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From Abstract to Tangible: *Supporting the Materialization of Experiential Visions with the Experience Map*

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Designing for pleasurable and engaging product experiences requires an understanding of how users will experience the product, sometimes at a very abstract level. This focus on user experiences, rather than on the formal qualities of the product, might cause difficulties for designers in the materialization of design ideas. Designers need to navigate through several choices, shaping and refining the product qualities in order to elicit the intended experience. To support this process, we propose a tool, the Experience Map, guiding designers in the progressive transformation of an 'experiential vision' into tangible formal qualities, considering all the opportunities perceived by the different senses. The paper presents the results of two studies in which we verified the potential of the Experience Map, first in a workshop with design students and second in four design cases with professional designers. The results show that the Experience Map can provide a good structure to organize creative thoughts and progressively decrease the level of abstraction, particularly to support novice designers. It stimulates greater confidence and awareness of design decisions, while allowing the exploration of several design directions in parallel. These benefits, together with the visually stimulating layout and its ability to foster awareness on design decisions, make the Experience Map an effective tool to support experience-driven design practice, especially in the early phases of the creative process and in the educational context.

Keywords – Multi Sensory Design, Design Process, Experience Design, Experience Map, Design Intentions.

Relevance to Design Practice – We provide a practical tool that links the intended consumer experience to product properties, thereby supporting an overarching methodology to design for novel product experiences.

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Introduction

In experience-driven design, designers aim at creating products that trigger rich and engaging experiences for people (Desmet & Schifferstein, 2011). For example, designers may want to wake up people 'with the light of sunrise', like in the popular 'Wake-up' lamp from Philips (Hassenzahl, 2011). Or, they may want office workers to engage with a copying machine as if they were 'dancing' with it (Hekkert, Mostert & Stompff, 2003). These descriptions envision novel experiences that designers aim at during users' interactions with products (Schifferstein & Hekkert, 2008). The experiences that arise from these interactions are subjective and context-specific, dynamically evolving over the course of product usage, and often influenced by multiple factors (Desmet & Hekkert, 2007; Hassenzahl, 2011). Hence, designing for novel product experiences can be highly challenging to pursue.

Over the last two decades, several design methodologies have been proposed to support designers in this process. These methodologies differ on premises and outcomes, whether targeting a material's unique expression, a specific emotional reaction, or a multisensory experience (Karana, Giaccardi, Stamhuis, & Goossensen, 2016; Desmet, 2002; Schifferstein, 2011), but they all share the goal of guiding designers through the process of designing for novel and meaningful experiences. They describe some steps that designers should go through, and some general activities that can assist them during specific moments of the process, such as user studies to explore users' perspective in-depth, or mind maps to organize creative thoughts. Other tools offer instead support for more specific issues, such as material considerations related to the meaning people associate with products (Karana, Hekkert & Kandachar, 2010), the tactile aesthetics of a product (Sonneveld, 2007), or the design of the product's interactive behavior (Colombo, 2014; Lim, Lee & Lee, 2009; Diefenbach, Lenz & Hassenzahl, 2013). Meanwhile, another part of the literature, prevalently related to interaction design and human-computer interaction, suggests the consideration of experience from an embodied cognition perspective. In this perspective, experiences are seen as complex phenomena that are lived through the body and that are difficult to capture and represent through user research (Klemmer, Hartmann & Takayama, 2006). This approach suggests to rely less on logical thinking and more

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on the use of the body as a means to materialize conceptual ideas, for example through experience prototyping (Buchenau & Fulton-Suri, 2000; Camere & Bordegoni, 2016), enactment (van Rompay, Hekkert, Saakes, & Russo, 2005), and thinking through doing (Klemmer et al., 2006). These approaches are particularly relevant to design with a focus on the performative qualities of products (Giaccardi & Karana, 2015; Karana, Barati, Rognoli, & Zeeuw Van Der Laan, 2016), when designing novel wearable technologies that aspire to be 'worn' and taken 'close to the body' (Tomico & Wilde, 2016) or with a focus on movement and spatial relationships (Camere, Caruso, Bordegoni, Di Bartolo, Mauri, & Pisino, 2015). To transform these experiential explorations into more tangible ideas, some research groups suggest the use of design schemas (Biskjaer, Dalsgaard & Halskov, 2014), interaction quality frameworks (Ross & Wensveen, 2010), user experience sketches (Buxton, 2010), or low-fidelity prototypes and material artefacts (Hummels, Overbeeke & Klooster, 2007; Isbister, Höök, Sharp, & Laaksolahti, 2006; Bergström, Clark, Frigo, Mazé, Redström, & Vallgårda, 2010).

All these methods and tools aim at assisting designers in the experience-driven design process, either at the initial stage of *idea generation* or in the final step of *embodiment design*, i.e., detailing the product design. However, we propose that between these stages there is a transition phase, during which designers can explore several alternative *materializations* of their initial idea. This transition represents a crucial and delicate passage to craft a product that is able to evoke the intended experience. The quality of their craft, the unique way in which they will transform their abstract ideas into a design concept, can ultimately determine the success of a product (Lawson, 2006; Lloyd & Snelders, 2003). During this phase, designers navigate through a whole set of possibilities: should the product's sensorial qualities be shaped congruently, or with some incongruences that can trigger a specific emotional reaction? Which kind of product character, or product metaphor, could contribute to elicit a specific symbolic association? What degree of aesthetic balance, symmetry, or variety could be more pleasurable and coherent to their experiential intention?

While this variety of possibilities might be overwhelming, we are currently unaware of any tools that focus on supporting designers in the transition phases, bridging the conceptual level of intended experience to the exploration of the product's formal qualities. Following only their intuition and subjective talent, designers might fail to come up with an original, appealing materialization that is able to elicit the intended user experience. This may cause to loosen the connection with the initial intention, which in an experience-driven process is often formulated after extensive time and efforts invested in researching users' present experiences, studying universal behavioral principles, and observing societal trends and developments (Desmet & Schifferstein, 2011; Hekkert & van Dijk, 2011). This issue is especially evident in the process of novice designers, who have little expertise in getting rid of first, unimaginative solutions (Lawson & Dorst, 2013). To support the materialization process, we propose a tool, namely the Experience Map (abbreviated as ExpMap), that suggests the progressive transformation of experiential visions through the definition of what the product should express (Camere, Schifferstein & Bordegoni, 2016). The tool assists designers along the journey of an experience-driven design process, but it also suggests specific actions to cope within each stage of the process. In the next section, we will first specify our definition of 'materialization'. We will then present the structure of the ExpMap and the possibilities it affords. Later on, we present two studies through which we verified the tool's usage, involving both design students and professionals. The results are discussed at the end of this paper, highlighting the tool's benefits and limitations, and providing valuable insights also for the general topic of Experience Design.

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The Problem of Materialization

An experience-driven design process generally starts with researching the current situation of user-product interaction. In addition, designers may study general principles and current developments in the technological, personal, and societal domains (Hekkert & van Dijk, 2011). This understanding provides the basis to define a vision of an original and meaningful user experience to aspire to, which is conventionally expressed in the form of an abstract statement ("driving a car should feel like flying freely through the open air like a bird"). Which products, and which formal qualities, match the intention of making users 'feel free like a bird'? Or 'enhance the sense of relatedness and belonging to a community'? These statements are descriptions of how users might feel when interacting with the future product, hence visions of possible future experiences to aspire to (Desmet & Schifferstein, 2011; Hekkert & van Dijk, 2011). Therefore, an 'experiential vision' represents the initial standpoint from which designers can determine *how* and *what* to design in order to elicit a specific experience during future use. Subsequently, they can start defining what kind of interaction they would like to shape and which type of product can evoke the intended experience, exploring several alternatives of embodiment. In summary, the activities performed in an experience-driven process can be grouped under three categories: 1) understand (e.g., understand users' concerns); 2) envision (e.g., envision the target user experience, formulate the target product character), and 3) create (e.g., build experiential models; evaluate the target user experience) (Desmet & Schifferstein, 2011).

These categories roughly correspond to the stages indicated by classic models of the design process (Roozenburg & Eekels, 1995; Ulrich & Eppinger, 1995), which can be summarized into 'exploring/analyzing', 'idea generation', 'concept design', and 'embodiment design'. Particularly, 'idea generation' is part of the process of envisioning how a situation can be changed into a preferable one (Simon, 1996), as it refers to an abstract idea that is not necessarily linked to any formal product or solution. In contrast, 'embodiment design' (or detail design) refers to the moment in which designers define the materials, colors, finishes, joineries, and details of the product. With the term 'materialization', we refer to the specific, transitioning state of a product design lying between the 'abstract idea' (in the idea generation phase) and the 'embodiment design'. During the materialization process, designers transform the abstract idea (or experiential vision) into a first bundle of physical qualities and explore several alternatives of product types, styles, shapes, and sensorial qualities that can trigger the intended experience. We see a fundamental difference between 'materialization' and 'embodiment design': the materialization process is not necessarily prescriptive of any specific detail (i.e., materials, shapes) but has an explorative function, during which designers start imagining the overall design that can elicit the intended experience.

Achieving an original materialization of design intentions, however, is far from easy. Design intentions are often expressed as generic and abstract statements that frame the designers' interpretation of the problem (Dorst, 2011). To better understand what we intend with 'materialization', we wish to discuss the example of the Pulse washing machine concept (Figure 1). The initial conceptual intention behind this design was to envision 'a washing machine that takes care of clothes as human touch does'. For this vague description, it is possible to imagine dozens of different materializations. What does it tell us about the product shape, or the materials to choose? Milan-based Deepdesign studio materialized their intentions by crafting each product quality adequately, so that it would concur in expressing their product vision: the form, the dimensions, the three-controls interface, and the mechanical process. In order to emulate the natural and relaxing movement of the hands washing the clothes, the designers replaced the common centrifugal force-based mechanisms with a system based on centripetal force. The machine architecture was designed as a womb embracing the clothes, rhythmically pumping water and air in and out of the cavity, so that the membrane compresses and releases the fibers of the fabrics mimicking the

Figure 1. The 'Pulse' washing machine, a concept developed by Deepdesign for Whirlpool (©deepdesign, reprinted with permission)**.**

movements of gentle hands washing them (Morozzi, 2009). The design of the Pulse washing machine expresses the designers' intention in a consistent way, reflecting it in all details. Eventually, these details may enable users to infer the conceptual idea underlying the product. The cognitive appreciation of designers' conceptual intentions can enhance their overall experience of the product (Khalaj & Pedgley, 2014; Da Silva, Crilly & Hekkert, 2015). But more importantly, referring to these intentions while shaping the product details helped the designers to come up with a strong, consistent design that makes the product unique.

