# Specification of Affective User Experience in Product Design

*Denis A. Coelho*

*Human Technology Group, Department of Electromechanical Engineering*
*Universidade da Beira Interior*
*6201-001 Covilhã, Portugal*

## ABSTRACT

This contribution reviews approaches and methods for developing product design specifications that place emphasis and priority on affective user experience. Understanding customers' affective needs is difficult to grasp. For example, if a person wants an impression of luxuriousness, then it is necessary to investigate which product design attributes make the individual sense such an impression. To answer this question, the relationship between affective features and product design attributes should be analyzed, considering an interactive, evolving, and individual perspective. Pleasure with products, Kansei engineering, product emotion, Fuben-eki and product personalities are the approaches reviewed to illustrate the existing resources for specification of affective user experience in design. The notion of a product's ecosystem as part of the design of the user experience is related to experience prototyping. With the aim of providing guidance to designers, this contribution discusses whether the affective user experience specification methods translate directly into product design features, or if these are attained by trial and error, the latter being mostly the case, except for Fuben-eki. An expanding vision of futurism and evolution, based on projected future technological capabilities, may be associated to gradually enriching affective user experiences, increasingly demanding users and enlarging and more pervasive product ecosystems.

**Keywords**: Pleasure with Products, Fuben-eki, Kansei Engineering, Product Personalities, Product Ecosystem

## INTRODUCTION

A fast paced changing world requires dynamic methods and robust theories to enable designers to deal with the new product development landscape successfully and make a difference in an increasingly interconnected world. Designers continue stretching the boundaries of their discipline, and trail new paths in interdisciplinary domains, constantly moving the frontiers of their practice farther (Coelho, 2013). Understanding customers' affective needs is difficult to grasp; product design practitioners often misunderstand what customers really want (Bahn et al., 2009). Customer needs or requirements depend directly upon product design attributes. For example, if a customer wants an impression of luxuriousness, then it is necessary to investigate which product design attributes make the customer sense such an impression. To answer this question, the relationship between affective features and product design attributes should be analyzed. In a practical manner, product design attributes should be selected based on the design practitioners' expert knowledge as well as design guidelines or golden rules.

The market of intangible products is growing and new types of products combining both tangible and intangible parts occur (Schütte, 2005). An example of these types of products are mobile communication devices. An artifact, the phone itself is needed, but this is just a smaller part. Its interface design is more cost intensive and more relevant



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to the customer. Rules for Interface design abound (e.g. Shneiderman, 2003: striving for consistency, enabling frequent users to use shortcuts, offering informative feedback, designing dialogs to yield closure, offering error prevention and simple error handling, permitting easy reversal of actions, supporting internal locus of control and reducing short-term memory load). Cyr et al. (2009) proposed that perceived interactivity (modeled as a formative construct that includes user control, connectedness and responsiveness) influences cognitive perceptions (for efficiency and effectiveness), cognitive–affective perceptions (for trust), and affective perceptions (for enjoyment) in websites. However, De Angeli et al. (2006) showed that the use of interactive metaphors contributes to users' attitudes and rating of the interface aesthetics, even when the usability of the system is worse. This effect can be explained by affective interpretation of user judgement (Norman, 2004), in that an interactive metaphor can induce curiosity and pleasure despite being more difficult to use (this notion is aligned with the approach proposed in Fuben-eki, by Kawakami, 2002). Coelho (2006) took an activity theory approach aligned with Kankainen (2002), making the the distinction between motivational and action level needs, and presented methods that can be used to uncover user requirements at these two levels of the activity of the user with an artifact in context. The activity in each of these levels may involve a different kind of reward (either positive or negative), in line with Fuben-eki's assumption.

Effectively and efficiently satisfying individual needs in product use could be achieved by means of personalization (Tseng et al., 2010). Individuals' characteristics such as personal taste, traits, innate needs and experience are important integral parts of product design. This dimension for design enables offering personally unique products that may contribute to a positive user experience. The product ecosystem in personalization can be viewed as a core infrastructure, hard components, and soft characteristics. Hard components consisting of tangible physical elements can be customized and changed to meet physical functional requirements. The soft characteristics address the customer experience in human–product–ambience interactions. They include not only the software part of products, but also user interaction, service processes, aesthetics outlook, and feel of the products. Soft characteristics are often easier to modify and thus can enhance the value for personalization. Zhou, Xu and Jiao (2011) point to the fact that with the advent of the experience economy, strategic advantages depend more on the totality of the user experience than on the power of technology embedded in the product. There product ecosystem design framework consists of three stages: affective-cognitive needs acquisition, analysis and fulfillment.

