Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 158 (2019) 474–484

Procedia Computer Science

www.elsevier.com/locate/procedia

3rd World Conference on Technology, Innovation and Entrepreneurship (WOCTINE)

Emotional design: the development of a process to envision emotion-centric new product ideas

Teresa Alaniz, Stefano Biazzo

University of Padova, Italy

Abstract

There is ample evidence, in many sectors, of the crucial importance of the emotional experiences in the interaction between users and products. Generating products with richer and significant emotional features is a complex challenge. In order to better face this challenge, professionals responsible for designing and developing new products could be facilitated with techniques and tools to understand emotions and to convey specific emotions in the new products. This paper presents the development of a process to support product design teams to envision emotion-focused new product ideas - Emotion-Driven Innovation (E-DI). We have adopted the process research methodology proposed by Platts, which encompasses four main steps: 1) state-of-the-art review, 2) process creation, 3) process development, and 4) process validation. This paper presents the results of the three first steps. The state-of-the-art literature review has been the foundation of the process creation step, which resulted in a three-phase workshop-based process: Emotion Knowledge Acquisition, Emotion Goal Definition, and Idea Generation. In the third step of the research methodology, the feasibility, usability, and utility have been tested through four studies which have involved master design students from Portugal and Italy. The results of these four tests show that Emotion-Driven Innovation process supports designers 1) to identify the occurrence of emotions in certain category of products present in the market, 2) to apply this information to make strategic decisions when defining the emotional intentions for the new product, and 3) to focus their creative thinking to develop strong and meaningful emotion-centric ideas.

© 2019 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship

Keywords: emotion-driven, innovation, product design

1. Introduction

It is now widely recognized that the emotional dimension of products and services is a critical success factor in many sectors, and user emotions have been the focus of many researchers in the design literature (e.g. Norman, 2004; Porter, Porter, & Chhibber, 2007; Fokkinga & Desmet, 2013; Yoon, Pohlmeyer, & Desmet, 2016). Many studies have demonstrated the importance of knowledge of emotions in relation with product innovation; for instance, in consumer research, there is ample evidence about how emotions affect purchase decisions and the crucial importance of the

1877-0509 © 2019 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship
10.1016/j.procs.2019.09.078

emotional attachment to products (Mugge, Schifferstein, & Schoormans, 2005; Schifferstein & Zwartkruis-Pelgrim, 2008). Emotions are "high-intensity, specific feeling states that are directed at a particular object, and direct ongoing thoughts and behaviours" (Desmet, Vastenburg, and Romero, 2016). Generating products with significant emotional features is a complex challenge, as professionals responsible for designing and developing new products should be able to focus the design effort in eliciting specific emotions. This challenge has been addressed in the design literature of the last 20 years, resulting in the development of different tools supporting the task of "designing for emotions" (e.g. Desmet, 2002; Sacharin, Schlegel, & Scherer, 2012; Fokkinga & Desmet, 2013; Yoon, Pohlmeyer, & Desmet, 2016).

Adopting a widely accepted framework that subdivide the innovation effort in the two key building blocks – the front-end of innovation (FEI: from knowledge acquisition to idea generation) and the back-end of innovation (BEI: from concept definition to product-process engineering) – it can be highlighted that the majority of existing tools are focused on the BEI with the aim of measuring the "emotional content" of an already formed concept, while only a few tools are dedicated to supporting the opportunity generation area of the innovation process with a well-defined framework of emotions. The present document aims to contribute to this stream of research with the development of a new workshop-based process targeted at supporting companies in the front-end of innovation through the creation of emotion-focused new product ideas; it has been named Emotion-Driven Innovation (E-DI). We have adopted the process research methodology proposed by Platts (1993), which encompasses four main steps: 1) state-of-the-art review, 2) process creation, 3) process development, and 4) process validation (Moultrie, 2006, 2007; Platts, 1993).

This paper is focused on the first three steps of the process research methodology and is structured as follows. In section 2 the results of the systematic literature review on emotional design methods and tools are presented. In section 3 we describe the creation of E-DI and, in the following section, we illustrate the four qualitative studies that have been conducted for the process development phase.

2. Emotional design tools: a systematic literature review

The systematic literature review aims to investigate the state-of-the-art of tools aimed to support the design and development of products with emotional value. The review has been performed applying the approach proposed by Tranfield, Denyer, and Smart (2003) which is composed by six main steps: 1) identification of research, 2) selection of studies, 3) study quality assessment, 4) data analysis, 5) data findings and 6) data synthesis.

The identification of research has been conducted by applying two sets of keywords: (emotions) and (product-design OR product development OR industrial design) in the title or in the abstract. Using the Scopus database, the search resulted in 625 documents coming from very different areas. In order to identify documents focused on the practice of designing products with explicit intention to provoke emotions, another set of keywords has been added (emotional design OR design for emotion OR emotion-driven design). The search resulted in 107 documents (step 2). Then we analysed the 107 papers in order to focus only on research contributions that specifically address the tools and techniques aimed to support the creation of new products with emotional value (step 3). After this selection, 22 tools were identified. In order to evaluate the impact of the identified tools in the practices of designing and developing new products, an innovation process model was adopted as a reference framework for the analysis. This innovation process model has been structured taking into account the well-known grouping of innovation activities into two main classes (Khurana & Rosenthal, 1997; Koen, et al., 2001 & 2002; Herstatt & Verworn, 2004; Eppinger & Ulrich, 2015):1) the front end of innovation (FEI) focusing on creating new product ideas (opportunity generation process) and the back end of innovation (BEI), aimed at transforming ideas in products ready for the market (product development process). Regarding the FEI process, it is possible to identify three fundamental components (see Terwiesch & Ulrich, 2009): knowledge acquisition on the evolution of the markets and technologies; goal definition to determine the "problem to solve"; and the idea generation to create and identify exceptional innovation opportunities. BEI has been articulated in the following two fundamental phases: the concept definition phase aimed to generate product concepts for further evaluation and development; and the implementation phase, where product and process engineering take place (see Ulrich and Eppinger, 2015; Verganti, 2009).

