Semantics-driven design for bonding with human scent

Citation for published version (APA):

Potuzakova, D., Croes, M. J. G., & Feijs, L. M. G. (2016). Semantics-driven design for bonding with human scent. *International Journal of Arts and Technology*, 9(3), 237-252.
<https://doi.org/10.1504/IJART.2016.10000192>

Document license:
TAVERNE

DOI:
[10.1504/IJART.2016.10000192](https://doi.org/10.1504/IJART.2016.10000192)

Document status and date:
Published: 01/01/2016

Document Version:
Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Semantics-driven design for bonding with human scent

Dominika Potuzakova, Misha J.G. Croes and
Loe M.G. Feijs*

Department of Industrial Design,
Eindhoven University of Technology,
Den Dolech 2, 5612 AZ Eindhoven, The Netherlands

Email: potuzak.dom@gmail.com

Email: m.j.g.croes@tue.nl

Email: l.m.g.feijs@tue.nl

*Corresponding author

Abstract: We describe two design explorations based on human scent using a terminology of 'open' and 'closed' semantics. We define 'open' by: each design is a carrier or container, conveying something else (the scent), which has its own meaning, not designed by the designer. If a product has no such a carrier function, its meaning, although eventually determined by the user or observer, can be controlled to a significant extent by the designer; that is what we call 'closed' semantics. In the design explorations of this paper, the designs carry scent, which belongs to the olfactory modality, but the other sensory modalities are still relevant (one can *see* the design, for example, or *touch* it). Therefore, each product that is a carrier offers an interplay between distinct sensory modalities (one for contents which is downloadable, the others being more or less fixed)

Keywords: product design; conceptual design; industrial design; product semantics; semantic analysis; human scent; bonding; human odour; premature child.

Reference to this paper should be made as follows: Potuzakova, D., Croes, M.J.G. and Feijs, L.M.G. (2016) 'Semantics-driven design for bonding with human scent', *Int. J. Arts and Technology*, Vol. 9, No. 3, pp.237–252.

Biographical notes: Dominika Potuzakova obtained her Bachelor in Engineering Product Design in London South Bank University in 2010. She joined the Faculty of Industrial Design at the Eindhoven University of Technology and finished her Master degree in 2012 and her PdEng Postgradual degree in 2014. Since 2009, she has been focusing her work on user-centred design and user research in the healthcare and well-being domains. Her Master, as well, as PdEng thesis were devoted to conceptual product solutions in the comfort and bonding between mothers and prematurely born babies. Currently, she works as a Senior User Researcher at AVG Technologies in Prague, Czech Republic

Misha J.G. Croes studied Industrial Design at the Eindhoven University of Technology where he obtained his Bachelor in 2008 and Master in 2010. With his Master graduation project FamilyArizing, he won the Dutch National Thesis Award in Health Care in March 2011. He is currently finishing his PhD and researches improvements for bonding between prematurely born incubator infants and their parents in the neonatal intensive care unit.

Loe M.G. Feijs studied Electrical Engineering and obtained his PhD in Computer Science at TU/e in 1990. He conducted many case studies in formal methods in Philips industry groups such as industrial automation, consumer electronics, components, and medical systems. In 1994, he was appointed part-time Professor at TU/e, Mathematics and Computer Science. From 1998 to 2001, he was the Scientific Director of the Eindhoven Embedded Systems Institute. In 2001, he was appointed a Professor for the Chair Industrial Design of Embedded Systems. He teaches product semantics and creative programming and performs research in bio feedback and neonatology.

This paper is a revised and expanded version of a paper entitled ‘Oris: bonding through maternal scent’ presented at the Proceedings of 8th International Conference on Design and Semantics of Form and Movement, DeSForM 2013, Wuxi, China, 22–26 September 2013.

1 Introduction

Product semantics is a central theme in the industrial design field (Krippendorff, 2006; Steffen, 2010; Bürdek, 2002). In this paper, we expand the theory of open and closed semantics and illustrate it by two design explorations. We define ‘open’ as: each design is a carrier or container, conveying something else (the scent), which has its own meaning, not designed by the designer. If a product has no such a carrier function, its meaning, although eventually determined by the user or observer, can be controlled to a significant extent by the designer; that is what we call ‘closed’ semantics. In the case studies of this paper, the designs carry scent, which belongs to the olfactory modality, but the other sensory modalities are still relevant (one can *see* the design, for example, or *touch* it). Therefore, each product that is a carrier offers an interplay between distinct sensory modalities (one for contents which is downloadable, the others being more or less fixed). The olfactory modality is interesting because it is hard to grasp and very different from the visual modality, which usually is very dominant in design.

The context of the design work is the cooperation between Eindhoven University of Technology (TU/e) and the Máxima Medical Center in Veldhoven (MMC) on the topic of neonatal care (Bouwstra et al., 2012). This paper is an extended version of a paper presented at DeSForM 2013 (Potuzakova and Feijs, 2013), but a second unpublished case study has been added and the semantic theory has been extended significantly.

