From Product Semantics to Generative Methods

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Abstract

Though recent work on product semantics has shown some useful insights and has also offered a theoretical framework to reflect on decisions on product form, it has yet to influence the design approach of students and practitioners. Alienation can be explained by the fact that the theories appear reflective and do not provide insights into the creative processes. This paper attempts to fill these gaps by proposing methods and tools seamlessly integrated with the design process.

Using the accepted categorization theory as a basis in product semantics, the paper proposes the idea of semantic space, which in turn is based on two subordinate spaces. 1) Product category space, built on Wittgenstein's ideas of human categorization and graded membership of these mental constructs, complemented further by Eleanor Rosch's ideas of object taxonomy and features bundle. 2) Product expressions space, also built on her ideas of the role of feature bundles in perceptual tasks.

Semantic space generates visual insights by analyzing examples mainly from within and also form outside the product category. This space is created by involving users and so reflects their perceptions. In a way it is designed to defuse the stereotypical perceptions that designers carry by considering themselves as users. The semantic space is constructed systematically and incrementally during the analytical phase of the design process and runs parallel to normal actions like data collection and analysis. It reflects the user's ideas of structure of product category as well as specific abstract mental constructs, structured around the gradient from typical to the atypical.

Later, the paper converts semantic space into a goal directed generative tool that prompts structured combinations as potential feature bundles. It is designed to encourage alternatives in form explorations that are not only innovative but also semantically consistent. Semantic space can also be seen as a rational and user-centric substitute for the familiar image-boards.

Keywords: Semantic space, Form innovation, Image boards, Perceptions, Generative methods

1. Focus on Meaning and Manmade objects

It is a normal practice to mix issues like product function, aesthetics, technology and culture in discourses on form. Isolated discourses on form have always been seen as suspects. The paper takes a view, that for deeper analytical understanding to emerge, it is necessary to see issues as independent from each other. Consistent with this thinking, the paper consciously uses phrases like 'form-making' and 'designing an image' of an object. It is argued that these should be treated as a special class of design problems and an intellectual exercise that involves a mix of rigorous analysis and creative problem solving. It also explores the synergic partnership between form innovations and conscious expression of meaning, and is another perspective in product semantics.

1.1 Overview of Literature on Meaning of Objects

Focus on meaning started with the special issue of the IDSA journal Innovation, which coined the term product semantics to declare its exclusive focus and capture its identity. [1] It listed the goals of product semantics as demystifying complex technologies, improving user product interactions and using opportunities of enhancing for self- expressions through products. [2] Key authors almost unanimously acknowledged the crisis of Functionalism as a result of post-modern revolt, which pointed out how designers have missed out on the rich range of qualities design can express. These authors suggested replacing the rational, analytical orientation of the old with the new functionalism based on expressive qualities. [3, 4] Alternative to this approach emerged with efforts to study applications of categorization theories by Wittgenstein and Eleanor Rosch to see object categories as mental constructs. [5, 6] This work showed the usefulness of concepts like typical as core as well as graded membership and fuzzy boundaries of categories to locate form innovation. It further explored applications of Rosch's ideas of object taxonomy to form related issues.

All theories treated form decisions as structuring of messages and showed a number of fresh insights. Designers were looking forward to the new ideas, but after the initial euphoria this literature had only a limited impact on the design community. Recent effort to reclaim the lost ground tried to broaden the scope of this discipline. For instance, De Souza draws on concepts from semiotics to account for HCI decisions. [7] Krippendorff in his new book aligned his ideas with Gibson's Theory of Affordances, which sees the observer as an active participant in a reciprocal relationship with the features of the environment. [8] While this is a valid theoretical position, Krippendorff's discussion underplays the reciprocal character of the process i.e. the need to build affordances in products to make them self-evident, self-instructive and intuitive.

1.2 Missing link

Product semantics literature is recognized as a substantial addition to design thinking, but in spite of its creative potential designers remained more comfortable with intuitively taken decisions and relied on its legacy from disciplines like art. Form making has a direct bearing on user perception and user experience, yet none of this was handled as user-centric approach. Product semantics theories were conceptually user oriented and were compatible with user-centric design thinking that came out of design methods movement of the 60s. Yet, none of these methods nor the work in product semantics explored involving users in form decision. Opportunity to use product semantics framework for user centric development of form remained unexplored. The initial excitement tapered off and the product semantics movement survived more as an academic subject. It did not influence the approach of design schools or of design practice. Product semantics that was to become a new wave in design remained a dream.