There are many different approaches to interface design, especially considering the growing importance of artificial intelligence and connectivity (e.g. the internet of things). Intangible interfaces are increasing in products. Affective experiences, in terms of pure awe and affordances or signifiers (Norman, 2008) are very much tied to the technological capabilities available. An expanding vision of futurism and evolution, based on projected future technological capabilities, may be associated to gradually enriching affective user experiences, and increasingly demanding users.

# EXISTING FRAMEWORKS THAT SUPPORT SPECIFYING THE AFFECTIVE USER EXPERIENCE

## Pleasure with products and displeasure in product use

Pleasure in product use (Jordan, 1998) and displeasure in product use (Jordan, 1996) are two complementary concepts. Pleasure appears as a development from functionality and usability, hand in hand with a revised approach to ergonomic design that departs from minimizing loss towards maximizing gain (Jordan, 2000). Coelho and Dahlman (2002) drew attention to the exchange value of comfort and pleasure. The concept of pleasure is taken here from the viewpoint of product development and engineering design. In this regard, 'pleasure with products' is defined by Jordan (1996) as the emotional and hedonic benefits associated with product use. In practice, the field of pleasure with products was structured by Patrick W. Jordan, and his publications on this area date back to 1995. A number of studies by other authors also considered pleasure in the context of design (e.g. Fulton, 1993; MacDonald, 1998; Desmet &Hekkert, 2001; Hauge-Nielsen & Flyte, 2001). A difficulty of affective concepts such as pleasure or emotion is that they are probably as intangible as they are appealing (Desmet & Hekkert, 2001). Although some interesting and promising studies have been reported, the research field is still short of conceptual clarity and

therefore lacks consensus on what the actual subject of study should be. Both the concepts of pleasure and emotion are somewhat undifferentiated, and are used as collective nouns for all kinds of affective phenomena. Design literature tends to refer to these when studying anything that is so-called intangible, non-functional, non-rational, or non-cognitive. Some of the reported studies involve 'experiential needs' (Holbrook, 1982), 'affective responses' (Derbaix & Pham, 1991), 'emotional benefits' (Desmet et al., 2000), 'customer delight' (Burns et al., 2000) and 'pleasure' (Jordan & Servaes, 1995). Naturally it is inherent to any newly emerging research field that the emulsion has not even started to crystallize, but an adequate definition of the subject of study would facilitate fruitful discussions between researchers (Desmet & Hekkert, 2001).

Design research literature refers to pleasure as a product benefit that exceeds just proper functioning. Pleasure is thus seen as an emotional benefit that supplements product functionality and even usability. In this sense, pleasure covers all pleasant emotional reactions, but it is not an emotion in such (Desmet & Hekkert, 2001). Although people differ in their emotional responses to products, general rules may be identified in the underlying process of emotion eliciting (Desmet & Hekkert, 2001). In his book Designing Pleasurable Products, Jordan (2000) brings forward the concept of pleasure as an overriding goal in product design. Pleasure is seen to contain, but also to exceed, many instances of Human Factor goals in Product Development, such as usability, or comfort. Coelho and Dahlman (2002) developed this idea to some extent, using the example of automobile seats to show the overlapping character of these goals and concepts, including functionality, usability, comfort and pleasure.

The rationale Jordan devised to systematize building pleasure into products, considers the four-pleasure framework, which was originally devised by Tiger (1992). This framework is deeply covered in Coelho and Dahlman (2011) who contributed towards verification of people's need for pleasure in products. The four-pleasure framework is used to build product benefit specifications, using an array of methods that include focus groups, questionnaires, private camera conversation (Vries et al., 1996), co-discovery (Kemp & Gelderen, 1996), experience diaries, reaction checklists, field observations, etc. The transfer from product benefit specifications to product requirements is done through the means of the equivalence between experiential product properties to formal product properties (Jordan, 2000). This is however the area where less knowledge has been unveiled. Still there are some experiential properties which can be transferred to formal properties fairly easily, such as light weight, vivid color, etc., which draw on previously existing notions borrowed from industrial design, concerning product aesthetics, task analysis and culture. An overview of Jordan's design method for pleasurable products is depicted in Table 1.