This paper is structured as follows: In Section 2, we describe the design context, which is common for the two design case studies. Section 3 describes Oris, a scent carrier intended to be used by the mothers of incubated babies. Section 4 describes ‘for daddy’, a similar design, but targeting fathers. Section 5 presents the semantic theory and we use Oris and ‘for daddy’ respectively as examples of closed/open semantics theory. Finally, in Section 6, we look back and discuss our conclusions.

2 Design context

Premature childbirth might occur as early as three months prior of a full term birth. When born prematurely, a baby might suffer severe medical problems that need immediate

attention from medical staff in the neonatal intensive care unit (NICU). Besides the medical problems with the fragile health of the baby immediately after the arrival to the world, parents experience a mental disturbance in terms of fear, confusion, and not being ready yet for birth (Charpak et al., 2005). Due to these conditions, the early bonding interaction between parents and their baby can be disrupted. Skin-to-skin contact (where the baby is laid on the bare chest of the parent) is usually postponed until the medical condition of the baby is stabilised. The parents' contact with the baby is limited during this postponement period. Involving parents to contribute to the care of their prematurely born baby and reading the behavioural cues of the infant increases parents' confidence in care-giving and may facilitate bonding (Maguire et al., 2007).

3 Design of Oris

A traditional user-centred approach was used in order to arrive at the final design of Oris. A scientific literature study preceded the initial qualitative user research with mothers of prematurely born babies. Close collaboration with involved stakeholders (mothers, NICU nurses, neonatologist, and clinical psychologists) was established and the feedback from them, as well as other specialists in the field of design, materials and technology, were iteratively incorporated throughout the whole design process. Several small to large iterative design cycles were succeeded. Those cycles involved: 'user research and specification finding', 'concept derivation', 'prototype development', 'prototype testing', and evaluation'. The whole design process and its content is extensively described in Potuzakova and Feijs (2013).

When a baby lies skin-to-skin on his or her mother's chest, the scent of the mother is acknowledged by the baby. This recognisable odour comes, among others, from the maternal axillary (armpit) (Cernoch and Porter, 1985) and neck (Schaal, 1986) region. In these regions, apocrine sweat glands secrete fluid that carries an individual unique human scent (Shelley and Hurley, 1952). The olfactory content of this scent depends on three factors: genetics, diet or environmental factors, and influences of outside sources (e.g., lotions, soaps, perfumes, etc.) (Curran et al., 2005). Despite these factors a baby can distinguish between his mother's and another lactating mother's odour (Cernoch and Porter, 1985). Mothers carry their olfactory signature not only from an armpit or neck region, but also from the breast regions. Such characteristic body odours play an important role in early child-mother recognition. Further relevance and importance of early olfactory stimulation in prematurely born infants is summarised in Croes et al. (2012) where they also propose examples of implementing improvements in the future research and design in the NICU environment.

Building on the observation and interviews with a mother and several neonatal nurses together with the inspirational interaction relabeling session, a concept of an intimate garment worn by mothers of prematurely born babies called 'Oris' was developed, (see Figure 1). The shapes (bubbles) implemented in Oris, as well as the interaction with Oris, were designed to communicate the collection and diffusion of a human scent in a subtle metaphorical form.

Oris works as follows: the bubbles grow in their shape once exposed to a warm environment and they shrink once exposed to a cold environment. This fullness interaction is also strengthened by the dynamic movement of these bubbles tearing their

way through an opening in the top layer underneath which the bubbles are embedded. The opening of the top layer and the bubble subtly popping out indicates that the scent of the mother is ready to be exposed (either collected or diffused). On the other hand, the closing of the top layer behind a bubble indicates that the mother's scent is ready to be preserved inside the garment. This very subtle interaction gives feedback to a mother that her invisible human scent is either getting collected and preserved or diffused. The subtle interactions are communicated in Figure 2.

Figure 1 Intimate garment for mothers of prematurely born babies collecting the maternal scent and diffusing it for a baby (see online version for colours)

Note: Two garments in one package and the scent bubbles shrunk inside the garment preserving the scent.

Figure 2 Visuals explaining the interactions of the Oris garment (see online version for colours)

bubbles enclosed in a cold environment (e.g. room)

bubbles slowly popping up in a warm environment (e.g. human skin)

bubbles showing "fullness" absorbing scent

bubbles retracted preserving scent

bubbles slowly popping up in a warm environment (e.g. incubator)

bubbles fully popped out diffusing scent

The design of the whole garment (an intimate necklace) is kept minimalistic and organic. This underlines the subtle interactions as well as its intended use for a natural scent recognition and intimate bonding through scent. The original colour of the bubbles is warm pink, which should also represent a warm heart of a mother being given to her beloved newborn. Later in the development, three other colours, soft yellow, blue, and green were implemented, Figure 3. This variety of colours gives the freedom for the mothers to choose their colours for their baby, e.g., according to the gender of the baby.