The usefulness of the identified tools in the different portions of the innovation process model has been analysed and classified with a three-level qualitative scale (*** strong, **medium, *weak). The objective of the tool and the method to use the tool were key elements in the analysis (see Table 1). The identified tools have embraced different approaches to emotion knowledge. Emotion knowledge is the explicit knowledge of emotions, including the circumstances that provoke the emotions and how the emotions are manifested (Desmet, Fokkinga, Ozkaramanli, & Yoon, 2016).

Table 1. The usefulness of the identified tools in the innovation process model.

No.	Name	Framework of emotions	Innovation Process model				
			Opportunity Generation Process			**Product Development**	
			Knowledge Acquisition	Goal Definition	Idea Generation	Concept definition	Product & Process Engineering
1	Software Usability Measurement Inventory (SUMI) (Kirakowski & Corbett, 1993)	-	-	-	-	***	*
2	The Self-Assessment Manikin (SAM) (Bradley & Lang, 1994)	X	-	-	-	***	-
3	Pleasure-Arousal-Dominance (PAD) Emotion Scales (Mehrabian, 1995)	X	-	-	-	***	*
4	2DES (Schubert, 1999)	X	-	-	-	***	-
5	Multi-Dimensional Scaling (MDS) Interactive (Stappers & Pasman, 2000)	-	***	-	-	-	-
6	Feel-Trace (Cowie, et al., 2000)	X	-	-	-	***	-
7	PrEmo (Desmet, 2002) (Laurans & Desmet, 2012)	X	-	-	-	***	**
8	EmoCards (Desmet & Overbeeke, 2001)	-	***	-	**	*	-
9	The [product & emotion] Navigator (Desmet, 2002) (Desmet & Hekkert, 2002)	-	***	-	***	-	-
10	FaceReader (Zaman & Shrimpton-Smith, 2006)	X	-	-	-	***	-
11	The User Compass Chart (UCC) (Sperling, Kristav, Olander, Eriksson, & Hans, 2006)	-	-	-	-	***	-
12	RealPeople (Porter, Porter, & Chhibber, 2007)	-	***	-	-	-	-
13	EmoTools (Bustillo, 2007)	-	-	-	-	***	-
14	Product Attachment Scale (Mugge, Schifferstein, & Schoormans, 2005) (Schifferstein & Zwartkruis-Pelgrim, 2008)	-	-	-	-	***	-
15	LEMtool (Huisman & van Hout, 2010)	X	-	-	-	-	***
16	The emotion slider (Laurans, Desmet, & Hekkert, 2009)	-	-	-	-	***	-
17	Geneva Emotion Wheel (Sacharin, Schlegel, & Scherer, 2012)	X	-	-	-	***	-
18	**Emotion Rainbow (Desmet, 2012)**	X	***	-	**	-	-
19	**Emotion Capture Cards (ECC) (Okaramanli, Fokkinga, Desmet, Balkan, & Eapen, 2013)**	X	***	-	-	-	-
20	**Positive Emotional Granularity (PEG) Cards (Desmet, 2012)**	X	***	-	***	-	-
21	Pick-A-Mood (Desmet, Vastenburg, & Romero, 2016)	-	-	-	_	***	-
22	**Negative Emotion Typology (Emotiontypology, 2017)**	X	***	-	-	-	-
	Three-level qualitative scale		**Strong** ***	**Medium** **	**Weak** *		

There are only twelve tools that adopt a specific set of emotions (positive and/or negative). The tools with a well-defined set of emotions can better pursue the development of the competence of emotional granularity. Emotional granularity is the ability of an individual to interpret and articulate his own and other emotional states, this ability is a core advantage in design activities (Yoon, Pohlmeyer, & Desmet, 2016). From the twelve tools with a specific list of emotions, only four are useful in the front end of the innovation process; none of these tools support goal definition phase, where it is clarified the "problem to be solved" in the idea generation phase. This fact is an important research gap to be addressed, as the goal definition phase is a critical phase in the innovation process**:** the 'problem to be solved' must be defined prior to starting with any activity aimed to bring solutions (Roozenburg, 1995).

The four tools that are useful in the idea generation activities share the same characteristic: they have the objective to

generate a large number of product ideas, similar to the classic creativity techniques which are focused on fostering divergent thinking (Michalko, 2010). Those techniques are useful to generate spontaneous solutions for simple problems but unrealistic to achieve specific complex targets (Osborn, 1953; Brown, 2009).
The literature analysis, therefore, reveals a major challenge: none of the tools analysed is capable to fully support in an integrated way all the fundamental components of the front-end of innovation: this is a serious concern as the quality of FEI outputs has a profound impact on the whole innovation process (see Murphy & Kumar, 1997; Koen, et al., 2001; Russell & Donald, 2008).