Given the encompassing character of this concept of pleasure with products, some of the human factor goals included in the concept have come close to attaining predictability (e.g. usability guidelines). This means in practice that it is partially possible to use the four-pleasure framework to attain some product property specifications. But the sum of parts is not equal to the whole, and a lot of work remains to be done in the area, as well as in defining pleasure metrics. Jordan (2000) also considers the distinction between need pleasures and pleasures of appreciation (originally devised by Lewis, 1987) to aid the four-pleasure framework in the process of structuring thoughts about pleasure. The field resorts to human subjects to test the achievement of design methods in terms of pleasurability (e.g. product pleasurability questionnaire – Jordan, 2000) and there is yet no predictability attained in understanding the transfer of formal properties to experiential ones. Product development requirements derived from pleasure with products approaches are loosely tied to formal product properties and are very much still in the realm of experiential properties. As an example, consider the following requirement from a fully worked example of a product benefit specification for a photographic camera targeted for a particular sub-group of society: "the camera should confer the impression of high cultural status on the user" (Jordan, 2000).

Thatcher (2012), proposed a framework for affect in designing for sustainability. The three-point framework is derived loosely from a combination of Jordan's (2000) three levels of application for ergonomics and Khalid's (2006) consumer decision-making model. What is borrowed from Jordan (2000) is the separation between components that are functional, usable, or aspirational. Coelho and Dahlman (2002) also suggested that Jordan's (2000) hierarchy of needs could be adapted to incorporate sustainability as an end goal. The three elements of Thatcher's framework (design for functional balance, design for early engagement, and design for aspirational ideology) depict the three points at which affective design tools might be leveraged to encourage the choice for sustainable products and behaviors. Ultimately, the process of promoting sustainable development may benefit from an understanding of what motivates people to adopt and want to continue to use sustainable tools, artefacts, and systems. Increasing the likelihood of success in achieving sustainable development, could depend on assessing the

affective resonance of proposed system development alternatives (Coelho, 2012). An alternative way to ensure the affective resonance was developed for toy design (Fernandes & Coelho, 2013), where the cognitive-affective stages of child development provide a road map for the relevant activities for each age and development stage.

Table 1 – Extract of Jordan's (2000) pleasure based approach to design.

| **People characteristics relevant for defining product benefit specifications** | **Methods for use in the creation and evaluation of pleasurable products (experiential properties)** | **Elements of product design (formal properties of product's elements)** |
|---|---|---|
| **Physiological** | **Empirical creation methods** | Color |
| Special advantages and disadvantages | Private camera conversation | |
| Musculoskeletal characteristics | Co-discovery | Form |
| External body characteristics | Focus Groups | |
| Body personalization | Think aloud protocols | Materials |
| Physical environment | Experience diaries | |
| Physical dependencies | Reaction checklists | Sound |
| | Field observations | |
| **Sociological** | Questionnaires | Interaction design |
| Status | Interviews | |
| Self-image | Immersion | |
| Social relations | Laddering | |
| Social labels | Participative creation | |
| Social personality traits | Controlled observation | |
| Social lifestyles | | |
| | **Non-empirical creation methods** | |
| **Psychological** | Expert appraisal | |
| Special talents and difficulties | Property checklists | |
| Psychological arousal | | |
| Personality traits | **Evaluation of design prototypes** | |
| Self-confidence | Product benefits specification | |

| | | |
|---|---|---|
| Learned skills and knowledge<br><br>**<u>Ideological</u>**<br>Personal ideologies<br>Religious beliefs<br>Social ideology<br>Aesthetic values<br>Aspirations | Product property specification<br>Visual prototypes<br>Models<br>Screen-based interactive prototypes<br>Fully working prototypes | |