Part of the difficulties related to materialization lies at the core of design thinking. In design practice, problems are ill-defined, constraints are often undetermined, and there are no right or wrong solutions, but only better or worse (Buchanan, 1992; Daalhuizen, 2014). As Dorst (2011) explained, design thinking does not only involve finding a solution to achieve a specific objective. Rather, it requires to first define this objective (the *why*), as the value or experience to aspire to. Then, we can proceed to understand *how* we can achieve the objective and *what* solutions can materialize this intention. In this process, many alternative directions can be undertaken, all of them entailing a number of different design solutions. To navigate through these possibilities, designers can alternate moments of exploration (divergence) and subsequent phases of refinement (convergence), in which the most promising directions are selected (Csikszentmihalyi, 1996). This attitude is recognized to foster the creative flow and the development of more refined design concepts (Ulrich & Eppinger, 1995). However, the process of materialization is influenced by several other factors that limit the designers' freedom (Bloch, 1995; Crilly, Moultrie, & Clarkson, 2009). Some of these are marketing-related requirements, such as accordance with the company's brand identity, target, and vision. Or, they might involve technical aspects, like rules and regulations that need to be followed, or manufacturing specifications that affect the choice of the materials. Production costs, available technological components, ergonomic needs, and competitors' analysis are other examples of variables through which designers need to navigate. While moving from the abstract level of conceptual ideas through the materialization in a product concept, designers need to work around these limitations and integrate these considerations into a meaningful and competitive solution. At the same time, they need to keep the focus on their initial conceptual intention, negotiating the constraints to push the boundaries and achieve innovation (Verganti, 2009). All these aspects are to be considered during the materialization of conceptual intentions. The whole process can be overwhelming, and the risk to get disoriented is high.

What Designers Have at Hand / How Designers Cope with Materialization

To prevent being overwhelmed by the many aspects they need to consider, designers can use several possible strategies to stimulate and refine the materialization of their design intentions. These strategies can function as steering principles to explore possible design directions, to fine-tune the future product qualities in order to match the initial design intentions. Examples of these strategies are consolidated aesthetic principles, such as the Gestalt Theory rules, a balanced unity-in-variety, or the 'most advanced, yet acceptable' design principle (Hekkert, 2006; Post, Blijlevens & Hekkert, 2016). In some cases, the use of metaphors can ease the process of materialization. Metaphors translate a concept into something more tangible by means of similarity (Cila, 2013), which can then be transformed more easily into a formalized design concept.

Otherwise, designers can be guided by considerations related to the sensory characterization of the product. Designers may choose to characterize the product through multiple or unusual senses, such as smell or touch, instead of focusing solely on the visual appearance. For example, the experience of a carpet can be enriched by provoking unexpected tactual sensations, perhaps combined with a well-designed auditory profile and thus resulting in a unique design (Schifferstein, 2006). In general, addressing the sensory characterization purposefully is recognized as a good strategy to elicit a specific emotional response, whether positive or negative, and to create rich user experiences (Schifferstein & Desmet, 2008). In this respect, designers can seek to achieve a perfect congruence among all the senses, so that the sensory qualities of the product will cooperate altogether to elicit the intended experience. Conversely, they may choose to trigger incongruencies across diverse modalities, as, for example, a tactual sensation that is unanticipated by the visual appearance of the product. This type of incongruencies can evoke surprise in users (Ludden, Schifferstein & Hekkert, 2008).

Beside conceptual speculations, designers can use a variety of design activities to engage with the materialization of conceptual ideas (Crilly et al., 2009). For example, collecting visual references that express the style and the feeling of the future product, and organizing them in mood boards or collages is a common practice to stimulate the embodiment of design intentions (Keller, Pasman, & Stappers, 2006; McDonagh & Storer, 2004). These collections of visuals help to specify the character that the product should express in order to evoke the intended experience. Furthermore, this activity fosters a free exploration while demanding the selection and organization of creative ideas, thereby supporting the aforementioned alternation of divergent and convergent thinking.

Sketching is another important activity to make conceptual intentions explicit (Cross, 1999; Yang, 2009). Just as prototyping, it is a way to consolidate ideas, stimulate reflection, and learn from the design concept, developing it into more refined solutions (Yang, 2005). Both activities are useful to explore alternative design directions in parallel, preventing idea fixation and fostering a more creative approach (Gerber & Carroll, 2010).

These practical activities and form-giving strategies are useful to stimulate creative thoughts, but they do not make designers more aware and in control while bridging the conceptual level of ideas to the level of tangible product qualities. Moreover, they do not facilitate the holistic integration of all the influencing factors, decisions, and aspirations designers must cope with during the materialization process. At present, designers can only rely on their mental abilities, intuition, and sensitivity.

Supporting the Materialization Process

As we explained, experiential visions often result in abstract statements that point at the intended user experience and that are scarcely informative of what qualities the product should possess to elicit it. As a possible link between the experience and the product level, we propose the definition of some qualities that characterize the interaction with the product. The Pulse washing machine (Figure 1), for example, could be described by interaction qualities such as ‘caressing’, ‘ephemeral’ or ‘quietness’. These descriptors represent what users should attribute to the product while experiencing the object and interacting with it (Hassenzahl, 2004). Describing the interaction qualities can help to pinpoint how the intended experience may unfold, and provide a first bridge between the experience and the materialization that can bring it to life (Hassenzahl, 2015). However, this information still concerns abstract concepts, failing to provide designers with terms defining tangible product properties. We argue that the process of materialization could be facilitated by a tool that integrates verbal descriptions and visual material, to specify aspects of the intended experience. With this objective in mind, we designed the ExpMap, a guiding structure that brings designers from the conceptual idea to the materialization in sensory qualities in a stepwise manner. We will now explain the tool’s structure, then present the results of two studies in which we verified the usage of the tool.

The ExpMap

The Experience Map (ExpMap) aims to foster a progressive transformation of a conceptual intention through its stepwise structure, supporting designers in the consideration and integration of several aspects, to materialize their idea in a unique, pleasurable, and original design. The tool has been developed through two explorative studies with designers (Camere, Schifferstein & Bordegoni, 2015; Camere et al., 2016), refining it on the basis of designers’ feedback. The tool is grounded in two frameworks present in the literature: the Vision in Product (ViP) design approach (Hekkert & van Dijk, 2011) and the Multi-Sensory Design method (MSD, Schifferstein, 2011). Specifically, the tool assimilates the theoretical structure of the ViP approach, which describes a design cycle from the past/present context to a future one, moving through three levels (the context level, the interaction level, and the product level) of experience. In addition, it integrates the specific focus on multi-sensory characterization promoted by MSD as a means to design a holistic and appropriate concept.

To fulfill designers’ needs, the tool should meet a number of requirements (Daalhuizen, 2014). First of all, the tool needs to be intuitive and to rely on conventional design practices. Second, it must be flexible enough to fit and adjust to a designer’s personal approach. Specifically, in this case, the ExpMap should entail a systematic, but neutral structure, avoiding to influence or bias designers’ choices. In addition, it should facilitate the consideration of opportunities coming from all the sensory modalities, avoiding to neglect unconventional sensory inputs.

The Structure of the Tool

The structure of the ExpMap is composed by five steps, arranged on a radial layout. The stepwise process assists designers in progressively transforming their experiential vision into a pattern of sensory qualities. Hence, they should move from the most abstract level (at the center of the tool) towards the external layers of the map. To describe the five steps of the ExpMap, we have completed the ExpMap for the example of the ‘Pulse’ washing machine (Figure 1), based on the descriptions of the project (Morozzi, 2009). The map (Figure 2) was also shown and discussed with the original designers.

Statement of Product Vision (1)

The first step of the tool requires designers to make an explicit vision statement that describes their experience-related design intentions. This statement should provide straightforward information on the quality of the experience, describing the value to aspire. Forming a solid, well defined, yet broad enough experiential vision is a complex and time-consuming activity, but essential for the subsequent steps (Hekkert & van Dijk, 2011). As we mentioned before, in the case of the Pulse concept, the experiential vision could be stated as ‘*a product that elicits in users a feeling of care for clothes*’.

Conceptual Exploration (2)

The second step asks designers to explore the intended experience by looking for sources of visual inspiration that describe it, gathered from various contexts, such as art, exhibitions, culture, trends, etc. The act of researching these visual references is a creative moment in itself, more than a simple consultation of pictures (McDonagh & Storer, 2004). Although still abstract in its representation, it corresponds to the first deep interpretation of the product vision, focusing more on ‘how’ that specific experience can be rendered in a product, than on ‘what’ kind of experience it will evoke. The second step of the ExpMap suggests organizing the collected inspirations in a mood board by inserting the most appropriate images and creating a collage. In Figure 2, the images describe the feeling of a bubble, a hug, and the freshness of laundry for the Pulse example.