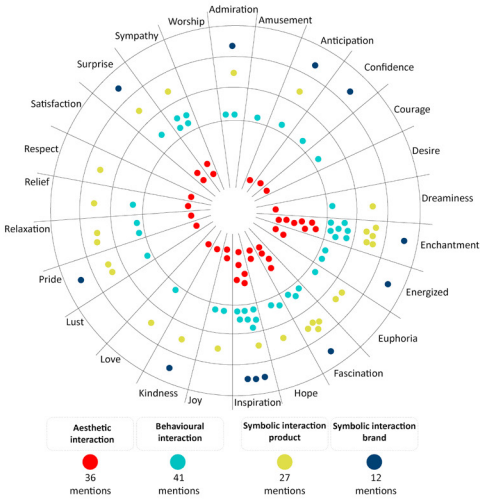
3. The creation of the process

The challenge raised in the systematic literature review is addressed in the process creation phase of the process research methodology; the ambition is to create a practical and industrially relevant process ("emotion-driven innovation" - E-DI) which can support companies to envision emotion-centric new product ideas. Three main activities have encompassed the creation of the process: 1) the elaboration of key-concepts to define the language to discuss emotions and the emotional interactions with products; 2) the definition of the main objectives of the process and its structure, and 3) the design of the methods to achieve the objectives of the process. These three activities were carried out in collaboration with a review team, composed by: two business design consultant, an expert in innovation and creativity, a manager of an open innovation company focused in design competitions, an R&D manager of a company specialized in product for organizing indoor and outdoor living spaces, and a professor of management at the University of Padova.

3.1. The language to discuss emotions in product innovation

We decided to focus E-DI on positive emotions. The explicit objective of "positive design" is to enhance people's subjective well-being (Desmet & Pohlmeyer, 2013), and the focus on the positive side of emotional experiences can better stimulate creativity, originality and innovative thinking (Desmet, Fokkinga, Ozkaramanli, & Yoon, 2016; Yoon, Pohlmeyer, & Desmet, 2016).
The approach to emotion knowledge that we have initially adopted is the framework of 25 positive emotion types elaborated by Desmet (2012). This framework emerged in the systematic literature review as the most analytic and complete collection of human positive emotions; it was elaborated from a list of 1434 emotion words, which represent the variety of positive emotions in the English language. The definitions of the emotions presented in Desmet's framework represent general manifestations of the emotions, primarily understood as experiences between people. In order to enhance the understanding of the 25 positive emotions in the practice of designing and developing new products, the concept of "emotional-job-to-be-done" has been adopted (Ulwick, 2016) and added to Desmet's emotion definitions. Emotional jobs statements are used to clarify what is the emotional effect that the product should create (see fig. 1b).
A product can perform an emotional job through a diversity of situations. It is acknowledged that a product can provoke emotions by its appearance, by the way it performs its function, by the symbolic meanings attached to the product or brand (Eisenman, 2013; Jordan, 1999; Kamp & Desmet, 2014; Norman, 2004 & Rampino, 2011). In this research project the different situations in which a product provokes emotions have been named human-product emotional interactions (H-PEI): 1) Aesthetic interaction (the physical perception of the product when it is not performing its function), 2) Behavioural interaction (the dynamic interaction with the user when the product is used as a tool to perform an activity), 3) Symbolic interaction – product level (the set of beliefs and values that a person can assign to a product), 4) Symbolic interaction – brand level (the set of beliefs and values that a person can give to a brand).
In order to explore the understandability and usability of the three key-concepts (the framework of emotions, the emotional jobs, and the human-product emotional interactions) an exploratory survey with a worldwide community of designers was conducted (the desall.com community). The questionnaire was sent to the design community through the crowdsourcing platform desall.com where participants were asked to: select a positive emotion type that a product has recently evoked; upload a picture of the product that evoked the selected emotion; using the category of the H-PEIs describe briefly the details of the product that has elicited the selected emotion. Fig. 1a displays the number of times that the positive emotions were selected in relation to the H-PEI.
The questionnaire was answered by designers from 27 different countries and a total of 70 responses were received.

An interactive workshop with the review team was organized to critically analyse the survey. This analysis represented the starting point for the refinement of the language to be used in E-DI. fig. 1b shows the final version of the list of positive emotions and the corresponding statements of the emotional jobs.



Positive Emotion	Emotional-Job-to-be-done
Admiration	The product stimulates the emergence of warm approval, respect and pleasurable contemplation
Amusement	The product gives a feeling of intense playfulness and fun
Confidence	The product gives a feeling of security and absence of anxiety (in relation to risks and uncertainties)
Courage	The product must make me feel that I am able to do difficult or dangerous things, to face uncertainty and to be able to trust and believe in my abilities
Dreaminess	The product frees the mind and helps to fantasize
Empathy	The product stimulates feelings of understanding and closeness towards other people
Enchantment	The product astonishes me and leaves me speechless
Euphoria	The product provokes a state of excitement
Hope	The product arouses a state of expectation linked to the fact that something good is about to happen or to the desire for a certain thing to happen
Inspiration	The product ignites a creative impulse.
Joy	The product arouses a state of happiness and cheerfulness
Kindness	The product stimulates feelings of delicacy and tenderness
Love	The product stimulates a feeling of profound affection towards someone or something
Pride	The product stimulates deep pleasure or satisfaction that rise from achievements
Relaxation	The product stimulates a state of peace and serenity
Relief	The product helps to get rid of a state of physical or mental stress
Sensuality	The product stimulates seductiveness or physical attraction
Surprise	The product amazes with something unexpected causing a state of pleasure
Vitality	The product makes me feel vital and full of physical and mental energy

Figure 1. (a) The selection of positive emotions in relation with the H-PEI; (b) Final list of positive emotions with the statements of emotional jobs.