## Kansei engineering and Fuben-eki

Prior to the development of 'pleasure with products', Nagamachi (2000) developed the methods behind Kansei engineering / Kansei ergonomics. He founded Kansei Engineering 40 years ago at Hiroshima University, choosing the Japanese word 'kansei', as it means feeling. Kansei Engineering (Nagamachi, 1995, 2002) is hence one of the oldest and most enduring successful attempt to design the affective user experience. Nagamachi (2000) explains that 'kansei' means the customer's psychological feeling as well as physiological issues. The array of methods developed is quite wide, including: Category classification, Kansei Engineering System, Kansei Mathematical method, Virtual Kansei Engineering, Collaborative Kansei Design System and the combination of Kansei Engineering and Concurrent Engineering. The methods include ergonomic experiments and intelligent system inference, which relies on databases built up by peoples' kansei (people's reactions to products). The databases contain information about links that have been established between formal and experiential properties of particular products. Nagamachi (2000), states that Kansei Engineering / Ergonomics has been applied to the design of products from many different companies and domains, including automobiles, construction machinery, electric home appliances, office machines, construction tools for the home, clothes and garments and cosmetics.

Research in Kansei engineering has evolved into a body of non-parametric approaches to analyse information from affective responses focused on neural networks (Ishihara et al., 1995), fuzzy logic (Hotta and Hagiwara, 2005) and rough sets theory (Nagamachi et al., 2006; Nagamachi, 2008). These approaches are, however, absent of metrological rules such as traceability and variance control (Rossi, 2007) and therefore, they remain ones of analysis of a particular sample without allowing results to be compared against others' findings. Camargo and Henson (2012) presented some concepts of the Rasch model, which could allow constructing valid measurement structures targeted at product features that are of interest for analysis.

Kansei Engineering can work in two ways – Nagamachi (1995) refers to these as the two directions of 'flow'. One direction of flow is termed from design to diagnosis. This involves manipulating individual aspects of a product's formal properties in order to test the effect of an alteration on the user's response to the product. The other direction of flow is from context to design. This involves looking at the scenarios and contexts in which the product is used and then drawing conclusions about the implications of this for design. This second direction of flow involves the gathering of qualitative data via field observations. The data is used to help establish the link between the formal properties of a design and the benefits associated with the product. The two directions of flow Mitsuo Nagamachi uses in Kansei Engineering have similarities with two approaches for design and research: research by design and design by research (Coelho, 2002; Coelho & Dahlman, 2006). The process resulting from the direction of flow from design to diagnosis is alike part of the process resulting from the theory breakdown approach, in compensating for lacunae in the theoretical structures. The process resulting from the direction of flow from context to design is alike the fielded experiment and observation methods described by Woods (2000) in approaching some of cognitive engineering design problems.

Fuben-eki stands for Further BENEfits of a Kind of Inconvenience. (Kawakami, 2011; Naito, Kawakami & Hiraoka,

2012). It opposes the assumption that the more convenient life is, the richer it is. Solely perceiving convenience may deprive users from the pleasure of intricately using the system. Inconvenient systems or methods provide users with such benefits as increased awareness, increased creative contributions and fostering affirmative feelings (Naito, Kawakami & Hiraoka, 2012). Fuben-eki touches the notion of displeasure, but only in the case of benefits accruing from that displeasure or inconvenience. The design principles of Fuben-eki as well as the benefits of inconvenience versus the convenience offered by the system are shown in Tables 2 and 3, respectively. The design principles are suggested to guide the designer in solving a problem, substituting for trial and error approaches. Initially two parameters are specified in the Fuben-eki matrix, the design principles suggested in the matrix are applied to the problem in question. According to the authors, this approach will guide the designer in solving the contradiction between the main convenience intended for the system and what would be lost as a result of the convenience. The principles of Fuben-eki and the matrix were developed based on the analysis of a set of examples (manual vs. automatic transmission, hand writing vs. word processor, etc.). A Fuben-eki design aims to rebuild systems to increase their subjective benefits, even though their apparent convenience may decrease. Given the limited scope of the examples the approach is based on, and the lack of validation, there is no guarantee that the purpose for using this approach will be achieved by the designer. However, this approach cannot be considered a pure trial and error approach, as it provides guidance to the designer.