Figure 3 Oris garments with their distinctive colours (see online version for colours)

Now we sketch a scenario we envision: a baby sometimes arrives as early as three months earlier than expected. In this situation, mothers are neither mentally nor physically prepared to have a baby. They feel fearful about the critical medical state of their child and tend to be confused. They would love to contribute to the upbringing of their own child, however, that is not possible because their child is incubated. For several weeks or months the two of them, who used to be one unity, are physically and mentally separated. This is the time when Oris can assist to overcome this separation. Oris shall be promoted by NICU nurses, because they are the first assistants that the mothers of prematurely born babies are in contact with. In the scenario, the full package of Oris is either purchased at the hospital or at a designated online shop. The Oris package comes with two Oris products in a specially designed carrier box. Mothers can choose which one of the four colours of Oris they would like to purchase. It is recommended to order always two different colours for later switching one coloured product with another one during use. The carrier box is also designed in a way that it can keep the scent of the mother for a long period of time. Mother starts wearing one of the products; let's say the one with pink bubbles. Her scent is loaded in it slowly and therefore she is suggested to wear it constantly whenever she feels comfortable. After wearing Oris, she brings it to the hospital for her baby. She places Oris next to her baby, close by her or his head or where convenient. The warm environment of the incubator helps to diffuse her scent for her baby. At this moment, she can already start wearing the second Oris (e.g., yellow). Her scent is loaded in this second Oris. The next time she visits her baby she can switch the 'evaporated' pink Oris for the newly scented yellow Oris. In this way, we expect the mother feels actively contributing to her child's healthcare, well-being, and comforting.

Moreover, the intimate bonding through scent is initiated and sustained. The whole scenario of intended use of Oris is displayed in Figure 4. The technological options for implementation of Oris as well as a user evaluation can be found in Potuzakova and Feijs (2013).

Figure 4 Process of an intended use of Oris (see online version for colours)

4 Design of 'for daddy'

Although most literature concerning parents in the NICU is focused on mothers or both parents, a growing body of literature is looking specifically at how fathers experience and cope with (premature) childbirth (Lundqvist and Jakobsson, 2003; Lundqvist et al., 2007; Lindberg et al., 2007; Arockiasamy et al., 2008; Sloan et al., 2008). In their study, Hollywood and Hollywood (2011), through interviews, conclude that premature childbirth instigates a multitude of experiences for fathers, which are diverse and complex. According to them, fathers experience, among others, 'immense anxiety', 'helplessness', 'fear of the unknown', and 'constraints with work' during the hospitalisation period of their child. Fathers tend to look for a 'planful problem-solving' coping strategy in the NICU (Hughes et al., 1994; Affleck et al., 1991). Furthermore, fathers experience difficulty in choosing between time spent with their child and at work (Premberg et al., 2011; Pohlman, 2005) and they tend to see their spouse's and child's needs as a higher priority than their own (Pohlman et al., 2007). It is hypothesised here that all this might be the reason why fathers describe their bond to their child as 'involving distance' (Guillaume et al., 2013), while being in 'an exposed position with hidden strong emotions' (Premberg et al., 2011). If we look at the father-child bonding situation in the NICU, it is safe to conclude that the situation is difficult for fathers.

Through interventions, such as Kangaroo Care¹ (Blomqvist et al., 2012) and family centred care (Higham, 2011), they are encouraged to be close to their child and be active in their care.

Some fathers, however, do not experience the ease of adapting to sudden parenthood as easy as others. Hugill et al. (2013) describe a situation where fathers take a ‘detour before going back to their partners to cry in silence by themselves’, showing that some fathers have difficulty experiencing their own initial emotions. For those fathers who want to rely on themselves, we decided to design a product that might help them cope with these difficult moments of private emotions.

To further focus on the communication from child to father, we started searching for publications that provided insight into which infant cues can elicit a response in the father. Green and Gustafson (1983) have shown that 45% of fathers are able to distinguish their 30 days old infant’s cry from their control. Gustafson et al. (2013) are more optimistic and show that fathers are just as good at recognising their child’s cries when they are given equal amount of time to spent time with their child. Fathers are well capable of recognising their newborn child from pictures (Kaitz et al., 1987, 1988; Bader and Phillips, 2002). In contrast to mothers (Russell et al., 1983; Kaitz et al., 1987), and the above-mentioned cues, fathers show clear difficulty in recognising their child with their nose alone (Ferdenzi et al., 2010). This meant an opportunity to support the father in having a broader spectrum in recognising his child opened up. Especially since various researches have shown that later in life they are just as well in recognising their child’s odour as mothers (Dubas et al., 2009). From this information, we concluded to take on the challenge to explore a design for an ‘olfactory communication product’ that helps fathers ‘train’ to recognise the body odour of their hospitalised infant during moments of private emotional connectedness to his child. To help us focus, we developed a stereotypical persona of a man working in an office environment, in which wearing a suit is an everyday phenomenon. The man, 32 years old, is struggling hard to decide to spent time between his career and his new prematurely born daughter. Although he thinks about her a lot, he does not always allow himself to do so, especially not while being at the office. This persona was accompanied with a mood-board to inspire us throughout the design process. For him, we decided to design a product that would allow him to keep his new daughter (mentally) close, without interfering too much with his everyday life at work. The product needed to match his lifestyle, his choice of clothing, and should be portable. It should blend into his everyday behaviour, not to attract too much attention. Finally, as described before, the design should be able to communicate the body odour of the child when the father wants to, as a means of recognising and getting to know his child.