3.2. E-DI: main objectives and methods

Emotion-Driven innovation is structured in three main phases: Emotion Knowledge Acquisition, Emotion Goal Definition, and Idea Generation. Figure 2 highlights the purpose, the main outcome and the methods of every phase.

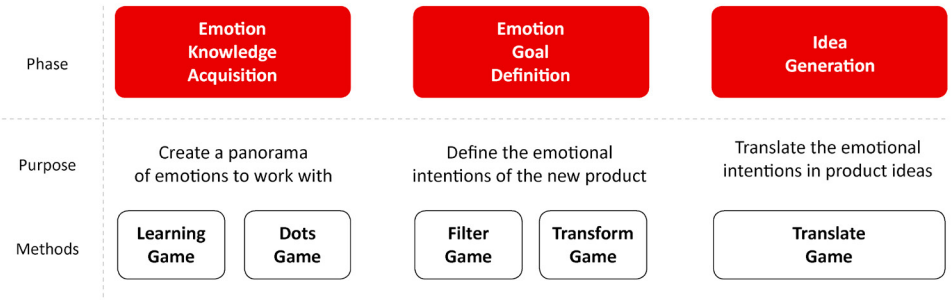


Figure 2. The structure of E-DI process.

Emotion knowledge acquisition

This phase is particularly critical because, in order to generate emotion-focused new product ideas, people involved in the project need to develop the competence of emotional granularity. This phase aims to support the team to create a panorama of emotions to work with the new product: “Learning Game” and “Dots Game” are the methods created for this phase of the process.

The Learning Game method aims to develop the competence of emotional granularity by discussing through a set of 19 cards, (figure 3a presents one of the Learning Game cards) personal emotional experiences recently evoked by the products. Dots Game is a method aimed to create a shared view of how the nineteen positive emotions are present in a thoroughly selected set of products that represent the situation of the target market. Every person has four dots to indicate its emotional experience, the person could indicate from 0 to 4 emotions. The emotional analysis is performed individually and then combined with the rest of the team.

Emotion goal definition

This phase is the core of the E-DI process; it is aimed to define the emotional intentions of the new product, addressing two challenges: to make strategic decisions by selecting the specific emotions that the new product has to evoke and to transform the selected emotions into a product design brief. Filter Game and Transform Game are the methods that have been developed to cope with these challenges.

Filter Game method allows defining the "emotional strategy" in the market for the new product, by selecting the specific emotions to work with. The circular board (see Figure 3b) facilitates the visualization of the results of Dots Game method and the discussion of the selection strategy: 1) pursue an incremental innovation strategy by targeting the most rated emotions, or 2) pursue a radical innovation strategy by targeting the "infrequent" emotions. Transform Game is aimed to transform the selected emotions into an "emotion-centered" product design brief using the four Human-Product Interactions (HPIs): team members should discuss and specify which HPIs should be used to evoke each of the selected emotions.

Idea generation

The third phase of the process aims to translate the emotional intentions in emotion-focused new product ideas. This idea generation session does not aim to generate a large number of ideas like classical brainstorming techniques (Osborn, 1953) frequently used in design thinking approaches (Brown, 2009; Kelley & Kelley, 2013); instead, it is focused to deliver few but strong and meaningful emotion-focused product ideas ("thick ideas"). The concept of "thick idea" is used here to refer to product ideas that contain rich details on how the selected emotions will be evoked in the four H-PEIs. Idea Generation is supported by the Translate Game Method, which is divided into two parts: a divergent step, where, for each single H-PEIs, the team is asked to imagine which product attributes will evoke the chosen emotions in the product design brief; a convergent step, where every team member has to creatively synthesize the inspirations that have emerged before and shaped a new product idea.

