictionary.com> students chose a definition of their adjective and two preferred synonyms, which when combined would verbally communicate the essence of the connotations they sought to evoke.

iii) Students collated high-quality images of products and non-products that they considered to strongly embody their adjective and synonyms.

iv) From their 'product' images, students identified and justified which kinds of sensorial information they considered to convey their adjective and synonyms.

Stage 2 – 'Design Brief'. Students were made aware that the semantic explorations of the preceding stage would be taken forward in the context of meaningful interaction. The full design brief was distributed, explaining that the assigned adjectives would form the basis of product interaction ideation and development. Students were free to determine the target user for their product, based on an understanding of who may value an '…*adjective...*' interaction.
Stage 3 – 'Acting-Out Interactions'. This stage asked students to think deeply about their adjectives and synonyms and to work towards an interaction vision by building relevant usage scenarios and considering how an '…*adjective...*' interaction might be experienced in practice. Students physically acted-out their interaction and storyline ideas using supplied primitive forms.
Stage 4 – 'Product Critique'. As an in-class exercise, students were divided into groups to source Internet images and videos for 'bedside alarm clocks'. Each group created a map of product attributes that they found worthwhile for discussion, including features, interaction, forms, and technology.
Stage 5 – 'Product Development and 1-to-1 Critiques'. Students continued to develop their ideas by creating a storyboard (visual narrative) of potential interactions and product attributes.
Stage 6 – 'Final Presentation'. The completed projects were submitted as (i) a presentation board, (ii) a fact sheet, (iii) a lo-fi physical mock-up for live acting-out of interactions, and (iv) augmented reality content, projecting multimodal information onto presentation boards and/or mock-ups so that these static visuals and objects could be 'brought to life' [13].

5 ANALYSIS OF INTERACTION PROPOSALS

Figure 2 compiles the nine completed bedside alarm clock proposals, including their thumbnails, brief descriptions and analysis.

6 DISCUSSION & CONCLUSIONS

The portfolio of nine student product designs demonstrated very successfully how changes in the qualities of multimodal interaction dramatically affect product character and, hence, intended interaction experiences. The adoption of the 'meaningful interaction' approach was fruitful for stimulating creativity towards interaction visions that were distinct from convention and which potentially had commercial relevance (though this latter point was never an emphasis). Sensory activation across the student projects was distributed as follows: visual (all), acoustic (all), kinesthetic (8/9) and tactile (5/9). This is high and pleasing representation rate, showing that the educational approach was effective at encouraging student designers to think beyond the dominant visual domain of design. The potential of the approach to propose multi-sensorial UX for new products is therefore demonstrated, leading to speculation that the approach can now be adapted for use in commercial contexts. Industry-student collaborative projects would be a sensible starting point for such adaptation.
None of the projects included activation of smell or taste senses. In relation to product design, for technological and social reasons these are less easily deployed modalities and therefore less obviously considered by students in their own designs. These modalities are known to be under-represented in product interaction and feedback systems: manufactured products are rarely smelled (at least not as a step within an instrumental interaction cycle), and even more rarely tasted. That said, if the design task shifted to a different product sector where smell and taste were relevant or prominent, the 'meaningful interaction' approach could well yield good results across the full range of sensory modalities. Follow-up studies can be conducted to investigate this point.