Table 2 – Fuben-eki design principles (Naito, Kawakami & Hiraoka, 2012)

| | | |
|---|---|---|
| 1. Degradation | 5. Time consumption | 9. Disorder |
| 2. Enlargement | 6. Continuity (analog) | 10. Constraint |
| 3. Increase the number of operations | 7. Fatigue | 11. Stimulation |
| 4. Increase the amount of operations | 8. Danger | 12. Less information |

Table 3 – Fuben-eki matrix (Naito, Kawakami & Hiraoka, 2012)

| **Benefits of inconvenience**<br>**Convenience of system** | **Enhance awareness** | **Devise ways** | **Improve** | **Under-stand the system** | **Prevent down-skilling** | **Be original** |
|---|---|---|---|---|---|---|
| **Fast** | 5, 7 | | | | | |
| **Quick** | 1, 2, 6, 7, 9,10 | 3, 4, 6, 1, 2, 8 | 3, 4, 6, 8 | 3, 4, 6, 1, 10 | 3, 4, 1, 6, 8,10 | 3, 10, 1, 4, 6, 9 |
| **Small/Light** | 1, 5, 6 | 5, 6, 1, 3, 4 | 3, 4, 5, 6 | 3, 4, 5, 6 | | 3, 4, 5, 6 |
| **Does not deteriorate** | 1, 2, 5, 6 | 1, 2, 5, 6 | | 3, 5, 10 | 3, 5, 10 | 3, 5, 10 |
| **Few types of operation** | 5, 9, 10 | 4, 5, 6, 8, 9 | 4, 5, 6, 8, 9 | 4, 6, 5, 9 | 5, 6, 8 | 4, 5, 6, 9, 10 |
| **Low amount of operations** | 5, 9, 10 | 3, 5, 8 | 3, 5, 8 | 3 | 3, 5, 8 | 3, 5, 9, 10 |
| **Homogenization** | 5, 10 | 3, 4, 5, 6, 8 | 3, 4, 5, 6, 8 | 3, 4, 6, 5 | 3, 4, 5, 8 | 3, 4, 5, 6, 10 |

## Positive and negative product emotions

Nagamachi's approach to designing products for kansei (feelings) comes very close to Jordan's approach to pleasure with products. Kansei Engineering can be seen as a method that fits nicely into being an operative of the theoretical structure adopted for pleasure (Coelho, 2002), and finds its justification in that structure. A similar approach has been developed by Desmet et al. (1999), working on product emotion measure, which was applied to exterior automobile aesthetics. It resorts to human subjects to categorize the emotions elicited by alternative product appearances, based on the comparison with 18 emotions. These emotions are represented by animations of a cartoon character presented on a computer interface. The emotion list is composed of: disgusted, indignant, contemptuous, aversive, disappointed, dissatisfied, bored, disillusioned, vulnerable, enthusiastic, inspired, desiring, appreciative, pleasant, attracted, satisfied, fascinated and softened.

Desmet (2012), identified 25 positive product emotions (when a car makes you smile) and 6 sources of emotion related to products. He also made a review of negative emotions, having found the following negative emotions: fear, anger, sadness, disgust, distress, contempt, shame, guilt. Surprise is considered by many of the reviewed studies as an ambivalent emotion, which may be either positive or negative, depending on the particular situation. Desmet's (2012) typology of 25 product emotions comprises two levels. The upper level concerns the emotional general category, and the lower level is populated by the emotion types, as follows: Empathy (sympathy, kindness, respect), affection (love, admiration, dreaminess), aspiration (lust, desire, worship), enjoyment (euphoria, joy, amusement), optimism (hope, anticipation), animation (surprise, energized), assurance (courage, pride, confidence), interest (inspiration, enchantment, fascination), and, gratification (relief, relaxation, satisfaction). After having identified this positive emotion set using fine-grain vocabulary, Desmet (2012) proceeded to empirically derive the sources of emotion in product-user interaction: object, meaning, interaction, activity, self and other people.

## Product personalities

Product personalities (Jordan, 2002) were used by Versos and Coelho (2011, 2013) to assist in verifying if signifiers intended for an object at the onset of the design process had been achieved in the designed concept. Moreover, da Cunha e Silva and Coelho (2011) used product personality attributes to transfer cultural traits to product specifications. Semiotics also plays an important role as we consider Norman's (2008) signifiers, particularly in intangible products, and affordances (Norman, 1988) for industrial design products (Figueiredo & Coelho, 2010). Coelho, Versos and Silva (2012) present the underlying rationale for the use of the product personality assignment approach (Jordan, 2000) in two design processes, albeit in different phases of the design process (in the specification stage and in the design validation stage). Table 4 provides an overview of the 17 product personality dimensions and each semantic ordinal categorical scale associated.