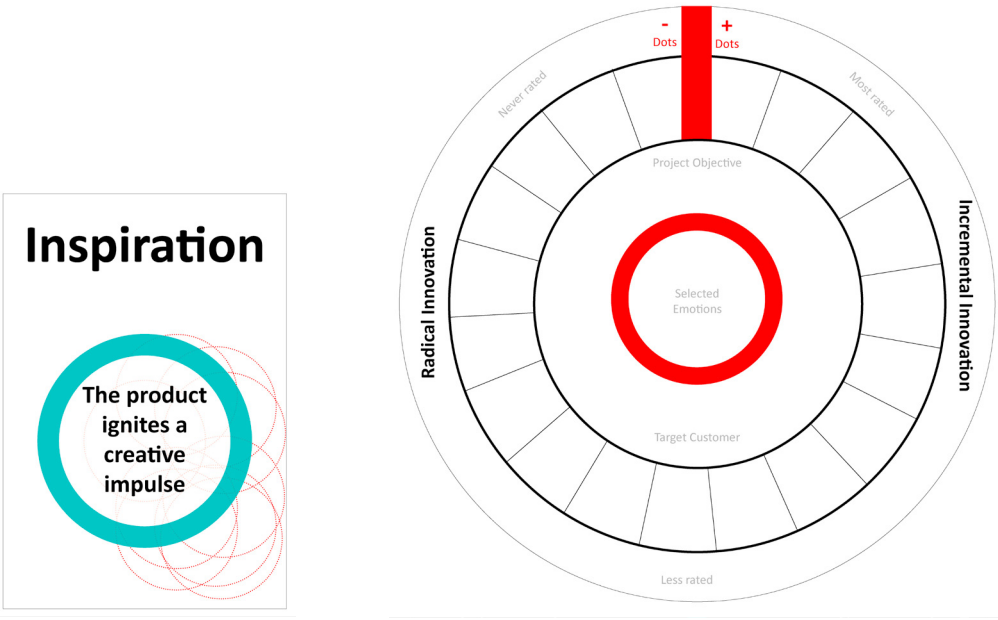


Figure 3. (a) Filter Game board; (b) The approach of the testing session of process development.

4. The development of the process

There are three fundamental conditions to be defined to develop a process (see Platts, 1993): 1) the type of involvement of the researcher: an action research approach was adopted as it is centred on the participation of the researcher as

facilitator; 2) the approach to evolve the process: we decided to iteratively refine the process after every test session, as this approach generates more robust and useful processes; and 3) the places to test the process: looking for strong improvements in the process it was decided to work in academic design environments. We tested the E-DI process conducting four qualitative studies. Two studies have involved design students without any professional practice as product designers; this profile of participants was chosen in order to assess the understandability of the language of E-DI with people that do not have any prior knowledge in the field, but at the same time they could give valuable feedback as they are open to assimilating new concepts. The second couple of studies involved senior part-time design students who, at the time of the studies, were also working as professional product designers; this profile of participants brought feedback related to the direct benefits of E-DI process in design activities. Studies 3 and 4 had the assignment of design a new home speaker in order to test all methods of E-DI.

The testing sessions involved assessing the feasibility, usability, and utility of the process. The evaluation of the feasibility of the process consists to verify if E-DI process can be executed and finished as it was laid down in the process creation phase. The evaluation of the usability of the process aims to test the structure, methods, and guidelines in order to develop an easy to use and learnable process. The assessment of the utility of the process concerns to verify whether the process is achieving its declared objectives (Platts, 1993 & 2001; Moultrie, 2007). Table 2 presents the approach of the testing sessions and the methods and moments where the feedback was gained.

Process Development Phase			Study 1	Study 2	Study 3	Study 4
Methods tested		Learning Game	●	●	●	●
		Dots Game			●	●
		Filter Game			●	●
		Transform Game			●	●
		Translate Game			●	●
Criterion	**Method to collect feedback**	**Moment to collect feedback**				
Feasibility	Direct observation	After the workshop			●	●
Usability	Direct observation	During the workshop	●	●	●	●
	Semi-structured interview	After the workshop	●	●	●	●
Utility	Direct observation	During the workshop			●	●
	Semi-structured interview	After the workshop			●	●
	Worksheets				●	●
Places			University of Minho - School of Architecture (Guimaraes, Portugal)	University of Porto - Design Studio FEUP (Porto, Portugal)		Scuola Italiana Design (Padova, Italy)
No. Of participants			12	4	4	7
Participants profile			Master design students	Ph.D. design students	Master design students and PhD students / Professional product designers	Master design students / Professional product designers

4.1. Results

The results of the four studies qualitative have been organized along three main themes: 1) the understanding and utilization of the "emotion language", 2) the achievement of the objectives of every phase of the process; 3) the capability of the entire process to support emotion-centric idea generation. Figure 4 displays the synthesis of the results.

	Language	Phases	Outcome
		Related criteria	
	Usability	Feasibility Usability Utility	Utility
+	**Understanding and using the language**	**Achieving the objectives of every phase**	**Supporting emotion focused idea generation**
	The statements of emotional jobs have facilitated to identify and differentiate the nineteen positive emotions.	***Objective 1: create a panorama of emotions to work with***	There is a similar understanding of the selected positive emotions for the new product; the ideas generated expressed similar characteristics despite the fact that every person generated the new ideas individually.
	The statements of emotional jobs have supported to generate a similar understanding of emotions between the team members.	The simple design of the Dots Game method has facilitated the accomplishment of emotional analysis by every participant.	
	The statements of emotional jobs have helped to recognise emotional experiences caused by products.	The creation of the panorama of emotions for the new product (which is the combination of the individual emotional analysis of all team members) has raised useful discussions to: gain knowledge about positive emotions, to understand own and other's emotional states, and to compare positive emotional states towards the same stimulus.	The new product ideas contain specific details related to every situation of the human-product emotional interactions.
	The application of the concepts of human-product emotional interactions has raised designers awareness about the different scenarios in which a product and its attributes (tangible or intangible) may spark different emotions.	***Objective 2: define the emotional intentions of the new product***	The new product ideas expressed novel features compared to the sample of products that was used to perform the emotional analysis.
	The application of the concepts of H-PEIs has helped designers to express their visions explicitly and coherently, yielding as a result of holistic emotion-focused ideas.	The circular board of Filter Game has stimulated the exchange of opinions, opened discussions and facilitated equal interaction between participants.	
		The concepts of radical and incremental innovation used in the Filter Game method have supported strategic decisions at defining a clear vision of the objectives of the new product in relation to the user, customer, or products from competitors.	
		The product design brief created in Transform Game method had stimulated systematic thinking by structuring the short list of positive emotions in relation with the H-PEIs.	
		Objective 3: translate emotional intentions in new product idea	
		The guidelines and boards of Translate Game method have helped to focus on creative thinking.	
		Step 1 of the Translate Game method has fostered convergent thinking by allowing the participants to express freely all their thoughts about the attributes for the new product idea.	
		Step 2 of the Translate Game method has encouraged convergent thinking by interpolating the inspirations created before in one new product emotion-focused idea.	
		The board of idea generation has facilitated to express the new ideas in a holistic way.	
-	The combination of emotion cards and human-product interaction cards created confusion to use Learning Game method.	**Objective 1: create a panorama of emotions to work with**	
	The Symbolic interactions (product and brand level) were difficult to understand as different interactions.	The lack of product images in the matrix of the Dots Game method was a disadvantage in the emotional analysis.	
		Objective 2: define the emotional intentions of the new product	
		The visual design of the circular board of the Transform Game method did not facilitate to write down the objectives of the new product.	
		Objective 3: translate emotional intentions in new product idea	
		The dimension of the board to generate ideas in Transform Game method was not sufficient to facilitate the expression of ideas.	