For inspiration, we looked at the historical evolution of odours and scents in (Western) society. In the 17th century, places famous for their perfumes were often found in France. Due to the expensiveness of perfumes it meant that upper-class consumers would buy their perfumes in very small quantities, and would save them in specially designed bottles in inconspicuous places. Unlike today, these smelling-bottles would only be opened to smell its content, not to drape the entire body in the odour. Although similar in use, sniffing tobacco or ‘snuff’ went through a completely different development. Snuff was quite quickly a common good for all layers of society. Made out of a large variety of materials, so called ‘snuff boxes’ were carried around at all times and used wherever the user wanted (Le Corbeiller, 1966). Although normally sniffed by placing

the snuff between index finger and thumb and bringing it to both nostrils, some people would tend to just dip their finger in the box inconspicuously and simply bring this to the nose (Le Corbeiller, 1966).

For the ‘office dad’ persona, the design needs to be portable, inconspicuous, and suit the working environment of the father. While looking for inspiration in ‘snuff boxes’ and perfume bottles we see the same traits coming back. People would keep their perfume as well as their sniffing tobacco to themselves, and especially in times of social pressure, would not even take the snuff box out of their pockets before indulging themselves in so largely desired ‘fix’ of the containers’ smell (most personal assets were scented as well). This specific interaction paradigm triggered the authors to develop a similar use case, but than for the office environment. Therefore, the proposed design of the scent container ‘for daddy’ is as follows: inside of the container is a piece of precious fabric, worn by his child and therefore containing her odour. This precious piece of material needs protection from outside air and other odours. Therefore, the inside of the ‘for daddy’ container is made out of glass in order to protect the infant’s odour. Furthermore, the container is sealed easily in order to make sure air cannot freely travel inside the container while it is closed. Finally, and this is especially crucial for the father, the container is designed to fit the user’s pocket without obstruction of its usage. Shape-wise, the design fits the trouser pocket by the curvature of the container. For the outside material, brushed stainless steel is proposed. Besides blending in with other personal assets of the father, the material would also ensure that the container would be sturdy and increase the feeling of protection for its content. Finally, we believe the container should be easy to manipulate while being inside the user’s pocket. This is done by implementing a clear rim on the opening side of the container. This way the father can feel and open the container without any problem (see Figures 5 and 6).

Figure 5 An overview picture of the ‘for daddy’ design’s features, materials, and functional design

For the use-case of our ‘office man’, we envisioned a scenario where the office man – ‘daddy’ is in a work meeting. During this meeting, his mind fades away towards his hospitalised daughter. Inconspicuously, the father reaches into his pocket, in which he keeps his ‘for daddy’ container. Opening the container with his hand, placing his fingers

inside the container, he ensures his fingers will take over the smell of the content, the odour of his daughter. By bringing his scented fingers to his face/nose, he enables himself to acknowledge his thoughts about his daughter without raising suspicion in his office peers.

Figure 6 The ‘for daddy’ design in relation to products relevant for ‘office dad’ (see online version for colours)

5 Semantic theory and analysis

5.1 Open and closed semantics

In this section, we will further expand the notions of open and closed semantics, deploying Oris and ‘for daddy’ as use cases. From a semantic perspective, the Oris and ‘for daddy’ designs are based simultaneously on two different approaches to product semantics. The first perspective we shall call ‘closed semantics’ (see Figure 7). It is more traditional yet sometimes a bit unavoidable. It is based on the sender-channel-receiver principle, proposed by Shannon for technical communication (Shannon, 1948; Steffen et al., 2000). The central square Figure 7 is the channel. The second perspective we shall call ‘open semantics’ (see Figure 8). It is more contemporary and much better fit for products, which work as a tool, a carrier or a medium. This is what Krippendorff (2006) in his book *The Semantic Turn* explains and illustrates. We assume that the distinction between closed and open semantics is not restricted to the visual modality or to a form, but that it applies for all modalities and modality-combinations including the visual-, haptic-, auditory-, olfactory modalities, and interactions or a combination of these.

First, we shall develop our theory of open and closed semantics somewhat further. After that we apply the theory and vocabulary to evaluate Oris and ‘for daddy’.

The classical sender-channel-receiver model as used by Shannon is given in Figure 9. In a closed-semantics approach, this model has been used in such a way that the designer acts in the role of transmitter, coding messages into signals, where the product is the signal. Other people ‘reading’ the product try to decode the message again. On top of the noise added (for example, when reading a traffic sign which is very dirty), there are

additional possibilities for misunderstandings because the transmitter and receiver may have different codes (which happens because the product is used in different contexts and because of cultural differences, amongst other reasons).