The paper is based on convictions that: 1) Form making is also an intellectual exercise and we are just beginning to understand its logic, 2) The appropriation of license to willfully change the world of objects should flow from such logic. Product semantics can potentially externalize part of this logic making it transparent to others on the team and 3) Creative efforts need not be based on intuition alone, but could exploit generative methods to bring the designer close to Eureka moments, than wait for them endlessly.

1.3 Transition from Semantics Theories to Methods

Efforts to convert product semantics framework into not very rigid and yet sequential methods integrated with the design process was started by the author some years ago. This paper reports analytical as well as generative methods and tools developed so far and also hints at future plans. As a proposal, it is not new. Some of the authors who had pioneered the movement in its infancy had hinted that product semantics could be treated as a creative tool waiting for the development of generally applicable research methods. [2] This paper hopes to fill this gap by suggesting methods and tools based on this author's earlier work in use of categorization theory to deal with product semantics. This theory has intuitive appeal to the design community and its exploration in project assignments has been tried in many design schools. It appears eminently suitable for developing analytical and generative tools.

Though product semantics is used as a framework in development of the methods, creativity remains the focus. Structured methods and tools are offered to nurture and encourage innovation, diversity and out-of-the-box thinking in form making and yet they ensure that the intended meaning is communicated. These methods are seamlessly integrated with the design process and fit into the designerly ways of thinking. So, it follows that this paper is structured along the typical steps in the design process.

2. From Product Brief to probing User Perceptions

Most projects depend on data collection and analysis for initial understanding. It involves defining user persona, his needs, aspirations, buying habits as well as studying other typical products that they buy. It rarely includes probing user perceptions of the specific product category, which is often guided as well as limited by what is available as competing products, their advertisements and the discourses they generate. How do we find out the way users structure a specific product category in their mind and get access to the associated visual expressions? The paper explains the ideas using studio based examples of student design projects used to explore the methods. One of the projects, design of cigarette lighter is used as a principle example. It was defined as follows. An Indian manufacturer wants to create a new design of a lighter and export it to the western markets. His preliminary observations indicate that the female segment is looking for lighter that is trendy and shows it roots in the country of its origin.

2.1 The Idea of Semantic Space

The concept of semantic space as well as the methods and tools proposed use categorization theory as a basis. However, limited space available here does not permit a more detailed discussion on the categorization theory nor is that the focus. The readers may want to access literature which discusses in detail different facets of the theory and its relevance to design of concrete objects. [5, 6] It is only briefly touched when relevant.

Semantic space as a concept has been discussed in design literature. [5, 9, 10] It is now developed into a version that is more comprehensive and used as a strategic application. It is based on recasting the idea of familiar image boards to ensure acceptability. Image boards have a direct relationship with form and communication issues, but are usually based on intuitive selection of images. The aim is to build semantic space involving users and to defuse the designer's perception of the product category and the images associated with it to create a context to explore new form possibilities. Semantic space can lead to generating visual insights from within as well as

outside the product category. Later it is used as a generative tool to encourage and prompt explorations in form. Semantic space itself consists of two subordinate spaces.

1. Product category space, built on Wittgenstein's ideas of human categorization as mental constructs, its graded membership, complemented by Eleanor Rosch's ideas of object taxonomy and characteristic features +
2. Product expressions space, built on Eleanor Rosch's ideas of role of perceptual and functional feature bundles in identification as well as her discussions on the principles of categorization.

3. Construction of Product Category Space

The construction of the category space is based on Wittgenstein's ideas of the way human intuitively structure the categories. What makes categorization theory relevant to design is its elegant explanation of how humans comfortably deal with the existing variety in objects and the ones yet to come into existence. It is a human fit to admit these non-identical objects into a single category and refer to it by a linguistic label. This paper touches his ideas briefly and then explores the nuances of constructing the product category space. Departing from the Aristotelian idea of categories, Wittgenstein suggested that human categorization is structured around a core or a central member, which is used as a cognitive reference to compare all potential members. [11] Thus the internal structure of the categories is not a homogeneous class, but reflects representative-ness rating of members, with not-so-typical examples positioned away from the core. So, less the member shares with the core, the farther it is from it. The members further down are close to the boundary and are often the avant-garde alternatives. Interestingly, categories do not have well defined boundaries; they are fuzzy and shiftable to accommodate new and yet unseen members.

Core reflects the essence of the category and is also the most typical (or a proper) example accepted by the culture to represent the category. Internal structure of the category is an asymmetric map and shows how the mind visualizes the discreet world of objects (products) as a graded mental construct. If the user built category structure is accessed, it has extensive implications on design innovations. How do we apply it in design projects?