Table 4 – Product Personality Dimensions (adapted from Jordan, 2000).

| **Scale for product personality pairs** |
|---|
| kind – somewhat kind – neither kind or unkind – somewhat unkind – unkind |
| honest – somewhat honest – neither honest or dishonest – somewhat dishonest – dishonest |
| serious minded - somewhat serious minded - neither serious minded or light hearted - somewhat light hearted - light hearted |

| |
|---|
| bright – somewhat bright – neither bright or dim – somewhat dim – dim |
| stable – somewhat stable – neither stable or unstable – somewhat unstable – unstable |
| narcissist – somewhat narcissist – neither narcissist or humble – somewhat humble – humble |
| flexible – somewhat flexible – neither flexible or inflexible– somewhat inflexible – inflexible |
| authoritarian – somewhat authoritarian – neither authoritarian or liberal – somewhat liberal – liberal |
| driven by values – somewhat driven by values – neutral – somewhat not driven by values – not driven by values |
| extrovert – somewhat extrovert – neither extrovert or introvert – somewhat introvert – introvert |
| naïve – somewhat naïve – neither naïve or cynical – somewhat cynical – cynical |
| excessive – somewhat excessive – neither excessive or moderate – somewhat moderate – moderate |
| conforming – somewhat conforming – neither conforming or rebellious – somewhat rebellious – rebellious |
| energetic – somewhat energetic – neither energetic or non energetic – somewhat non energetic – non energetic |
| violent – somewhat violent – neither violent or gentle – somewhat gentle – gentle |
| complex – somewhat complex – neither complex or simple – somewhat simple – simple |
| optimist – somewhat optimist – neither optimist or pessimist – somewhat pessimist – pessimist |

Each one of the product personality dimension scales inherently includes to opposing personality traits. Each one of these may however be deemed as either positive or negative, depending on the individual, the product or system in question, and even the context and time of use. The author has used these dimensions in several studies involving industrial design students. When introducing the instrument to students they tend to ask themselves if they prefer products that reflect their own personality or if they would rather have products quite different from their personalities, even opposite. Unveiling the 'wants' and 'unwants' in terms of product personality dimensions is bound to be very specific to each individual and to the context of use of the product and the product function itself.

# DISCUSSION

While defining an affective user specification is bound to be a difficult task, whether existing or intended potential or future users are involved in the creation of the specification or it is entirely designer and, or, expert created. This task is especially difficult for new intended products and systems, for which there is no applicable earlier version, or, in alternative, no applicable benchmark, attaining the specified affective user experience properties (and verifying the attainment thereof) depends to a great extent on the design practitioners' expert knowledge. This is bound to be an iterative and extended process. For the most part, the approaches to specification described in this contribution require for effective usage that the designer puts her or his creativity to use in order to generate product and system concepts that might meet the requirements set forth. Experience prototyping (Suri, 2003) and envisaged user or user proxy evaluation is the indirect manner by means of which the evaluation cycle can be closed earlier on the design process before an actual physical and or fully functional prototype is available. Experience prototyping is a form of prototyping that enables design team members, users and clients to gain first-hand appreciation of existing or future conditions through active engagement with prototypes (Buchenau & Suri, 2000). The notion of a product's ecosystem as part of the design of the user experience is related to experience prototyping, as this approach provides the freedom to expand system limits as product ecosystems enlarge. It is expected that the ongoing research efforts in various design domains shall gradually provide well accepted guidelines to complement designer's expertise in attaining a more straightforward design process to fulfill affective user experience specifications, considering enlarging and more pervasive product ecosystems.

Positive, neutral and negative emotions, product personalities, pleasure with products, Kansei engineering and Fuben-eki, and their respective scales and instruments may provide an interesting and varied set of approaches, that designers may consider in preparing for drafting an affective user experience specification for a newly designed or a redesigned technical product or system. With the aim of providing guidance to designers, this contribution discussed whether the affective user experience specification methods translate directly into product design features, or if these are attained by trial and error, which is mostly the case, except for Fuben-eki. An expanding vision of futurism and evolution, based on projected future technological capabilities, may be associated to gradually enriching affective user experiences, as well as increasingly demanding users, which is bound to expand the importance of the affective user experience in product and systems design, as well as an increasing imbalance towards intangible interfaces, rife of signifiers, supported by increasingly powerful and versatile technology.

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