Figure 7 Closed semantics according the Shannon channel-coding principles such that the designer encodes messages intended to be understood by the user (see online version for colours)

Figure 8 Open semantics according Krippendorff's semantic turn principles such that the designer creates possibilities for the user to load the product with her own contents and meanings (see online version for colours)

Figure 9 Traditional communication model as used for telecommunication (see online version for colours)

Open semantics can be chosen as an approach to design products that are intentionally more flexible in their use, and therefore allow users to give different meanings to them, as explained in Krippendorff (2006). For an open semantics approach, we can no longer

consider the product to be in the role of a signal, but the product itself acts as the channel. This channel, or carrier is loaded with content, which is unloaded later. Still there is the possibility of ‘noise’ entering the channel. Moreover, the content could leak, which is usually unwanted (in communication theory this is the reason for shielding and encryption). In case of physical content, leakage is also unwanted in order to avoid loss of content and protect the environment. Figure 10 shows this product-as-channel model.

Figure 10 Adapted communication model for open product semantics (see online version for colours)

Whereas Shannon developed his model for information processing, typically digital information over an analogue channel, the new product-as-channel model could be applied to both physical situations (tangible matter as content) and to information-processing (digital photos being carried by a photo-browsing). In most of the examples in this article, we address physical situations. From this product-as-channel model, we derive some key aspects to be distinguished for carrier-products: content type, loading, transport, protection, containment, emotional values, extra semantics, and rituals. For example, *loading* is about practical aspects of how to load the content into the carrier, for example, opening mechanisms, which usually come with feed-forward information, which is usage of (closed) semantics in itself; typically these semantic aspects, for example, how to open a bottle, are handled in another modality than the modality of the content (an audio-player has buttons which provide haptic and visual feed-forward function).

We mention a few examples. First, a lunch box: the content is food, loaded by the user, who transports, it usually in a bag. This product protects its content against bacteria, and at the same time provides containment of the smell (of the content). The rituals are user-defined. In the same way a canteen (bottle) contains drinks, provides containment against leakage, release via the bottle cap. A baby bottle, to contain milk protects its content against bacteria, has a teat for release, but has the extra emotional values of love and care. A flask contains a (secret) drink, to be protect from other people’s eyes and the emotional value sometimes is shame. Perfume bottles are factory-loaded and have the emotional value of being expensive (which raises emotions such as feeling proud and achievement). Often they are also loaded with remarkable extra semantics such as bodies, flowers or even a bomb by Viktor and Rolf. A snuffbox for snuff (tobacco) protects its contents against air, contains the smell, and has the extra meaning of luxury. A pee bag is meant to contain urine, to be protected against other people’s eyes; containment is important to prevent embarrassment, and the emotional value could be shame.

In the same way, we analysed a wallet for money, a diary for text, a letter envelope for text, a memo recorder for (personal) sound, an mp3 player for (entertainment) sound, a photo pendant for (personal images), an army dog tag or SOS tag for identity, a set of epaulettes carrying rank signs, but at the same time carrying symbolic values referring to the army, for being tough, strong, or make a link to outdoor activities. Eventually, the epaulettes, even when not carrying rank signs, get a symbolic meaning of their own. A friendship pendant carries the symbolic values of love and friendship (but there is a type of two interlocking pendants, which physically carry each-other). Another variation carries the lovers' names. Typical love and bonding carriers tend to have a strengthening of the same symbolic meaning with multiple semantic symbols and icons: hearts, precious metals, pink colours, etc. A wrist watch carries time and so does a pocket watch; many watches carry extra meanings of luxury and expensiveness. The pocket watch also has a 'retro' trend association. It is the shift in technology that makes many traditional carriers appear old-fashioned or retro, like the pocket watch.

The meanings of the above examples range from very physical to much more symbolic. In many cases, the analysis goes in two or more steps, like the epaulettes, which physically carry the patch with the rank sign, where the rank sign in turn has a symbolic meaning.

5.2 *Semantic analysis of Oris*

Looking at Oris, its design intentions, its key function, and the application domain, we can claim that first of all, Oris is a carrier in the olfactory domain. It works by open semantics. The user uploads her own scent for her child to get a human-to-human bonding advantage from it, which is an absolutely clear case of open semantics. It is an extension of the purest and most natural example of personalisation: the scent of the mother is among the very few things familiar to the new-born child in its big, strange, and overwhelming world (next to perhaps a few sounds such as the parent's voices and the heart beat of the mother). Because of this openness in the olfactory domain, any other meanings associated with Oris have to be in the visual, haptic, interactive domain.