Selection of Expression (3)

The third level of the tool addresses the definition of qualities that together form the expression of the product character. At this point, the initial vision should be described in a more tangible way, defining how it might feel to observe and interact with the product (Hekkert & van Dijk, 2011). Designers should select a set of keywords that describe the product character, reflecting on what the product will express through its properties (Hassenzahl, 2004). The more specific and unique these keywords are, the more they will help in the subsequent steps. In our example, the experiential vision was detailed through adjectives like ‘caressing, quiet, faded’. Furthermore, this step stimulates designers to identify which modalities, like vision or touch, can better express

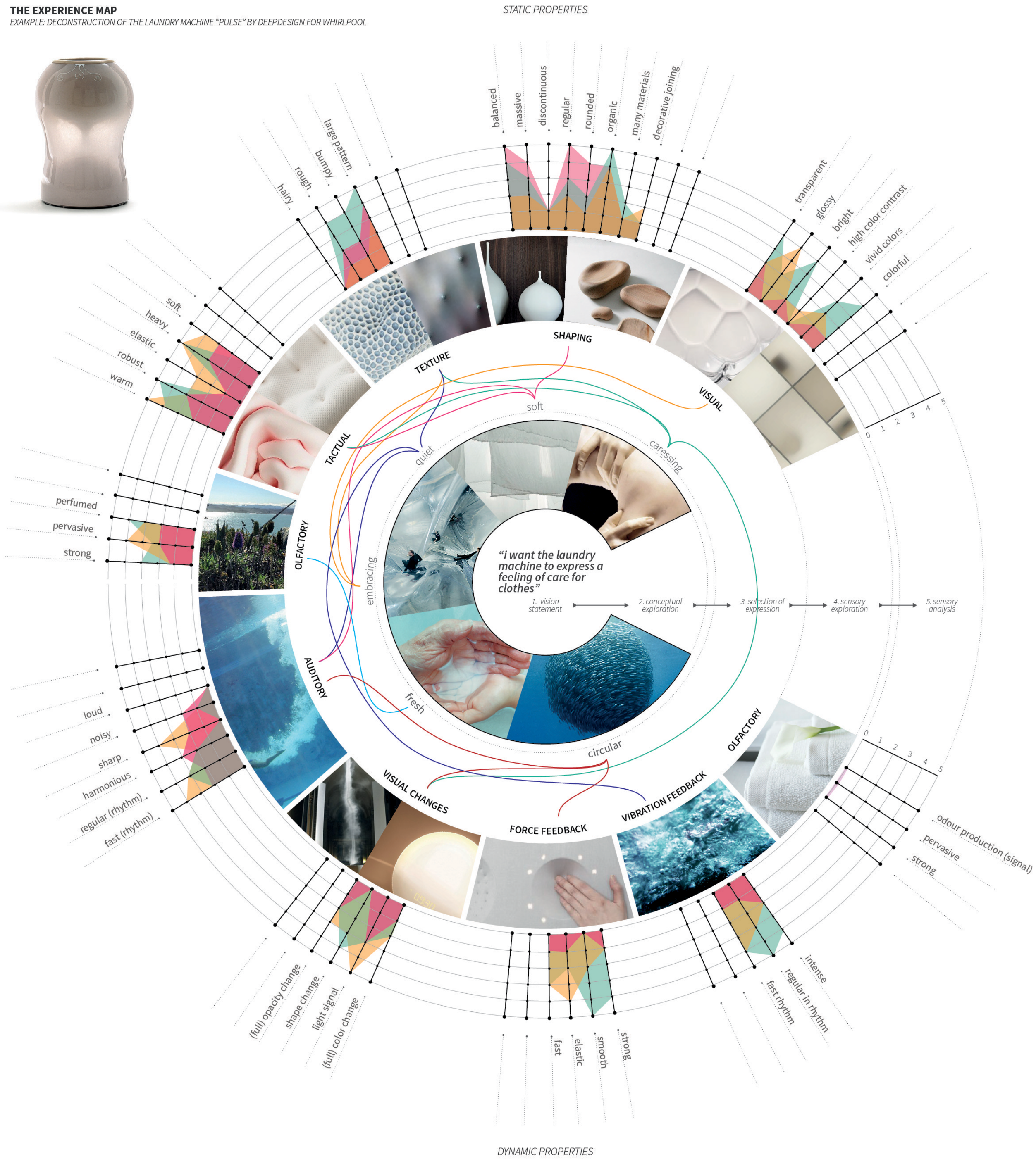

Figure 2. The Experience Map describing the 'Pulse' concept materialization process.

these aspects of the product character. For instance, a product can give a soft feeling through its shape and tactual qualities, and it can evoke freshness through its olfactory sensations (Figure 2, the Pulse concept). These interrelationships between descriptors and modalities can be represented by color-coded connections. This activity is meant to help bridging the experience level to its materialization, by asking designers to reflect on the role of each sensory modality in transforming the experiential vision into tangible features, and yet not immediately specifying how.

Sensory Exploration (4)

The following step of the ExpMap presents designers with ten frames, similar to Step 2. It asks designers to explore the experiential vision in a more tangible way, imagining how the future product must look or feel, in its details and its dynamic qualities. To do so, designers are asked to consider the different sensory modalities and collect a new set of visual inspirations, which should be more concrete than the ones added at the conceptual exploration phase. The upper part of the map (from visual to auditory) addresses the characterization of the static appearance of the product, i.e., how the product itself will be perceived by users. The bottom part of the map is meant to support the dynamic characterization of the concept, defining how interactive features, such as buttons, sounds, and visual interfaces should be shaped. The 'auditory' category was positioned across static and dynamic properties without a neat separation, because sound properties can be related both to the material of the product or to the sound signals it produces during interaction. Furthermore, the listed categories (visual, shaping, texture, tactual, olfactory, auditory, visual changes, force feedback, vibration feedback, and olfactory feedback) are not limited to the conventional five sensory modalities, because other important characteristics, such as manufacturing qualities (for example, rounded edges, surface regularity, or decorative joints that are obtained during production process dynamics) can be essential to characterize the product.

Sensory Analysis (5)

The fifth and last step of the map proposes designers to shape their materialization in terms of sensory qualities. Designers are provided with a list of sensory qualities, which stimulates them to make decisions about the details of their concepts. They can analyze how much the suggested quality is appropriate to express their experiential vision. A five-points rating scale (0 = not all; 5 = very much), helps to identify relative differences. The list of sensory qualities included in the ExpMap was developed through literature review (Camere, Schifferstein & Bordegoni, 2015). Many of the adjectives focus on selected sensory modalities or on material and manufacturing qualities (Sonneveld, 2007; Van Egmond, 2008; Karana, 2009). This list is obviously not exhaustive, but it contains the most common features considered during concept development. Designers are encouraged to explore other characteristics, which they can include in the free space left in each category. With this last step, the ExpMap guides designers through all the possibilities coming from the sensory characterization of the product, and not just the visual appearance. The list of sensory qualities and the sensory categories included in Step 4, are meant as a generic selection of aspects to be considered in a multisensory, experience-driven process, and they are based on the aggregation of other validated lists present in literature (Karana, 2009; Sonneveld, 2007; Colombo, 2014; Malnar & Vodvarka, 2004; Van Egmond, 2008). Yet, designers are free to adjust the categories and the sensory list to the needs of each specific project, for example by adding the category of taste or adding relevant terms.

One possible use of the ExpMap is to differentiate between alternative directions to follow when materializing the experiential vision. This last step offers the opportunity to generate several patterns of sensory qualities that correspond to alternative materializations of the same experiential vision. To do so, designers can focus on one or more product expressions defined in Step 3. For example, for a "caressing" product expression, designers may identify a visual appearance made of vivid colors, organic forms, and large textural patterns (Figure 2, green pattern). Another materialization can instead pivot around the expression of "quietness", as depicted by the pink pattern in Figure 2, which could be characterized mainly by a regular vibration feedback and harmonious sounds. Eventually, these patterns constitute the foundation to design different materializations in parallel. They highlight possible design directions that are connected to the initial experiential vision by manifesting the logical progression of creative thinking, and the motivations behind all decisions taken along the creative process. Naturally, these decisions can be subverted at any time by designers, but these eventual changes will then be pursued with a greater awareness, because designers are visually confronted with their previous logic and decisions. From this last step, detailing the design concepts, sketching, prototyping, and testing them should flow more easily. In the next sections, we will present the results of two studies in which we challenged the use of the ExpMap in two different contexts, first in a design education workshop and second through case-study observations.

Study 1—
Concept Generation Workshop

The goal of this study was to verify the use of the ExpMap and whether it can support concept generation, even in fast-paced creative sessions. A design workshop is conventionally considered as an appropriate method to observe design practice in a reasonably comparable way and over a short period of time (Blessing & Chakrabarti, 2008). Hence, we set up a half-day intensive workshop in the context of a design education course.

Participants

Thirty-one design students (15 females, 16 males; mean age = 23.9 years) were recruited from a cross-disciplinary elective course focusing on Materials & Design at the School of Design (Politecnico di Milano). Participants were all following a program at the MSc level. The workshop was facultative and not relevant for the final grading of the course. All the participants teamed up in pairs, 15 groups in total.

Design Assignment

Participants were given an assignment, in the form of a design brief. We asked them to generate as many concepts as possible, using the ExpMap as a support tool, starting from the same, pre-determined experiential vision. The design brief targeted the design of an interactive scent dispenser for office workers to elicit the positive feeling of being surrounded by nature. The brief described the rigid, industrialized, and static qualities of common workplaces as opposite to nature's dynamic light, colors, the freshness of air, etc. All these elements contribute to perceive natural environments as pleasurable, healthy, and comfortable. Design students were asked to mimic these qualities of dynamic beauty and transform them into a multisensory experience triggered by a scent dispenser. Hence, design students were encouraged to think of unusual interaction modalities and of possibilities coming from a multisensory characterization.

The experiential vision provided to students was worded as: '*I want the user to experience inside the workplace the qualities of metamorphosis in nature*'.

Materials

Together with the ExpMap, participants were supplied with a detailed explanation of the tool's steps and a glossary for the list of sensory qualities (see Appendix I). The glossary includes a definition to clarify the intended meaning of each sensory descriptor, as well as the antonyms.

The search for inspirational references is a time-consuming activity, but essential to stimulate the creative interpretation of a design problem (Camere, Schifferstein & Bordegoni, 2015). To support the collection of visual inspirations during Step 2 and 4 of the tool, we developed two sets of pictures. The database for Conceptual Exploration included 270 images (http://pinterest.com/conceptualexploration), while the second, supporting the Sensory Exploration phase (http://pinterest.com/sensoryexploration), contained 377 images. Both were made available to students as Pinterest boards. The pictures were selected from databases of visuals popular for design (e.g., Designspiration, Tumblr blogs, Dezeen, LeManoosh, etc.). For the first database, the criterion used to select pictures was their level of abstraction (i.e., not containing products or direct references of style). For the second database, on the contrary, we selected only pictures that could act as visual references for each sensory category. For example, for the 'visual' category, we collected pictures representing formal or color-related product qualities. These databases were not validated, because designers often use their own collection of visual references, tailoring each database according to each specific project.