3.1 Capturing User's Perceptions of Product category Structure

The idea is operationalized by giving users equal size photographs of competing products from a product category and asked to give direct typicality rating or alternatively classify them into groups based on linguistic hedges. [5, 10] (The lighter project suffers from the access limitations to the western users during the short project time. So, the westernized urban Indian users were used as a substitute.) When data was compiled for cumulative rank, both methods reveal the way users collectively perceive the core member (often the typical example) as well as how they position the products on the gradient and on the border sequenced as a map. Web tool analysed the data and gave the values which are mapped as distances from the core as seen in figure 1. Notice the values between the most typical (.1) and the next (1.4). What used to be a typical instance a few decades ago appears to have shifted to number two positions now. The case study is used to explain the method. The method is user centric and reflects sensitivity to their age, gender and culture. Product images visually define the lighter-ness of a cigarette-lighter and thus help in characterizing the core and the gradient. The asymmetric structure gives access to the visual features that are strongly associated with the core and with

different locations on the gradient. [10] In a way, it defines the subculture's shared understanding of the category. By locating the fuzzy boundary and the products beyond this, the culture indicates the level of tolerance for that category.

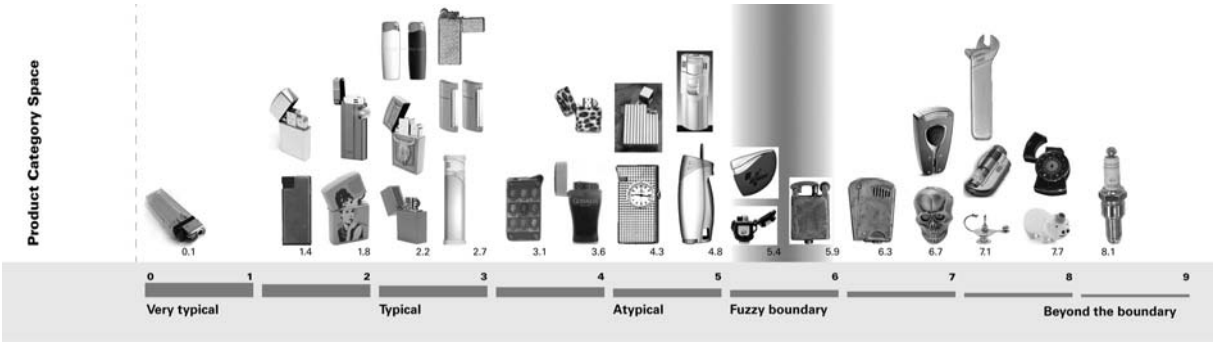

Figure 1: Product category space. The method revealed the way users perceives the core member (often the typical example) as well as the competing members on the gradient for category cigarette lighter.

3.2 Search for new Product Position

The category space shows the innovation receptiveness of the user group and offers opportunities to explore new positions on the gradient. Its asymmetric structure can be potentially used as an opportunity space for strategic design and business decisions. [10] The decisions required are: Where should you position your new innovation? Can the company support that level of innovative differentiation?

Designing a form can be seen as creating a logical position on the gradient. Position determines who you are competing with as well as the degree by which you want to visually express differentiation and thus create your exclusive identity with respect to the products in the proximity. However, the complete product images used so far do reflect the current perceptions of the product category, but have limitations.

4. Overcoming the Limitations: Use of Semantic Clues

The complete images of products reflect the influences of the prevailing product conventions and assumed mental boundaries which are not easy to break. Their completeness could in fact block exploration of new visual potential. This limitation is countered by systematically searching for fragments of potential semantic clues that users are willing to associate with the product category space.

The idea of visual clues as semantic devices is not new and is referred to in literature on product semantics as well as in cognitive psychology. In product semantics literature, McCoy refers to them, when he says, 'in a world full of black boxes, we need visual clues to their meaning.' [3] Friedlaender suggests that responses to such semantic devices are initially intellectual and later emotional. [4] In cognitive psychology, Smith et al showed how characteristic features and not the defining features help humans identify objects. [12] Similarly, Eleanor Rosch, focusing on predictability in the real world, showed how identification is aided by unique bundles of correlated perceptual and functional features. [13,14] This literature suggests that select bundle of visual clues appear to almost metonymically represent the object and is often adequate to recognize it. In a visual encounter with the product, perceptual features are visual clues and act as semantic devices critical for identification and response. [10] The fact that the identification of product category is often based on simple visual clues (characteristic visual features) can be used effectively to search for more opportunities. The focus

shifted to identifying potential visual clues that users are likely to associate with the category. Earlier methods had to be modified for these explorations.