In the (dynamic) visual domain, the opening and the closing of the top layer above expanding and shrinking bubbles signifies the possibility of the bubbles to contain, preserve, protect, and release the scent. The semantics is mostly of the closed type, but this is done to compensate for the complete absence of any fixed point in the olfactory domain. It is possible that the (dynamic) visual appearance of Oris can carry a sexual connotation to someone in the audience (suggested by anonymous reviewer). However, the design of Oris was not primarily designed with this intention, and if we philosophise into the essence of giving a life to a new child, we humans do evolutionary give a birth by having sexual intercourse. Perhaps, if the parent's fantasy allows it, Oris could be used as an educational tool for the child where she gets explained how she was born. However, by intentional metaphor, the visual domain of Oris tells about the open-semantics carrier olfactory nature of the bubbles. Further, we have chosen to make the choice of the material (sending a clear message of love, tenderness, being fragile) as the closed type of semantics, which has the advantage that it is fit for the context (either worn by the mother, or when in the incubator next to the baby) and that it informs the user (once again) about the intended application. But then for the colour schemes, the interaction and the packaging, Oris' semantics is very open again. For example, the ritual of adopting two colours, such that one is being loaded with scent while the other is with the

baby and then the subsequent switching. This is something the mother (and the father) can invent themselves. There are other rituals they can invent with the colour scheme, but there are many more rituals and meanings regarding later usage of the Oris (for example, where to keep it, when to wear it, whom to give it to later, etc.)

5.3 Semantic analysis of ‘for daddy’

The form, the material, and the affordances are chosen on the basis of the design considerations of Section 4. From a semantic viewpoint, these considerations belong to two clusters:

- Symbolic/iconic/closed considerations. The form, the material, and the affordances are based on existing conventions for typical men’s accessories and on the possibilities to let the design resemble other men’s accessories.
- Open semantics considerations. The form, the material, and the affordances are also opening up possibilities of usage that are compatible with typical or expected men’s behaviour and that allow for the development of new rituals. The new rituals are not fixed, but the design hopefully lets the young father find his own ways of carrying the baby’s scent and getting in touch with it.

We begin with a discussion regarding the symbolic/iconic/closed considerations. It is well known that men’s fashion tends to be uniformised. Notably the business dress is very much standardised and the changes induced by trends and fashion industry are small and subtle. The same holds for accessories, whose form and material are mostly used to show quality through usage of expensive materials (leather, gold, silver, and stainless steel) and craftsmanship (in fountain pens and watches). In the same way, ‘for daddy’ tells a message of quality.

The open semantics considerations are to support at least the father as outlined in Section 4, and in particular to support him in keeping the new child mentally close, without interfering too much with everyday work. If he wears a business suit or a jacket, the ‘for daddy’ container can be kept in the pocket of the jacket, where he can secretly open it and transfer the scent onto his finger or fingers. More often than not, he does not want his colleagues to notice his actions. This determines the form, which thus unavoidably has obvious resemblances with the flask (fitting body shape, being almost invisible when in the pocket). At the same time, another ritual is still possible: to put some or all of the in-pocket accessories on the table, typically one’s glasses, a pen, the smart phone, perhaps a traditional agenda. Then in this scenario, the ‘for daddy’ will blend in well. This is why the (closed) semantics of ‘quality’ is important (see for example, the mood-board presented in Section 4). The affordance of opening and closing is like the sniff box (yet not retro).

The main characteristic of open semantics is that the user defines what the object means by choosing how to use it and find new ways of using it. Although the use case scenario of Section 4 for the ‘office dad’ persona shows one possibility, users will find new possibilities and rituals. How to load it, how to use it when the father is with the child, how to use it in relation to the mother, are all left open.

6 Concluding remarks

We explored semantics by giving attention to a particular type of semantics, where the product is open in the sense that the product is a carrier of something physical. Other types of product semantics are important too, when the product carries intangible symbolic or digital meanings. In either case, the product gets loaded with one or more meanings to be received and used elsewhere. If the designer fixes the meaning, we called it closed semantics; if the user can upload or establish meaning, we call it open semantics.

One important finding of this paper is that there is a typical pattern of interplay between sensory modalities and openness. In both designs, the relevant modalities are: visual, haptic, and olfactory (scent). The scent is the main modality for which the designs are open: it's the scent which is being carried. But in order to support the functions and the rituals of loading, transporting, releasing, and protecting the scent, the designed objects are equipped with signs such as the colouring scheme, the haptics of opening and closing, and the material qualities. The latter signs are coded in the tradition of closed semantics (yet supporting the carrier function). The same pattern is also at work in other examples and other modalities (a loudspeaker for example, where the visual appearance tells about the direction of the sound to be expected).

There are several ways to load a product with meaning such as the 'ratio facilis' and 'ratio difficilis' explained by eco for symbolic meanings and physical actions for meanings with more physical aspects. We undertook the experiment to cover such diverse types of semantics with the same terminology. This turned out fruitful, because notions such as content-type, transport, containment, and protection apply to all these kinds of semantics. We found that there is a gradual scale between physical semantics and symbolic semantics, with all kinds of combinations. The combinations turned out essential in the design of Oris and 'for daddy': symbolic meanings support the physical carrier meaning.