Figure 4. Synthesis of the results of the qualitative studies.

Understanding and using the language

The statements of emotional jobs have supported participants to understand the differences between the 19 positive emotions; even more in the emotions that seem to have the same meaning (e.g. Relaxation and Relief). From observing participants using the language of E-DI, we can state that the vocabulary and the guidelines to apply it have raised useful discussions where participants shared and listened how positive emotional experiences are caused by products, and how emotional experiences can vary depending on the context where a person interacts with the product. These activities helped to create a common understanding of the emotions and to formulate new ideas to enrich emotional experiences. Regarding the H-PEIs, participants commented that the symbolic interaction **at** product level and brand level were difficult to recognize as two different interactions. The feedback was taken into account to reformulate the H-PEIs as three interactions (Aesthetic, Behavioural, and Symbolic) and to present these concepts in a different format in the following workshops.

Achieving the objective of every phase

Regarding the three objectives of the E-DI process, we observe that the creation of the shared view of how emotions occur in a sample of products was an inspiring and useful activity to participants. Participants expressed satisfaction with an analysis that involved identifying their emotions. Participants suggested to include the picture of the products that are being analysed in the Dots Game matrix in order to facilitate the activity. The achievement of the analysis had helped to understand how different emotional experiences can be caused by the same product.

Studies three and four have shown that the visual design of the Filter Game stimulated the equitable participation of people. The concepts of radical and incremental innovation have been crucial elements in the selection of emotions for the new product. The correlation of the categories of innovation with the results of the emotional analysis had encouraged deep reflexions 1) select the emotions to pursue a category of innovation and 2) to understand what the selected emotions signify to the people that are involved in the design activities. The concepts of incremental and radical innovation have served as a guide to visualize the objectives of the new product. Participants also found good support in the Transform Game method to structure and itemize the objectives.

As far as idea generation is concerned, the Translate Game method stimulated divergent and convergent thinking. The generation of details encourages the expression of all thoughts about how selected emotions can be provoked; while the creation of ideas helped to synthesize the inspirations created before to shape an idea able to achieve the stated objectives. The visual design of the Translate Game method was modified according the feedback of participants: we modified the size and the visual structure of the board in order to facilitate an adequate expression of the idea.

Results of:	Study 4		
Filter Game	Positive emotions selected		
	Confidence, Surprise, Pride and Admiration		
	Emotions from incremental innovation spectrum		
Transform Game method	The selected emotions in the Human-Product Emotional Interactions		
	Aesthetic	**Behavioural**	**Symbolic interaction**
	Admiration	Surprise	Admiration
	Pride	Confidence	Confidence
	Perceived by the senses of the human body of:	**At the moment of:**	**Symbolizing**
	Hearing	Before using it	Sculpture
	Sight	While using it	
Translate Game method	**Translate Game method - details written in step 1**		
	Speaker as sculpture	Feedback with LED lights	Interaction with the delivery date
	Architectural piece in scale	Wow effect by discovering functions	High-end materials
	Different textures to touch	Facial recognition to play personalized playlists	Communicate the values of the brand
	Fine lines	Controls that disappear or appear according interaction	
	Contrast of empty and full space	Additional functions to the usual intended for a speaker	
	Iconic shape		

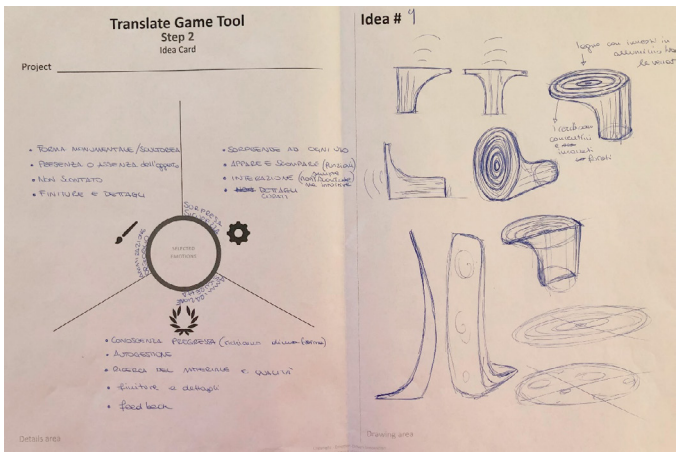


Figure 5. (a) Output of worksheets of study 4; (b) Idea generated in study 4.