4.1 Cropped image method

The methods continue to probe user perceptions, however the product images are cropped into smaller units such that only one or two visual clues are visible and the identification of the object that they belong to is not easily revealed. Cropping, and the resultant de-contextualization, ensures that the category identity is carefully concealed. (See figure 2 later) Thus the focus is on capturing isolated visual expressions of abstract mental constructs that are often difficult to capture through a single example. The meaning and the power of the visual clues as semantic devices becomes apparent when the context is erased and when they are presented as de-contextualized elements for focused attention. By changing the questions asked, cropped images are shown to users in different ways as will be explained in sections 4.2 and 5 that follow.

4.2 Visual clues: What could exist in the Extended Category Space

How does one find out how users associate visual clues with the product category? Can we extend the search beyond the product category? Photographs of product form largely from within the category taxonomy [13] are cropped into smaller units. In the taxonomy, ignition device is a more inclusive super-ordinate category for lighters and includes a large number of other products such as gas lighters, match boxes, spark plugs etc. Images from such devices were collected, cropped and shown to users and they were asked to guess the object category or the super-ordinate category. Cumulative score of the correct guesses is computed for each image. All the images are grouped now into three classes based on the user data. The result is a map of potential visual clues that are likely to be associated with the core as well as with the gradient. (See figure 2) It shows how users are willing to permit the entry of visual clues like metal parts, rings around the nozzles and grills into this product category. It is interesting to note that the map includes images which do not belong to the category lighter but to its super-ordinate. The fact that users associate these visual clues with the category suggests that they are the potential resource for form innovation.

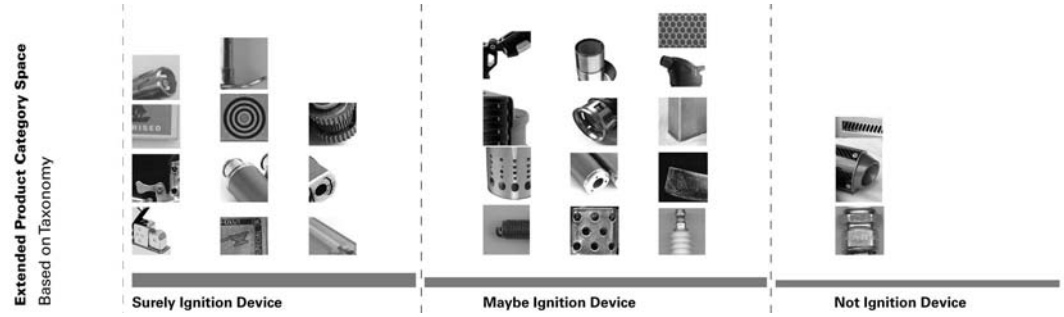

Figure 2: Cumulative score of the correct guesses was computed for each image. This allowed grouping into three classes; Surely (closer to the typical), Maybe (not-so-typical) and Does not belong (beyond the boundary).

Product category space has two layers stacked one above the other and arranged linearly. The bottom layer contains gradient with complete images of products. The top layer contains gradient of visual clues from the product taxonomy that are potentially associated with the product category, shown in figure 3 later. In both the layers typical cases will be on the left side and not-so-typical and atypical towards right. The new gradient offers

opportunity to search for clues that are semantically consistent with the product category and thus, can be potentially useful.

5. Going beyond: Construction of Product Expressions Space

What other user perceptions do we need to capture complete understanding of semantic space? If we go back and de-construct the brief, it hints at several expressions and identities besides references to the category. In the lighter case study two expressions emerge from the brief: 1) Feminine-ness and 2) Indian-ness. In other projects the list included references to linguistic expressions like youthfulness, contemporary-ness, rustic-ness etc. How does one get clues to the user's interpretation of these words?

5.1 From Linguistic to Visual Expressions

In exploiting linguistic expression towards explorations in form, Lannoch focused on semantic transfer. [9] He suggested that since verbal language provides the most differentiated and comprehensive expression of meanings, semantic characteristics captured in words should increasingly define form. His semantic transfer process starts with exploration of words that describe the nature of objects, their orientations and actions. The complex verbal imagery is then transferred into spatial (visual) representations without accounting for their use or function.