About Oris and 'for daddy': A scent is rather difficult to communicate and visualise. However, this primarily developed human sense offers a powerful function to be a cue for memory-retrieval (Zemke and Shoemaker, 2007). The early bonding between parents and their (prematurely born) babies is crucial for the future physiological as well as mental development of the babies (Charpak et al., 2005). The concept propositions elicited new questions and options for further research and design. To get a solid affirmation that a mother's scent has the potential to calm a baby down there needs to be further studies done. Also matters of realisation and hygiene need further attention. The same goes for the effect of the child's scent on the emotional state of the father.

Acknowledgements

The authors thank Sidarto Bambang Oetomo and Astrid Osagiator for their help and support.

References

- Affleck, G., Tennen, H. and Rowe, J. (1991) *Infants in Crisis: How Parents Cope with Newborn Intensive Care and its Aftermath*, Springer-Verlag, New York.
- Arockiasamy, V., Holsti, L. and Albersheim, S. (2008) 'Fathers' experiences in the neonatal intensive care unit: a search for control', *Pediatrics*, Vol. 121, No. 2, pp.e215–e222.

- Bader, A.P. and Phillips, R.D. (2002) 'Father's recognition of their newborns by visual-facial and olfactory cues', *Psychology of Men & Masculinity*, Vol. 3, No. 2, p.79.
- Blomqvist, Y.T., Rubertsson, C., Kylberg, E., Jöreskog, K. and Nyqvist, K.H. (2012) 'Kangaroo mother care helps fathers of preterm infants gain confidence in the paternal role', *Journal of Advanced Nursing*, Vol. 68, No. 9, pp.1988–1996.
- Bouwstra, S., Chen, W., Feijs, L.M.G., Bambang Oetomo, S. and Van der Linden, W.M.J.H. (2012) 'Designing the parents-to-infant bonding experience in the NICU', in *Proceedings of GlobalHealth 2012, The First International Conference on Global Health Challenges*, pp.7–13, ISBN: 978-1-61208-243-1.
- Bürdek, B.E. (2002) 'Global gestalt-competence', *Design News. Magazine for Industrial Design*, p.260, Tokyo.
- Cernoch, J.M. and Porter, R.H. (1985) 'Recognition of maternal axillary odors by infants', *Child Development*, Vol. 56, No. 6, pp.1593–1598.
- Charpak, N., Ruiz, J.G., Zupan, J., Cattaneo, A., Figueroa, Z., Tessier, R. and Cristo, M. (2005) 'Kangaroo mother care: 25 years after', *Acta Paediatrica*, Vol. 94, No. 5, pp.514–22.
- Croes, M., Chen, W., Feijs, L.M.G. and Bambang Oetomo, S. (2012) 'Olfactory stimulation in premature neonates: the relevance of early experience', in *Proceedings of GlobalHealth 2012, The First International Conference on Global Health Challenges*, pp.21–26, ISBN: 978-1-61208-243-1.
- Curran, A.M., Rabin, S.I. and Furton, K.G. (2005) 'Analysis of the uniqueness and persistence of human scent', *Forensic Science Communications*, Vol. 7, No. 2, p.23.
- Dubas, J.S., Heijkoop, M. and Aken, M.A.G. (2009) 'A preliminary investigation of parent-progeny olfactory recognition and parental investment', *Human Nature*, Vol. 20, No. 1, pp.80–92.
- Ferdenzi, C., Schaal, B. and Roberts, S.C. (2010) 'Family scents: developmental changes in the perception of kin body odor?', *Journal of Chemical Ecology*, Vol. 36, No. 8, pp.847–854.
- Green, J.A. and Gustafson, G.E. (1983) 'Individual recognition of human infants on the basis of cries alone', *Developmental Psychobiology*, Vol. 6, No. 16, p.485–493.
- Guillaume, S., Michelin, N., Amrani, E., Benier, B., Durrmeyer, X., Lescure, S., Bony, C. and Danan, C., Baud, O., Jarreau, P-H., Zana-Taïeb, E. and Caeymaex, L. (2013) 'Parents' expectations of staff in the early bonding process with their premature babies in the intensive care setting: a qualitative multicenter study with 60 parents', *BMC Pediatrics*, Vol. 13, No. 1, p.18.
- Gustafsson, E., Levréro, F., Reby, D. and Mathevon, N. (2013) 'Fathers are just as good as mothers at recognizing the cries of their baby', *Nature Communications*, Vol. 4:1698, doi: 10.1038/ncomms2713.
- Higham, S. (2011) 'Family-centred care and the evolving role of fathers', in Davies, R. and Davies, A. (Eds.): *Children and Young People's Nursing: Principles for Practice*, pp.31–56, Hodder Arnold, London, UK.
- Hollywood, M. and Hollywood, E. (2011) 'The lived experiences of fathers of a premature baby on a neonatal intensive care unit', *Journal of Neonatal Nursing*, Vol. 17, No. 1, pp.32–40.
- Hughes, M.A., McCollum, J., Sheftel, D. and Sanchez, G. (1994) 'How parents cope with the experience of neonatal intensive care', *Children's Health Care*, Vol. 23, No. 1, pp.1–14.
- Hugill, K., Letherby, G., Reid, T. and Lavender, T. (2013) 'Experiences of fathers shortly after the birth of their preterm infants', *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, Vol. 42, No. 6, pp.655–663.
- Kaitz, M., Good, A., Rokem, A.M. and Eidelman, A.I. (1987) 'Mothers' recognition of their newborns by olfactory cues', *Developmental Psychobiology*, Vol. 20, No. 6, pp.587–591.
- Kaitz, M., Good, A., Rokem, A.M. and Eidelman, A.I. (1988) 'Mothers' and fathers' recognition of their newborns' photographs during the postpartum period', *Journal of Developmental & Behavioral Pediatrics*, Vol. 9, No. 4, pp.223–226.