Supporting emotion-focused idea generation

The ideas generated in study 3 and 4 expressed novel features compared to the sample of products used to perform the emotional analysis, with very specific details on the human-product emotional interactions; this is a reassuring result as the main aim of the process is to foster the generation of novel and emotion-centric product ideas. Even though the ideas were generated individually in the Translate Game and expressed different morphological configuration, the details on "how to provoke emotions" among the ideas are conceptually similar. This fact emphasize that the team has unified their understandings on the selected emotions and focused the creativity effort on specific "emotional directions". Figure 5a displays the outputs of the worksheets of study 4 and figure 5b presents one of the ideas created in this last qualitative study.

5. Conclusions

Emotional design research has made significant efforts to demonstrate the value of emotion knowledge in design practices. The four qualitative studies presented in this paper have been proven that Emotion-Driven Innovation process is an approach that can be applied to generate ideas with rich emotional content. In the early phase of the process, participants identified how emotions are present in a specific sample of products (the "panorama of emotions"). This "panorama of emotions" was thereafter correlated with the concepts of radical and incremental innovation and opened discussions that had effectively supported the emotional goal definition. In the last phase of the process participants said they felt inspired and confident to express their ideas, even though it was the first time they were challenged to ideate something with explicit emotional goals and guided by a specific framework of emotions**.** Based on current findings, the next step of our research will be focused on process validation in order to apply E-DI process in contexts of real design practice.

References

[1] Bradley, M., & Lang, P. J. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, pp. 49-59.

[2] Brown, T. (2009). *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation.* HarperBusiness.

[3] Bustillo, C. (2007). *Emoscope: An Emotional Usability Tool. Formalization and Application in User- Centered Design (UCD).*

[4] Cowie, R., Douglas-Cowie, E., Savvidou, S., McMahon, E., Sawey, M., & Marc, S. (2000). 'FEELTRACE': An instrument for recording perceived emotion in real time. *ISCA tutorial and research workshop (ITRW) on speech and emotion.* Newcastle.

[5] Desmet, P. (2002). *Designing emotions.* Delft University of Technology, Department of Industrial Design.

[6] Desmet, P. (2012). Faces of Product Pleasure: 25 Positive Emotions in Human-Product Interactions. *International Journal of Design*, pp. 1-29.

[7] Desmet, P. M., & Pohlmeyer, A. E. (2013). Positive design: An introduction to design for subjective well-being. . *International journal of design*.

[8] Desmet, P., & Hekkert, P. (2002). The basis of product emotions. In *Pleasure with products, beyond usability* (pp. 60-68).

[9] Desmet, P., & Overbeeke, C. (2001). Designing products with added emotional value; development and application of an approach for research through design. *The Design Journal*, pp. 32-47.

[10] Desmet, P., Fokkinga, S. F., Ozkaramanli, D., & Yoon, J. (2016). Emotion-driven product design. In *Emotion Measurement* (pp. 405-426).

[11] Desmet, P., Vastenburg, M. H., & Romero, N. (2016). Mood measurement with Pick-A-Mood: review of current methods and design of a pictorial self-report scale. *Journal of Design Research*, 241-279.

[12] Eisenman, M. (2013). Understanding aesthetic innovation in the context of technological evolution. *Academy of Management Review*, págs. 332-351.

[13] *Emotion rainbow*. (2017). Retrieved from http://studiolab.ide.tudelft.nl/manila/emotion_rainbow/

[14] Eppinger, S., & Ulrich, K. (2015). *Product design and development.* McGraw-Hill Higher Education.

[15] Fokkinga, S. .., & Desmet, P. (2013). Ten ways to design for disgust, sadness, and other enjoyments: A design approach to enrich product experiences with negative emotions. *International Journal of Design*, 19-36.

[16] Fokkinga, S. (2017, 07 19). *Negative Emotion Typology*. Retrieved from http://emotiontypology.com/

[17] Herstatt, C., & Verworn, B. (2004). The 'fuzzy front end'of innovation. In Bringing technology and innovation into the boardroom. London: Palgrave Macmillan.

[18] Huisman, G., & van Hout, M. (2010). The development of a graphical emotion measurement instrument using caricatured expressions: the LEMtool. *Emotion in HCI–Designing for People. Proceedings of the 2008 International Workshop*, (pp. 5-8).

[19] Jordan, P. W. (1999). Pleasure with products: Human factors for body, mind and soul. En *Human factors in product design: Current practice and future trends* (págs. 206-217). London: Taylor & Francis.

[20] Kamp, I., & Desmet, P. (2014). Measuring product happiness. *Conference on Human Factors in Computing Systems - Proceedings*, (pp. 2509-2514).

[21] Kelley, T., & Kelley, D. (2013). Creative confidence: Unleashing the creative potential within us all. Currency.

[22] Khurana, A., & Rosenthal, S. R. (1997). Integrating the fuzzy front end of new product development. MIT Sloan Management Review.