The idea is to understand users' associations of cropped visual clues with various words (adjectives) which are treated as scales. This helps locate the visual sources for various expressions, independent of the objects to which they belong. Cropped images of user's objects reflecting these expressions by varying degrees are rated by users on a 1-5 scale. Cumulative results provide the degree by which a particular image is distant from the core expression. However, in the lighter case-study a different method was explored. Users (women) were given the images, asked to identify the objects and also describe them. The descriptions were analyzed based on the nouns and adjectives (like girly, flowery, glossy, stylish etc.) so as to establish the degree by which they refer to feminine products (See results in product expression space in figure 3). Based on this data, additional associated images were collected.

Using words from the brief that need visual interpretation, product expressions space is constructed as a graded map of visual clues, vertically stacked. The top-most row shows a cluster of object-images (non-sequenced) reflecting Indian-ness. They could have been sequenced had the users been accessible.

6. Consolidating into Semantic Space

Semantic space can also be seen as a kind of image board. However, in constructing this space there is a rationale that dictates the form and position of the visuals. It is constructed systematically and incrementally during the analytical phase of the design process thus running parallel to normal actions in data collection and analysis. It reflects the perceptions of users regarding product category structure as well as specific abstract mental constructs. Semantic space is structured along the typical and the atypical. It defuses the stereotypical perceptions that designers may carry considering themselves as users.

Semantic space combines the two subordinate spaces: 1) product category space and 2) product expressions space. In the first space, the bottom row contains a graded map with full images of product from that category. The row/s above contain similar map/s, but of visual clues from the taxonomy that can be potentially associated

with this category (See figure 3). Above this space is the product expressions space, which contains graded maps of de-contextualized visual clues in multiple linear stacks, each representing a particular linguistic expression. Except the bottom row of the product category space, the image fragments are not necessarily specific to the product category (In this case lighter). The semantic space now roughly resembles an image board, but shows collective perceptions, capturing the movement from typical to atypical visual clues. Where it departs completely from the image board is its potential use as a generative tool based on structured combinations to encourage innovative form explorations.