Procedure

Prior to the workshop, participants attended a quick introduction of 40 minutes on the experience-driven design approach and the structure of the tool. Designers were then given the design assignment and the materials to work with. They were asked to complete the assignment in 3 hours. The concepts needed to be represented in one poster (A3 format), motivating their design decisions, and submitting it together with the related ExpMap. At the end of the design activity, participants were requested to provide feedback on their experience with the tool.

Tool Evaluation

In order to determine the tool's advantages as a support for concept generation, we used a mixed-method approach, combining the observation of participants' activities, document collection, and participants' subjective evaluation of the tool at the end of the workshop. Three facilitators (the first author and two PhD researchers) observed participants' interactions with the map by taking pictures and notes on an observation journal (see Appendix II). The observation was meant to identify how and when designers used the map, whether before, during, or after generating concepts. Also, they took note of all the questions raised by participants, possible difficulties in the use of the map, as well as of group dynamics.

Document collection is considered an interesting method to gather supplementary information on designers' interaction with a map (Blessing & Chakrabarti, 2008). Specifically, we were interested in possible correlations between the resulting maps and the sketches. A creative assessment of design results (maps+sketches) was not performed, because this study focused on the designers' perspective and their personal experience, exploring what benefits they found in the tool. For this reason, we analyzed the resulting maps by observing and comparing them on the basis of several criteria: a) the completeness of the maps; b) the level of their correctness, i.e., whether participants could distinguish the different steps; c) the maps' refinement, i.e., how much designers detailed them; d) the maps' visual correlation with the design concept (e.g., if we recognized shapes or colors that had been clearly embedded in the design concept). Design concepts were analyzed to identify their originality, level of multisensory detailing, and adherence to conventional product typologies.

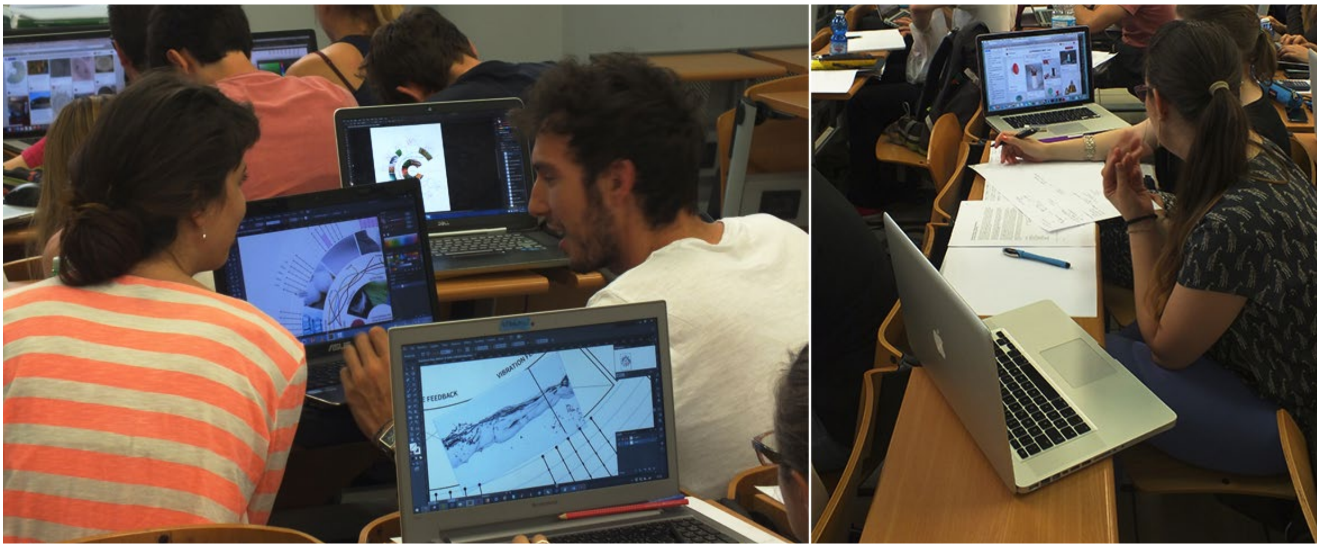

Figure 3. Students using the ExpMap to discuss their ideas.

At the end of the workshop, we distributed a questionnaire to investigate participants' subjective experiences. The questionnaire included a quantitative evaluation and four open-end questions. The quantitative evaluation was articulated in 30 questions asking participants to rate their agreement with a proposed statement on a 5-points scale, where the value -2 meant "I do not agree at all" and the value +2 "I agree very much". The questions were provided in English and Italian, as the students attending the course formed an international audience. The questions addressed whether the tool was visually clear, easy to use, immediately understandable, effort demanding, and rigid. Other questions evaluated if the tool fostered a fluent design process, the organization of creative thoughts, the organization of visual inspirations, confidence in design choices, awareness of design decisions, critical thinking, the consideration of multiple alternatives, and coherence in design choices. They also addressed whether the tool was a support for the embodiment of the vision, conceptual exploration, the selection of an expression, sensory exploration, and selecting the pattern of sensory qualities. Furthermore, we asked if the map was useful to communicate the concept and to facilitate the discussion with other stakeholders. and whether the map was important to boost creativity, to stimulate idea generation, to elaborate the concept, to achieve a novel design, to refine the product aesthetics, to achieve more original solutions, to stimulate multisensory considerations, and to achieve unexpected outcomes and a more meaningful materialization.

In response to the open-ended questions, participants described how they tackled their choices related to the sensory qualities of the product, and what principles they used to deal with the materialization process. Second, they indicated how the ExpMap supported them in the concept generation, and which benefits and limitations they identified in the tool. The responses to these questions were analyzed using a Grounded Theory approach (Strauss & Corbin, 1990; Saldaña, 2015). This approach recommends to identify categories and themes as they emerge directly from reoccurrences in the designers' answers.

Results

Observations

During the workshop, the facilitators observed a good flow in participants' usage of the map. Generally, designers used the tool following its steps without difficulties. Only few doubts were raised to facilitators to clarify aspects of the tool. These questions concerned in all cases Step 3 (Selection of product expression): participants did not understand the exact purpose of relating the keywords of Step 3 to the sensory categories of Step 4. Apart from this aspect, designers worked with the ExpMap in a fluent and familiar way, but facilitators noticed that designers used the ExpMap in different ways. Some groups (5/15) approached it as an activity to complete before actually starting the concept generation, to reflect on their ideas and then use the map as a baseline. Others (8/15) were instead alternating the specific activities of the tool with moments of reflection that were prompted by the use of the ExpMap. Lastly, a few groups (3/15) started with concept generation immediately after reading the design assignment, using the map only to further refine their materializations after they generated a concept.

Design Outcomes

After 2:45 hours, we collected a total of 16 maps and 20 design concepts, as three groups had developed more than one concept. Figure 4 shows two examples of maps with the related sketches. All the maps were completed in most of their phases, with the exception of Step 3, which was not fully completed by a substantial number of groups (8/15). One group (Figure 4, left) used the last step to select two alternative patterns of sensory qualities, which were eventually transformed into two different materializations. Regarding the correctness of the maps, several groups (6/15) did not manage to distinguish between the different levels of abstraction needed in Step 2 and Step 4. These designers used very abstract pictures for both steps, while Step 4 requires adding visual references that describe more tangible, sensorial details of the future product. Despite this aspect, most of the maps (10/16) were carefully refined, as participants clearly had spent efforts in exploring multiple design directions. In Figure 4 (top), designers selected two alternative patterns of sensory qualities, pinpointing two possible materializations of the experiential vision. In another case (Figure 4, bottom), several connections demonstrated the engagement of designers. In a large majority of maps (11/16), correlations between the ExpMaps and the resulting design concepts were visually evident in how the visual references related to the product concepts. Interestingly, 10/16 maps presented a clear uniformity of colors embedded in the pictures. Examining the sketches, it was evident that the majority of designers were triggered by bio-inspired designs. A total of 14/20 concepts were mimicking natural structures or shapes (e.g., fungi, flowers, sea urchins, or sea shells). Three concepts, instead, were interestingly different from the conventional typology of interactive scent dispensers. Lastly, several materializations (9/20) were shaped with significant attention towards the integration of different sensory modalities and the interactive qualities of the product.