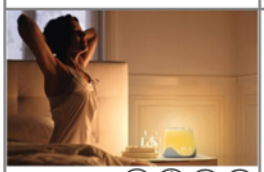
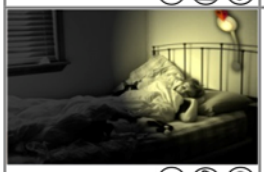
	**Adaptive Interaction**: serving or able to adapt; showing or contributing to adaptation. **'Mr.Quiet'** is a mechanical product 'creature' adaptive to users' sleep location and posture. Each day the user must set the alarm based on the amount of sleep to have, by pulling and extending the creature's tongue. Printed on the tongue is a scale of hours/minutes and a comment on whether the sleep duration is sufficient or not. The product is clipped to a nearby object (e.g. pillow, pyjama) and quietly makes its way back to the clip as the hours of sleep pass. It operates discretely by sounding its alarm and vibration in close proximity to the person sleeping.
	**Amusing Interaction**: pleasantly entertaining or diverting. The operation of **'Monolight'** uses magnetic resistance embedded in various locations around the anonymous looking cuboid body. The user sets the alarm time with a special magnetic stylus: as the magnetic resistance is felt more strongly, so the speed of the alarm adjustment increases. This gives a precision kinesthetic feel to the interaction, as well as a sense of amusement through its novelty. The amusement continues at alarm time, when a purring cat is sounded, gradually morphing into a wild cat if the alarm is not cancelled. To cancel the alarm, 'Monolight' must be turned on its head and into a recess, which requires effort to act against magnetic repulsion – surely waking up the user in the process.
	**Calm Interaction**: peaceful, quiet. **'Zen'** harnesses elements of nature for its interaction, and through each element a sense of calm is conveyed. The product gradually illuminates (mimicking sunrise) and emits initially quiet but increasingly loud sound as the alarm time approaches, to get the body prepared peacefully for waking up. Users define a soundscape by layering different 'nature' sounds (e.g. leaves, campfire, thunder) to wake up to. Each sound is represented tangibly as a pebble, making the placing and replacing of pebbles a ritualistic approach to alarm setting and cancelling.
	**Charming Interaction**: pleasing; delightful: a charming child. The icosahedron product form of **'Poly'** is purposefully captivating to generate curiosity and desire to pick it up and handle it. The product assumes a responsibility to wake up as well as tell when to go to bed (if desired) in an elegant, carefully composed manner. It has unobtrusive and clear functions shared with a smart phone (app) interface. In the morning, a random face of the icosahedron lights up, asking the user to pay special attention to locating it and shutting off the alarm by placing the illuminated face downward.
	**Cheerful Interaction**: promoting or inducing cheer, pleasantness, brightness. **'Daisy'** is animated, colourful and playful. It brings brightness at the time of waking up. The head of the clock – containing a light and ringer – leans over as it counts down to the alarm time, getting ever closer to the sleeping person's head and readying them for waking up. Unusually, one interacts directly with the 'clock hands' to set the alarm time; once the alarm time is reached, the mechanical hands literally 'clap' to sound the alarm.
	**Engaging Interaction**: winning; attractive; pleasing. **'DingDong'** tries to make the waking up process more engaging through a multi-sensory experience. Two minutes ahead of the alarm time, the product starts to warn the user with increasing auditory and visual alerts. When it is time to wake up, the display physically pops out and exposes the loudspeaker, resulting in an unsilenced and louder alarm tone. The display also exhibits a swinging motion to alert the user. Making an effort to place the display back to its base cancels the alarm.
	**Helpful Interaction:** giving or rendering aid or assistance like a caring, human-oriented and humanlike friend. **'IntelliWake'** is helpful in that it provides humanlike advice and greetings on its display, along with feedback about sufficiency of sleep durations based on the planned alarm time. Throughout the sleeping hours, the product displays how much sleep time is left. With the accompanying app, users can track their sleep durations over time and use the information to change sleeping habits for the better.
	**Innovative Interaction**: using or showing new methods, ideas; tending to introduce something new for the first time. Innovative interaction is provided in **'GameClock'** through gamification of the waking up process and the form and functions provided on the product. The product is used as part of a social network, offering 'points' to members based on whether they can wake up early compared with friends. Points are deducted for snoozing and delaying the getting-up process. Points turn to real rewards once a total has been reached, dependent on the interests of the social network.
	**Simple Interaction**: clear, easy to understand, deal with, use, etc. In **'Sooth Up'**, dual functionality of a bedside lamp and alarm clock is provided. The product body is used as a tangible joystick controller offering simple movements: the x-axis mapped to alarm time up/down, and the y-axis mapped to lamp intensity up/down. To simulate the dawn, the product gently glows and its alarm becomes audibly louder as the alarm time approaches. Snoozing or cancelling is mapped to pushing the product body forwards or backwards.

Figure 2. Completed bedside alarm clocks with 'adaptive', 'amusing', 'calm', 'charming', 'cheerful', 'engaging', 'helpful', 'innovative', and 'simple' interaction.

ACKNOWLEDGEMENTS

Our thanks are extended to our Design for Interaction students, who participated in the Bedside Alarm Clock Project: Ahmet Burak Aktaş, Efe Alpay, Koray Benli, Meriç Dağlı, Ezgi İlhan, Mert Kulaksız, Merve Özdemir, İsmail Yavuz Paksoy, Sevcan Yardım.

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