- Krippendorff, K. (2006) *The Semantic Turn; A New Foundation for Design*, Taylor & Francis, CRC Press, Boca Raton, London, New York.
- Le Corbeiller, C. (1966) *European and American Snuff Boxes 1730–1830*, The Viking Press, New York.
- Lindberg, B., Axelsson, K. and Öhrling, K. (2007) 'The birth of premature infants: experiences from the fathers' perspective', *Journal of Neonatal Nursing*, Vol. 13, No. 4, pp.142–149.
- Lundqvist, P. and Jakobsson, L. (2003) 'Swedish men's experiences of becoming fathers to their preterm infants', *Neonatal Network: The Journal of Neonatal Nursing*, Vol. 22, No. 6, pp.25–31.
- Lundqvist, P., Westas, L.H. and Hallström, I. (2007) 'From distance toward proximity: fathers lived experience of caring for their preterm infants', *Journal of Pediatric Nursing*, Vol. 22, No. 6, pp.490–497.
- Maguire, C.M., Bruil, J., Wit, J.M. and Walther, F.J. (2007) 'Reading preterm infants' behavioural cues: an intervention study with parents of premature infants born < 32 weeks', *Early Human Development*, Vol. 83, No. 7, pp.419–424.
- Pohlman, S. (2005) 'The primacy of work and fathering preterm infants: findings from an interpretive phenomenological study', *Advances in Neonatal Care*, Vol. 5, No. 4, pp.204–216.
- Potuzakova, D. and Feijs, L.M.G. (2013) 'Oris: bonding through maternal scent', in Chen, LL., Djajadiningrat, T., Feijs, L.M.G., Fraser, S., Hu, J., Kyffin, S. and Steffen, D. (Eds.): *Design and Semantics of Form and Movement. 8th International Conference on Design and Semantics of Form and Movement (DeSForM 2013)*, Wuxi, China, 22–25 September, pp.159–169.
- Premberg, Å., Carlsson, G., Hellström, A.L. and Berg, M. (2011) 'First-time fathers' experiences of childbirth a phenomenological study', *Midwifery*, Vol. 27, No. 6, pp.848–853.
- Russell, M.J., Mendelson, T. and Peeke, H.V. (1983) 'Mothers' identification of their infants' odors', *Ethology and Sociobiology*, Vol. 4, No. 1, pp.29–31.
- Schaal, B. (1986) 'Presumed olfactory exchanges between mother and neonate in humans', in Le Camus, J. and Cosnier, J. (Eds.): *Ethology and Psychology*, pp.101–110, I.E.C. Toulouse.
- Shannon, C.E. (1948) 'A mathematical theory of communication', *The Bell System Technical Journal*, Vol. 27, No. 3, pp.379–423.
- Shelley, W.B. and Hurley Jr., H.J. (1952) 'Methods of exploring human apocrine sweat gland physiology', *AMA Archives of Dermatology and Syphilology*, Vol. 66, No. 2, pp.156–161.
- Sloan, K., Rowe, J. and Jones, L. (2008) 'Stress and coping in fathers following the birth of a preterm infant', *Journal of neonatal nursing*, Vol. 14, No. 4, pp.108–115.
- Steffen, D. (2010) *Design Semantics of Innovation. Product Language as a Reflection on Technical Innovation and Socio-Cultural Change*, Department of Art and Design History, Bergische Universität Wuppertal, Germany.
- Steffen, D., Bürdek, B.E., Fischer, V. and Gros, J. (2000) *Design als Produktsprache – Der 'Offenbacher Ansatz' in Theorie und Praxis*, Verlag form, Frankfurt am Main.
- Zemke, D.M.V. and Shoemaker, S. (2007) 'Scent across a crowded room: exploring the effect of ambient scent on social interactions', *International Journal of Hospitality Management*, Vol. 26, No. 4, pp.927–940.

Notes

- 1 Kangaroo care is a technique practiced on preterm infants wherein the infant is held, skin-to-skin, with an adult