Designers' Feedback

Thirty-one participants filled out the questionnaire with 30 different questions. Answers from participants were converted in values from 1 to 5, to ease statistical analysis. In order to reduce the number of variables to be reported here, their responses were subjected to Principal Components Analysis, which yielded 10 components with Eigenvalues >1 and a total amount of variance explained of 79.9%. After Varimax rotation, these 10 factors were interpreted as 'generates unexpected outcomes' (11.6%), 'stimulates concept generation' (10.0%), 'demands effort' (9.8%), 'is easy to use' (9.3%), 'is rigid' (7.3%), 'supports embodiment' (7.2%), 'has a sensory focus' (6.9%), 'supports multisensory aesthetics' (6.3%), 'facilitates confrontation with other people' (6.0%), and 'creates awareness of decisions' (5.6%). To obtain a mean score for each of these 10 factors, we averaged the ratings of the items that had the highest loading for this factor, with the

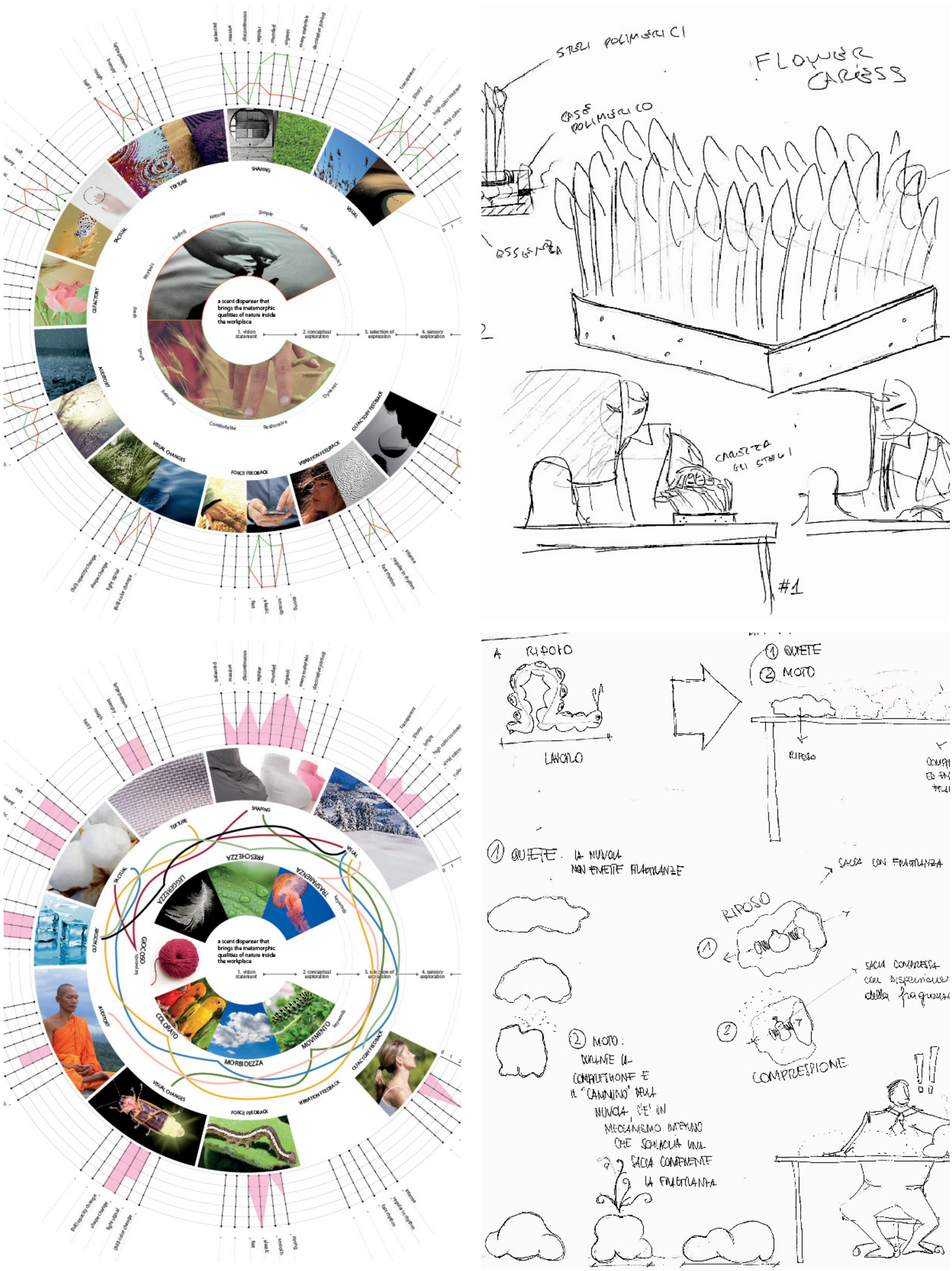

Figure 4. Two of the resulting maps correlated with the generated design concepts.

exception that we deleted one item for which the highest loadings on all factors were below 0.5, and we deleted two items that had loadings above 0.5 on two different factors. The means and standard errors for these factors are represented in Figure 5. These means generally reflect a positive attitude towards the ExpMap, with high ratings on ease of use and evidencing its supportive role in multiple aspects of the design process. On the other hand, participants also recognized that using the tool required some effort and might have some unwanted rigidity.

From the qualitative questionnaire, we collected a total of 218 text segments that were coded in 32 categories of re-occurring segments. These categories were subsequently grouped into 8 general themes of participants' opinions on the tool. In Appendix III, we show the complete list of abstracted categories for each theme. Table 1 shows the 8 themes in relation to their occurrence (N = number of segments) and the valence of the comments (i.e., whether participants meant them as positive or negative judgements in the context of their statements). Participants have reported that they especially appreciated the ability of the ExpMap to (a) stimulate productive thinking and (b) make them feel more in control of the design process. The tool enabled them to "seek coherence in the design process", "keep track of the choices made, avoiding incongruences". Furthermore, participants claimed that (c) the tool helped them to refine and develop their idea in a careful way, because they could reach "a more detailed definition of the qualities that can better express my idea," that "it facilitated a development of the concept under many point of views," and it helped in "considering aspects that normally we tend to neglect too much". A few accounts also addressed limitations of the ExpMap: in some cases, it was perceived as too limiting (e), and participants reported that they were not feeling comfortable in using it (g). They claimed that the tool was "not very flexible" and "hardly adapting to my needs," as they preferred to rely "more on intuition", finding the step-by-step structure "too strict."

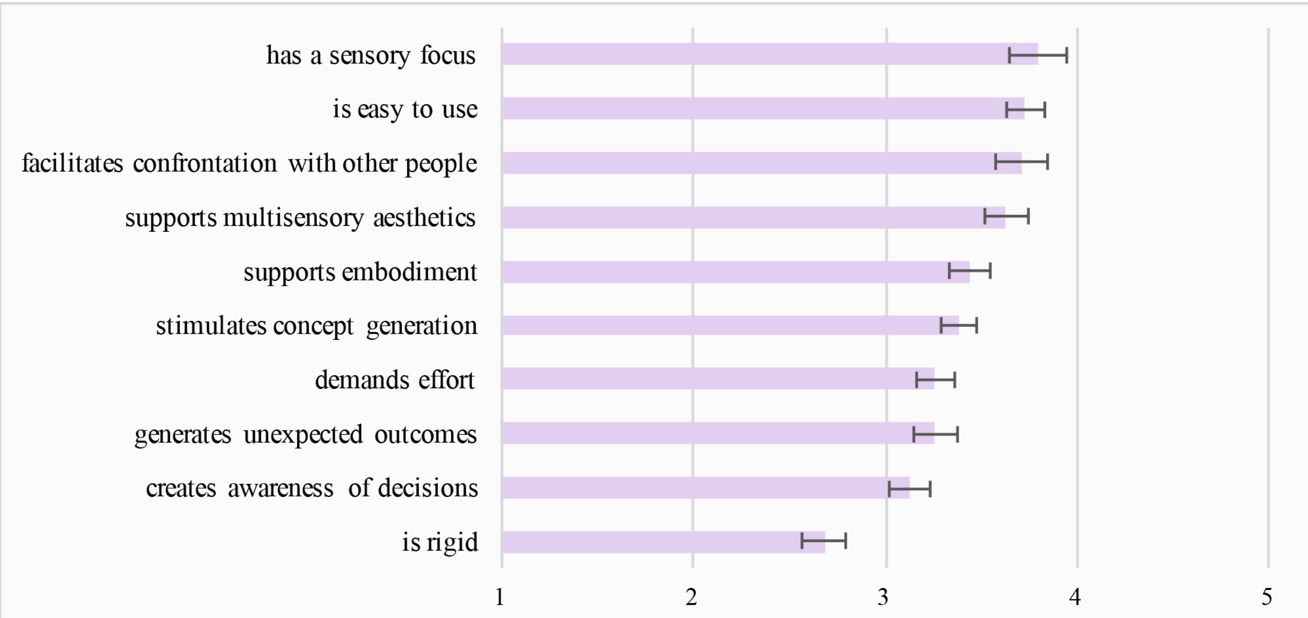

Figure 5. Mean scores (±2SE) **for the 10 factors obtained through Principal Component Analysis.**

Table 1. Extracted themes of participants answers and occurrence in segments (N total = 218)**.**

Themes	*N*	*Valence*
a. Stimulating productive thinking	54	+
b. Ownership and control of design process	45	+
c. Supporting idea development & refinement	44	+
d. Fostering vision embodiment	26	+
e. Limiting the design process	15	-
f. Facilitation of synthetic thinking	14	+
g. Scarce ownership of tool / method	13	-
h. Problems in the interface	7	-

Discussion

The overall objective of this study was to test the ExpMap for concept generation in a controlled setting. The results are largely positive. Observations and design results show that participants were able to use the map fluently without familiarizing with it beforehand, even in a fast-paced design session. This, together with the quantitative evaluation provided by participants, supports the tool's usability and intuitiveness. From the quantitative analysis, we could infer that participants recognized several advantages in the ExpMap, mainly as a structure to facilitate and stimulate the materialization of an experiential vision and its embodiment in a concept design. An interesting result from the Principal Components Analysis was that the item '*Through the tool I was able to collect and organize many inspirations*' had a negative loading on the first factor 'generates unexpected outcomes', whereas '*Thanks to the tool I could arrive at unexpected outcomes*' had a positive loading on this factor, which indicates that responses on these two items are negatively correlated. This suggests that some of the participants for whom the tool generated unexpected outcomes were unable to use the tool to organize their findings. Hence, the tool may work in two different ways: by organizing inspirational findings, designers can use the layout of the tool to structure their underlying thinking process. As a consequence, the insights and ideas they derive from the use of the tool may not be perceived as unexpected anymore. On the other hand, for some designers who have trouble in organizing their thoughts, the tool may serve an as inspirational tool that intuitively generates new ideas, without the designer being consciously aware of the different steps he or she is taking.

Although we did not evaluate the ideas generated for their quality or creativity, we note a general uniformity among the sketches. This lack of diversity might be interpreted as a sign of possible restrictions to designers' creativity coming from the ExpMap. However, at least two other factors might have caused this uniformity of ideas. First, designers were all students attending a master program, thus comparable to novice designers for their level of expertise. Second, this uniformity of design ideas could be related to the choice of providing the same experiential vision to all participants. As mentioned earlier in the paper, the development of an experiential vision is a fundamental step that allows a personal interpretation of the design problem (Hekkert & van Dijk, 2011). Lacking this moment, we expected design outcomes to be less diverse and original.