[23] Kirakowski, J., & Corbett, M. (1993). Software Usability Measurement Inventory (SUMI). *British Journal of Educational Technology*, pp. 210-212.

[24] Koen, P. A., Ajamian, G. M., Boyce, S. C., Fisher, E., Fountoulakis, S., & Seibert, R. (2002). Fuzzy front end: effective methods, tools, and techniques. New York, NY.: Wiley.
[25] Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D'Amore, R., & Karol, R. (2001). Providing clarity and a common language to the "fuzzy front end". *Research-Technology Management*, 46-55.
[26] Laurans, G., & Desmet, P. (2012). Introducing PrEmo2 new directions for the non-verbal measurement of emotion in design. *8th International Conference on Design and Emotion: Out of Control - Proceedings.* London.
[27] Laurans, G., Desmet, P., & Hekkert, P. (2009). The emotion slider: A self-report device for the continuous measurement of emotion. *Affective Computing and Intelligent Interaction and Workshops, 2009. ACII 2009. 3rd International Conference on* (pp. 1-6). IEEE.
[28] Mehrabian, A. (1995). Framework for a comprehensive description and measurement of emotional states. *Genetic, Social & General Psychology Monographs*, 339-361.
[29] Michalko, M. (2010). *Thinkertoys: A handbook of creative-thinking techniques. .* Ten Speed Press.
Moultrie, J. C. (2006). A tool to evaluate design performance in SMEs. *International Journal of Productivity and Performance Management*, 184-216.
[30] Moultrie, J. C. (2007). Development of a design audit tool for SMEs. *Journal of Product Innovation Management*, 335-368.
[31] Mugge, R., Schifferstein, H. N., & Schoormans, J. P. (2005). A Longitudinal Study of Product Attachment and Its. *E - European Advances in Consumer Research Volume 7*, 641-647.
[32] Murphy, S. A., & Kumar, V. (1997). The front end of new product development: a Canadian survey. *R&D Management*.
[33] Norman, D. (2004). *Emotional design: Why we love (or hate) everyday things.* New York: Basic Books.
[34] Okaramanli, D., Fokkinga, S., Desment, P., Balkan, E., & Eapen, G. (2013). Recreating Alaturca: consumer goals conflits as a creative driver for innovation. *Brilliant Transformations; proceedings of Qualitative Research, Valencia*, 17-19.
[35] Osborn, A. F. (1953). *Applied imagination.*
[36] Platts, K. W. (1993). A process approach to researching manufacturing strategy. *International Journal of Operations & Production Management*, 4-17.
[37] Porter, C. S., Porter, J. M., & Chhibber, S. (2007). RealPeople; Capturing the Emotions of Product Users. En *Meeting Diversity in Ergonomics* (págs. 187-208).
[38] Rampino, L. (2011). The innovation pyramid: A categorization of the innovation phenomenon in the product-design field. *International Journal of Design*.
[39] Roozenburg, N. F. (1995). *Product design: fundamentals and methods.* John Wiley & Sons Inc.
[40] Russell, R. K., & Donald, T. (2008). Critical success factors for the fuzzy front end of innovation in the medical device industry. *Engineering Management Journal*.
[41] Sacharin, V., Schlegel, K., & Scherer, K. R. (2012). Geneva emotion wheel rating study. *Center for Person, Kommunikation, Aalborg University, NCCR Affective Sciences.Aalborg University, Aalborg*.
[42] Schifferstein, H. N., & Zwartkruis-Pelgrim, E. P. (2008). Consumer-product attachment: Measurement and design implications. *International journal of design*, 1-13.
[43] Schubert, E. (1999). Measuring emotion continuously: Validity and reliability of the two-dimensional emotion-space. *Australian Journal of Psychology*, pp. 154-165.
[44] Sperling, L., Kristav, P., Olander, E., Eriksson, J., & Hans, L. (2006). Exploring emotions for design of your future chair. *Proceedings from the 5th Conference on Design and Emotion 2006.*
[45] Stappers, P. J., & Pasman, G. (2000). Exploring databases for taste or inspiration with interactive multi-dimensional scalin. *Proceedings of the XIVth Triennial Congress of the International Ergonomics Association and 44th Annual Meeting of the Human Factors and Ergonomics Association, 'Ergonomics for the New Millennium'*, (pp. 575-578).
[46] Terwiesch, C., & Ulrich, K. T. (2009). *Innovation tournaments: Creating and selecting exceptional opportunities.* Harvard Business Press.
Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management*, pp. 207-222.
[47] Ulwick, A. W. (2016). *Jobs to be done: theory to practice.* Idea Bite Press.
[48] Verganti, R. (2009). Design driven innovation: changing the rules of competition by radically innovating what things mean. Harvard Business Press.
[49] Verganti, R. (2009). Design driven innovation: changing the rules of competition by radically innovating what things mean. *Harvard Business Press*.
[50] Yoon, J., Pohlmeyer, A. E., & Desmet, P. (2016). When 'Feeling Good' is not Good Enough: Seven Key Opportunities for Emotional Granularity in Product Development. *International Journal of Design*, pp. 1-15.
[51] Zaman, B., & Shrimpton-Smith, T. (2006). The FaceReader: Measuring instant fun of use. *ACM International Conference Proceeding Series*, (pp. 457-460).