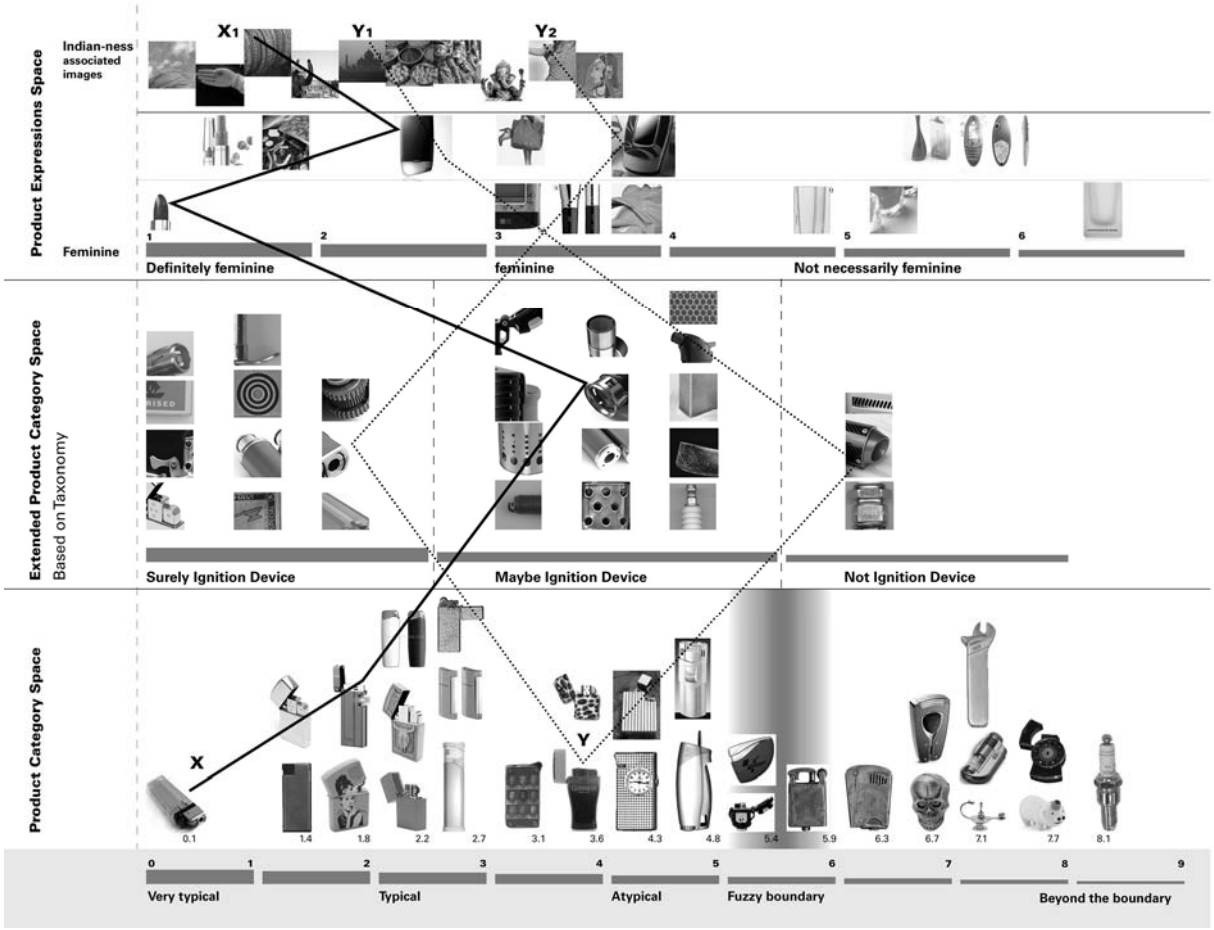

Figure 3: Demonstrates generative use of semantic space. It provides structure to the selection of clues depending on the goals and strategic decisions. Position Y shows how different options are possible in spite of the location on the category space being constant.

6.1 Using Semantic Space as a Generative Tool

How is the semantic space used generatively? The generative possibilities of the semantic space are based on the large canvas it offers from which the visual clues can be borrowed, thus automatically controlling the meaning. It is almost like throwing in bundles of right words and relying on the designer to provide the grammar to construct new sentences. The space allows endless possibilities of putting different visual clue bundles together, either by consciously shifting attention and focus or by an algorithm. The semantic space prompts explorations in both logical as well as sometimes irrational bundles of visual clues.

Structured selection process attempts to offer a rationale to the exploratory play. While bombarding of visual clues from different stacks of the semantic space throws up new possibilities, the bottom row in the product

category space keeps reminding the designer of: 1) the strategic goals and the location that were proposed earlier and 2) at the level of form, the visual competition from which the proposed design needs to be differentiated.

6.2 Innovation Based on Structured Selection

The system of selecting the visual clues for explorations is completely goal dependent and is a kind of balancing act. Most designers often push their clients away from the core to get maximum freedom to explore though this may not always be strategically right. There are many location options possible in the bottom row of the product category space and the method shows how one can innovate irrespective of the location on the gradient. If the desire is to be close to the typical, larger numbers of clues should be selected from regions close to the core so as to generate new concepts in form. See combination X-X1 in figure 3 leading to the new design in figure 4).

Figure 4: The lighter example borrowed from the lipstick the idea of the rotating base for the dual purpose of not only pushing up the lighter mechanism, but also igniting it. The visual expression of the rotating ring borrowed from the colorful bangles commonly associated with women in India.

Even from this single position, different bundling of clues ensures variety and innovation. In the middle of the bottom row, there are greater opportunities of balancing by borrowing from both the left side and right side of the stacks (Combinations Y-Y1 and Y-Y2 in figure 3). Semantic space permits de-linking of innovation from location, thus showing how one can be creative at any location. Options of bundling alter the focus of the message a bit, but retain the location on the gradient.

6.3 Designer's Creativity Matters

The focus is on the process that creates conditions for the designer to take a creative leap, but does not automatically ensure creative results. It is up to the designer to find relationships, connect what appears unconnected and hold them long enough to transform them into innovative forms. It is back to visual grammar and the traditional process of sketch-based explorations to help the designer integrate the bombarded clues into a coherent message.

Generative use of semantic space does demand a different attitude where the designer is expected to be comfortable with exploratory combinations not necessarily based on logic. It is assumed that there are neither wrong, irrelevant combinations nor is there a need to demand reasons for accepting them. Typically, even such combinations tend to make sense a little later when one sees them in different context. It is also important to ensure that the judgment be suspended in the generative phase. In the ultimate analysis, it is critical to be effective than right. [15]

To sum up, while remaining rooted in product semantics theory, this paper focuses on operational and formal methods that are user centric, accounting for strategic thinking and yet promoting innovations in product form. It was successfully tried-out on several student projects as a generative tool. The designer-friendly web-based interactive analytical as well as generative tool is still a 'work in progress'.

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