Results also identify that designers perceived some rigidity in the structure of the ExpMap. From participants' qualitative answers, we can establish a connection between this perceived rigidity and the tool's structure and interface. Some participants reported that the tool offers a limited space compared to their actual needs. Step 2 and 4, in fact, force designers to select only few pictures, because the image boxes are relatively small. In our view, this apparent limitation is actually a quality of the ExpMap, as it demands reflection on design decisions, narrowing down the possibilities. Reasonably, this might trigger a perception of rigidity in the tool, somehow confining designers' liberty in the creative process.

Summarizing, this first study supports the ExpMap's solidity in supporting the materialization of experiential vision, showing a positive assessment from novice designers in the context of design education. However, we aim at investigating the tool's potential in a setting closer to the reality of design practice. The next section reports the outcome of a subsequent exploration of the ExpMap usage in four design cases.

Study 2—*Case Studies*

The reality of design practice can differ substantially from the representation of a time-limited, fast-paced design education workshop. Thus, when developing a method or a tool, it is essential to evaluate its usage in a context as close as possible to real design practice, in which the complexity of projects increases, designers work on several projects simultaneously, and they often develop their own methods and strategies to cope with design problems. In this follow-up study, we investigated how the tool performs when used for projects that are diversified and last for several weeks. Four case studies were set up to observe designers' use of the ExpMap in everyday design practice, based on review meetings, document collection, and interviews at the end of the project.

Method

Participants and Cases

Four groups of designers with various levels of expertise took part in the study. Table 2 summarizes personal data of participants and the specific information for each project. The observation followed the exact duration of each project, with the exception of Case 4, in which the project had already started two weeks before, but was still in the early stages. In this case, the design team consisted of 2 junior designers and 1 senior designer, who participated in the study as interviewee.

Procedure

Participants were provided with a package containing the map, a vocabulary, and a step-by-step explanation of the tool. In order to interfere as little as possible with the normal design flow,

Table 2. Overview of the cases' characteristics.

	Case 1	*Case 2*	*Case 3*	*Case 4*
Participants	3 novice designers	3 novice designers	1 junior designer	1 senior designer
Project	Wearable medical device for nutrition	Interactive weather station	Bathroom tiles	Structure for a rehabilitation device
Duration	4 weeks	4 weeks	3 weeks	8 weeks

we did not perform direct observations or record activities on camera. Instead, we planned a minimum of four meetings with the designers, during which we collected documents related to the project, i.e., sketches, drawings, notes, and state of progress in the ExpMap. During review meetings (2 per project, divided along the duration of the observation), we gathered informal feedback from the participants about their experiences with the map, for example concerning any doubts encountered while using the map. The meetings lasted approximately one hour, asking participants to show the state of progress with the map and the project, describing how they used it along the different phases of the project. In addition, participants were formally interviewed at the end of the observation. The open questions addressed how designers structured their use of the tool, how it fitted into the project and their standard practice, and which benefits and limitations they could identify in the ExpMap.

Results

We summarize the most relevant points of these case studies here, specifically targeted at the following issues: a) how designers addressed each step of the ExpMap, e.g., personalizing it or the strategies chosen to deal with it; b) the type of input and output of the tool; c) the usability of the tool. For further details of our analyses, we refer to Camere et al. (2016).

In Case 1, designers started with the intention to design a wearable device to support kids with special nutritional needs. They formulated the product vision as: "*a friendly, playful and vibrant eating companion who will help kids to improve their eating behavior*". The vision was further detailed through the product expressions "*light, friendly and playful*", that were then transformed, through the last step of the map, into several alternative patterns of product qualities. The designers selected these patterns to shape several customizing accessories for the wearable device (Figure 6). Particularly, they focused on the part of the tool related to dynamic qualities, pinpointing different interactive modalities that they then tested through low-fidelity prototypes. Generally, the designers appreciated the tool and did not experience any problems with it. They could clearly distinguish between the levels of abstraction needed at each step, completing the map along with the materialization process. In the interview, they reported to be satisfied with the ExpMap, being "*excellent in allowing us to be broad and open, yet specific at the same time*". They also found good support in the transformation of abstract experiential visions into tangible qualities from the third step. However, the designers also claimed to be inhibited by Step 5, because they perceived the list of sensory qualities as too analytic and quantitative. Nonetheless, they specified that when facing the prototyping phase, such a methodological and parametric approach helped them to shape the prototypes in a purposeful way, maintaining a solid connection between their decisions and the initial intention.

Case 2 concerned the design of an interactive weather station for office environments. The designers started with the intention to design "*a device that can reflect the constantly evolving, dynamic qualities of the room ecosystem*". Through the use of the ExpMap, the designers selected three alternative

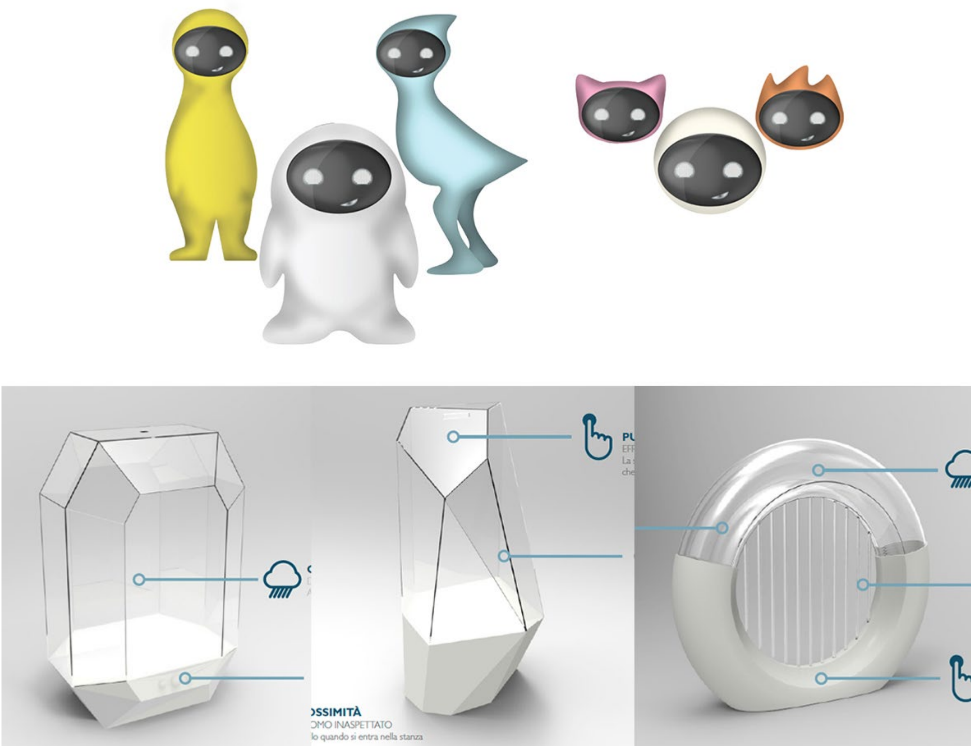

Figure 6. Two concepts developed through the use of the ExpMap (top: Case 1; bottom: Case 2)**.**

materializations, differing in both static and dynamic qualities (Figure 6). Each of them was targeted to achieve the intended product expression of either a static, calm, or emotional product. The designers followed each step carefully, and detailed all the steps precisely, progressing with the map and the concept generation altogether. After completing Step 5, designers developed a matrix and a table to summarize their choices for the three different directions (Figure 7). The resulting map showed high correspondence with the developed concepts as represented in virtual prototypes. During the pre-study interview, designers reported that they were doubtful about possible limitations to their creativity. This feeling was counterclaimed at the end of the project when designers expressed surprise for how "*the map revealed to be very useful to punctually identify all the sensory and dynamic characteristics, and to manage the complexity of a multisensory process*".

Case 3 concerned the design of bathroom ceramic tiles. The input was the vision of "*making users experience the feeling of lying on the sea foreshore*". The junior designer developed three alternative materializations, selecting three patterns in Step 5. Because the case concerned a non-interactive product, the designer adjusted the layout of the map to her specific needs, cutting off the part on dynamic qualities and concentrating on the static qualities. As in Case 2, after Step 5, she also developed a table to summarize her design decisions, and the three materializations appear to be highly correlated with the visual references of the map. She experienced some problems with the tool, as she claimed that the rating scale of Step 5 was too broad and difficult to assess. In the interview, the participant specifically expressed that some ideas came up during the completion of Step 5, therefore as a direct consequence of the tool. She reported that the tool was highly beneficial for her to get back into the project, while working simultaneously on other projects, quickly remembering the logic behind the design decisions she had taken. She also noted that she found the tool time-expensive, and sometimes rather broad or generic, but especially useful for the prototyping phase. She described that Step 5 helped her to shape the prototypes, by making her manage the decision process in a more meaningful and purposeful way, by facilitating the choice of sensory qualities in relation to the product expression and the experiential vision.

The last case was the closest to everyday design practice, involving a senior designer (4 years of experience) of an Italian design agency. The project dealt with the aesthetic restyling of the structure for a robotic arm. The input for the ExpMap was the intention "*to provide users with higher comfort during rehabilitation*". As the observation of this case started when the designers already had explored their conceptual intentions at an abstract level, the participants decided to use the ExpMap only to identify alternative product characters. For this reason, they developed four maps, differentiated only in how they completed Step 4 and 5. Their interaction with the tool was less fluent than in the other cases, and the four maps were less detailed. During the review meetings, the senior designer, interviewed on behalf of the team, explained that they had difficulties understanding how to use

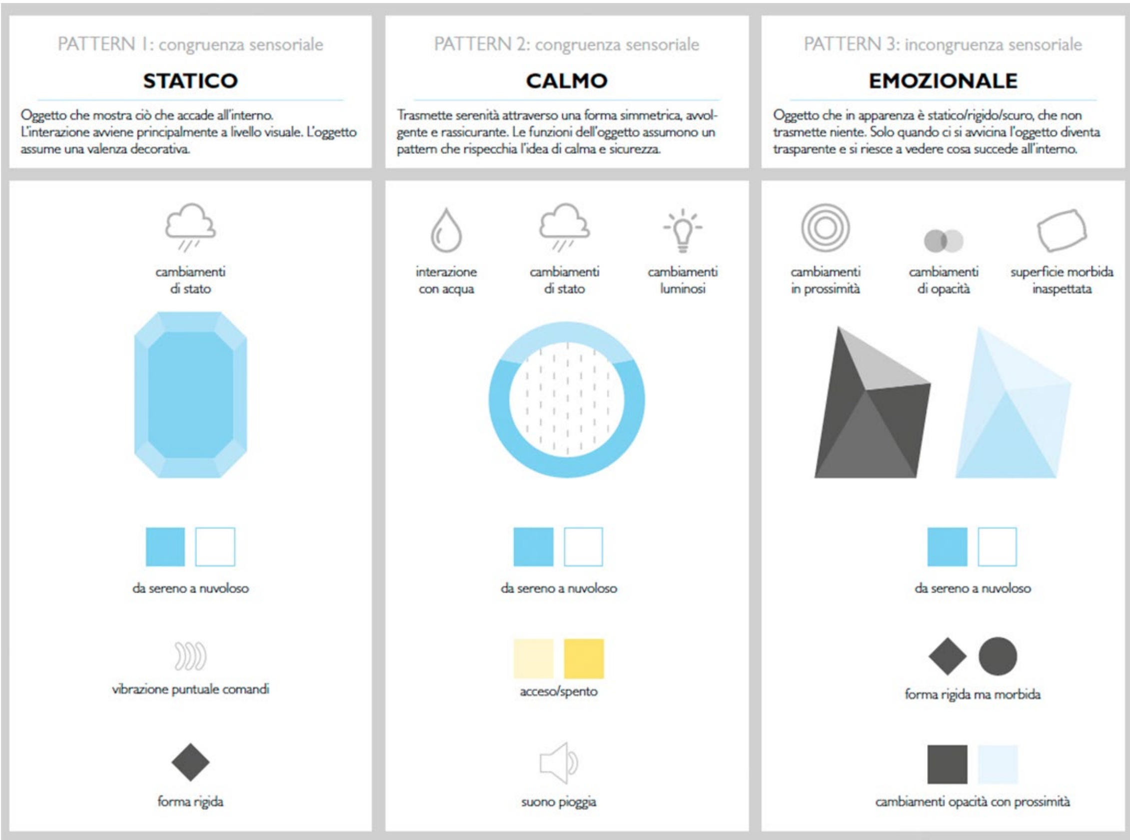

Figure 7. The side-tool developed by participants of Case 2.

the ExpMap for complex products, such as the support structure they were designing, which is composed of several parts. They then understood they could use it as a general guide, commenting that: "*otherwise, we could have gone on endlessly. We can move from the general to the infinitesimal part, from the shell to the joystick to the button… It would become a hypertrophic explosion, and when do I stop? I could find myself designing the screw*". In the interview, the senior designer also expressed some resistance towards the use of the ExpMap, which felt "*a bit over-structured (...) actually I think that my thinking process is lighter. (...) When I see the image of a Nike Air, I know intuitively the direction I want my design to go towards… If I take the picture, and I write 'sporty', my fellow and I already know what we are referring to. We know that all the textile part will be made of 3D textiles, that the part next to it will be of soft foam and that the structure will be a frame wrapped in a membrane. Then it becomes only a matter of detailing*".

Discussion

These cases clarify the benefits and limitations of the ExpMap for a context outside design education. As in Study 1, designers appreciated the tool's ability to support them in the transformation of abstract, conceptual ideas. The stepwise structure of the tool proved efficient, suggesting that the core of the tool lays in the selection of the expression, which bridges the level of experience to the embodiment in product qualities. From this specific study we can see that designers approached the tool in very different ways, sometimes skipping steps or creating more maps for the same project. These differences show the ExpMap's ability to adapt to the designers' subjectivity and to different projects. Despite this, participants claimed some rigidity in the tool, as in Study 1, and especially from the senior designer of Case 4, who claimed the tool to be overly structured. However, this can be related not to the tool's structure, which proved in fact adaptable, but to designers' assessed reluctance to adopt new methods and tools (Daalhuizen, 2014), which is more common when the expertise of designers progresses.

A noticeable occurrence in the case studies is that designers started with very different starting points in terms of vision statements. Most of them did not achieve a well-defined description of the experience they intended to elicit with a user. Some statements referred to product characteristics (Case 2), interaction qualities, or used a metaphor (Case 3) instead of pinpointing the intended feelings of targeted users. This might suggest that designers need stronger guidance in defining a clear initial statement and to distinguish the difference between the experience, the interaction, or the product level (Hekkert & van Dijk, 2011). However, through these case studies we can also observe an unforeseen benefit for design practitioners: it helped keeping track of their creative thinking process while dealing with different projects at the same time. Furthermore, in two out of four cases, designers developed some side tools for the ExpMap, viz. the table and matrixes of Cases 2 and 3 (Figure 6), to summarize the choices made in Step 5 for each alternative materialization. This might suggest a need for additional tools connected to the ExpMap, or it might be related to a general feeling of being constrained by the space of the map. However, we argue that limitation in space may also be beneficial, as it stimulates designers to make choices, discarding what is less relevant when selecting pictures or descriptors that pinpoint the intended characteristics of the future product. Perhaps this is what makes the tool unique compared to other design tools: it is a guidance for both explorative and selective moments of design process. As such, the tool fosters the alternation between divergent and convergent thinking modalities, which is important to stimulate creativity (Csikszentmihalyi, 1996).

Finally, the designers of these cases used the last step of the ExpMap to setup the prototyping activities related to their projects. Specifically, in Cases 1-3, the designers developed parametric/parallel prototypes (Dow et al., 2010) embodying the alternative materializations selected through the last two steps. The prototypes developed were 'parametric' because they describe the product concepts in terms of variables, but they were also a direct manifestation of a specific experience scenario and a product character. These prototypes were then used to assess their ideas, reflecting on the insights gathered to further refine them. Therefore, the results of Study 2 show that the ExpMap can also support the prototyping activity in a purposeful way, by assisting designers in defining the focus of the prototyping more carefully (Buchenau & Fulton-Suri, 2000; Camere & Bordegoni, 2016) and in challenging the diverse materializations in relation to the experiential vision.

General Discussion

The two studies described here show that the ExpMap can be used as a stable structure to support the process of materializing experience-oriented conceptual intentions. Designers from both studies appreciated the stepwise structure, which allowed them to record and organize creative thoughts and inspirations, and to move from the abstract level of experience to the tangible level of product qualities. In both studies, designers easily became familiar with the tool, because it integrates activities that are common in design practice, such as the construction of mood boards, with the use of descriptive terms to pinpoint different design steps. This made the ExpMap easy to learn and use, increasing the chances of fitting into designers' processes. Interestingly, the results of Study 1 showed that this awareness might provoke the feeling of achieving less original or unexpected outcomes. However, our quantitative and qualitative investigations suggest that this feeling is not correlated with a constrain in creativity, but rather with the tool's ability to guide designers step-by-step and manifest the logic behind their design decisions. In this way, the ExpMap fosters a sense of control and awareness that eliminates some uncertainty of design process.

Novice designers tend to struggle more than experts in the materialization of conceptual intentions, especially when these are experience-oriented. As a result, in our studies the ExpMap was assessed more positively by the novice designers than by experienced designers. This is a logical consequence of the tool's ability to boost designers' confidence in tackling complex decisions, which is an appealing benefit for unexperienced designers who still need to learn how to deal with design problems, while experts have usually already developed their own approaches and tools. This interpretation is substantiated by the feedback received from the novice designers who joined Study 1 and 2, and from the senior designer of Case 4, who claimed that the map was too structured for him. While this result should be investigated further, our findings suggest that the use of the ExpMap is more beneficial in the context of design education and for novice designers, than for expert designers.

Possibly, some designers may describe the tool as rigid, because it confines them to the domains of words and images, whereas some designers might prefer to include samples of materials as well in their experiential map. Material samples can evoke textures, smells, and sounds that may remain unnoticed in the current tool. In addition, physical explorations of experience can provide important insights that are difficult to capture in cognitive descriptions (Klemmer et al., 2006). We acknowledge this limitation and invite designers to use the ExpMap as complementary to the physical exploration of tangible artefacts and material samples, employing it to maintain the designer's focus on the multisensory aspects and materialization process supported by the tool.

The two studies highlight only few limitations in the tool's layout, mostly related to the selection and management of visual references in Step 2 and 4. This is particularly due to the circular arrangement chosen, which alters the way designers normally relate to their inspirational references. Although other, more linear layouts could be considered, the circular design is particularly suited to identify logical relationships between design intentions and selected qualities, as it allows the designer to visualize multiple alternative materialization pathways in a single overview. Nevertheless, a digital interface would allow designers to select and navigate through the visual reference in a more interactive way.

Another important aspect that emerged from Study 2 relates to the difficulties in defining a clear, broad enough, but at the same time descriptive experiential vision that pinpoints the impressions and feelings that product usage might evoke while interacting with the product (Step 1). Given the importance of this step for the adequate use of the ExpMap, some support should be provided to designers, perhaps in the form of specific questions or guidelines, to help them define the product vision. For instance, the ViP method (Hekkert & van Dijk, 2011) suggests designers to determine what they would like to offer to people within the established context, by answering a question like "we would like people to feel... while...".

Furthermore, we noted that participants of both studies used Step 3 in many different ways. While this provoked confusion in the usage of the map, it might as well have given designers the freedom to explore their own approach. The future development of the tool should bring a clarification on the role of Step 3 and how designers can use it in relation to the subsequent steps. Lastly, when designers selected more than one pattern of sensory qualities, they felt the need to summarize their choices in a separate format, as in Figure 6. Hence, we conclude that Steps 1, 3 and 5 might benefit by developing further guidance for designers.

An advantage of the ExpMap proved by these studies is the ability to foster an approach more focused on the multisensory characterization of the product, as opposed to designers' dominant focus on the product's visual appearance. The participants of both studies expressed that the structure of the ExpMap stimulated the consideration of unconventional / multiple sensory modalities, which they would otherwise neglect. Specifically, the last step of the ExpMap is useful, because it suggests possible qualities and it challenges designers to think whether these qualities are relevant or not to materialize the intended experience. While offering the possibility to add or change the qualities, the list provided by the tool is a combination of other lists present in the literature that have been validated as the most relevant to describe the sensorial characterization of a product (Karana, 2009; Sonneveld, 2007; Van Egmond, 2008; Colombo, 2014). Specifically, we see the inclusion of dynamic qualities as a strong advantage of the tool.

Finally, Study 2 showed that the ExpMap can be a handy tool when dealing with Experience Prototyping activities (Buchenau & Fulton-Suri, 2000; Camere & Bordegoni, 2016). With this term, we refer to the practice of prototyping for an experience-driven design process, challenging a design concept to explore whether it can materialize the intended user experience. In some cases of Study 2, participants structured the prototypes based on the decisions taken through the ExpMap, because the tool manifests the assumed relationships between the experiential intention (the vision) and the alternative materializations (the pattern of sensory qualities). For example, in Case 2 designers developed three alternative prototypes based on three patterns of sensory qualities, which all linked to a specific product expression. By offering a solid connection between the experiential vision and the materialization, the Experience Map can help designers to think simultaneously at the micro-level of sensory qualities and at the macro-level of integrated user experience. While being still experimental, the approach tested in the two studies has shown to give consistent outcomes with different groups of designers. The ExpMap presents several advantages and possibilities of use because of its flexible nature. In our results, participants identified the potential of the tool to act as a platform of confrontation with other stakeholders, to motivate and describe the nature of their design decisions, and to discuss their ideas with other colleagues in teamwork.

In previous studies (Camere, Schifferstein & Bordegoni, 2015), the ExpMap was also used to analyze existing products by starting from rating the product appearance to infer the logic behind design decisions. This 'reverse use' of the tool can offer interesting possibilities, for example, for Material-Driven Design (Karana et al., 2015), i.e., when developing novel visions of product applications for emerging or not yet existing materials. In this case, rating first the future and desired sensorial qualities of the material, and then proceeding with understanding what meanings can be expressed through these, may help to define the new experiential vision for that specific material. Other potential uses of the ExpMap will be thus explored in the near future. For now, we can conclude that the ExpMap is a strong support for designers to cope with the transformation of abstract and complex experience-oriented intentions into appealing, fine-tuned, and carefully crafted product concepts.

Conclusions

The paper presented the Experience Map, to provide a link between the abstract and the tangible in the process of designing for user experiences. The tool assists designers to elaborate on the experience they want to elicit and to define what sensory qualities and dynamic features can characterize the product to evoke such an experience. In the two studies described here, we challenged its use in different contexts and targeted different pools of designers. Both studies showed that the tool is a solid and reliable structure to support experience-driven design, and that it carries several advantages for novice designers. The ExpMap is a visually stimulating, stepwise structure that fosters designers' confidence and awareness of their decisions when it comes to crafting the product that will bring the intended user experience to life. The map makes designers consider novel design opportunities coming from all the sensory modalities, stimulating them to go beyond the focus on visual appearance. This approach should not be considered as a way to parametrize the design of a product, and thus achieve an 'optimal' product configuration. Rather, the ExpMap provides a structure for designers to balance the contribution of each product quality, while shaping the object as a coherent whole in order to achieve an appropriate, original, and engaging experience. The ExpMap, in conclusion, offers the possibility to finally bridge the level of conceptual, experiential intentions, and the materialization in tangible product qualities, a gap that is normally difficult to overcome and not supported by any tools in the related literature. As demonstrated, the strength of the ExpMap lays in its strong visual connotation, stimulating designers to think at the macro-scale of targeted user experiences, and simultaneously at the micro-level of product qualities, refining the materialization of experiential visions up until every detail of the future product.

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Appendix I—*Sensory Vocabulary*

STATIC EXPLORATION
Analyse and deconstruct the vision exploring the static properties of the object

	TERM	DESCRIPTION		5 4 3 2 1 0	
VISUAL	**colorfulness**	*number of colors present in the object*	colorful	●—●—●—●—●—●	monochromatic
	color intensity	*vividness of colors*	vivid colors	●—●—●—●—●—●	pale colors
	color contrast	*difference between the colors present in the object*	high color contrast	●—●—●—●—●—●	low color contrast
	brightness	*luminosity of colors*	bright	●—●—●—●—●—●	dark
	glossiness	*ability of the object to shine and reflect light*	glossy	●—●—●—●—●—●	matte
	transparency	*ability to see through the object*	transparent	●—●—●—●—●—●	opaque
SHAPING	**decorative joining**	*the joint between two or more parts is visible and used as a decorative trait*	decorative joining	●—●—●—●—●—●	invisible joining
	material combination	*quantity of materials present in the object*	many materials	●—●—●—●—●—●	single material
	organicity	*free-form and flowing in appearance*	organic	●—●—●—●—●—●	geometric
	rounding	*presence of rounded and soft edges*	rounded	●—●—●—●—●—●	sharp-edged
	regularity of shape	*uniformity and symmetry of the shape*	regular	●—●—●—●—●—●	irregular
	discontinuity of surface	*presence of irregularities*	discontinuous	●—●—●—●—●—●	continuous
	massiveness	*solidity of the object*	massive	●—●—●—●—●—●	spacious
	balance in proportions	*the object presents harmonicity in its proportions*	balanced	●—●—●—●—●—●	unbalanced
TACTUAL	**softness**	*softness of the feel*	soft	●—●—●—●—●—●	hard
	heaviness	*perceived weight of the object*	heavy	●—●—●—●—●—●	light
	elasticity	*ability to stretch*	elastic	●—●—●—●—●—●	rigid
	strength	*the capacity to resist to shocks*	robust	●—●—●—●—●—●	fragile
	warmth	*perceived temperature of the object*	warm	●—●—●—●—●—●	cold
TEXTURE	**scale of texture**	*size of the elements in the pattern*	large pattern	●—●—●—●—●—●	small pattern
	bumpiness	*height of the texture*	bumpy	●—●—●—●—●—●	flat
	roughness	*regularity of the surface*	rough	●—●—●—●—●—●	smooth
	hairiness	*presence of fibers/hair*	hairy	●—●—●—●—●—●	hairless

Appendix II—*Facilitator's Journal and User Questionnaire*

		CONDITION A				
GROUP ID		◌	◌	◌	◌	◌
WHEN DO THEY USE THE EXP. MAP? (related to concept generation)	*before*	☐	☐	☐	☐	☐
	during	☐	☐	☐	☐	☐
	after	☐	☐	☐	☐	☐
	don't know	☐	☐	☐	☐	☐
DO THEY HAVE ANY PROBLEM WITH THEIR GROUP?	*yes*	☐	☐	☐	☐	☐
	no	☐	☐	☐	☐	☐
DO THEY HAVE ANY PROBLEMS WITH THE USE OF EXP. MAP?	*yes*	☐	☐	☐	☐	☐
	no	☐	☐	☐	☐	☐
	problem	…………	…………	…………	…………	…………
DO THEY COMPLETE THE MAP ALL AT ONCE?	*yes*	☐	☐	☐	☐	☐
	no	☐	☐	☐	☐	☐
WHICH STRATEGY DO THEY CHOOSE?	*sens. congruence*	☐	☐	☐	☐	☐
	sens. incongruence	☐	☐	☐	☐	☐
	metaphor	☐	☐	☐	☐	☐
	explicit	☐	☐	☐	☐	☐
	implicit	☐	☐	☐	☐	☐
	modality dominance	☐	☐	☐	☐	☐
	multimodal elicitation	☐	☐	☐	☐	☐
	other	…………	…………	…………	…………	…………

COMMENTS

THE EXPERIENCE MAP

QUESTIONNAIRE

Please evaluate the TOOL:

I found the tool **useful** to deconstruct the object.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

The tool **improved my skills** towards Multisensory Design

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

It was **easy** to understand the different phases of the process.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

I would like to **use it** in other projects.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

The tool is **visually clear**.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

It required an **effort** to complete the Map.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

The tool provides a **flexible** structure...

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

...and I felt free to **interpret** it.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

Please evaluate the SENSORY PROPERTIES list:

The list of properties is **complete**.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

The terms are **immediate** to understand.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

The words are **appropriate** to describe the object.

NOT AT ALL ●—●—●—●—●—●—● VERY MUCH

OPEN QUESTIONS

1. Do you think the tool would be an useful support for the design process?How would you use it?

2. Which are the advantages and disadvantages of the tool?

3. Any other suggestions/ comments:

Appendix III

Table 3. Complete list of abstracted categories and their occurrence in participants' feedback.

Abstracted category	*Theme*	*Occurrence*
Stimulation of new original solutions / features	Productive thinking	54
Support to consider multisensory aspects		
I felt more creative		
Completeness of ideas		
Usefulness of collection of visual inspirations		
Definition of concept / idea embodiment	Support for idea development & refinement	44
Completeness of ideas		
Explicitation of ideas		
Exploration of alternatives		
Structure for organising thoughts	Ownership & control of design process	45
Supporting a more systematic approach		
Collection of inspirations		
Fluidity	Facilitation of synthetic thinking	14
Divergent / convergent thinking		
Freedom of thoughts / no rigidity		
Time saving in the definition of ideas		
Seeking coherence	Fostering vision embodiment	26
Direct correlation between input and output		
Checking back and forth		
Problematic interface	Limiting interface	7
Only visual and not multimodal		
High threshold / not immediate		
Difficulty in image search		
Rigidity / scarce flexibility	Scarce ownership of tool/method	13
Fixation from EM's suggested structure		
Difficulty in following the steps		
Scarce support for idea generation	Limitations in support of design process	15
Limiting ideas		
Time demanding		
Difficulty in seeking coherence		