The Innovation Pyramid: *A Categorization of the Innovation Phenomenon in the Product-design Field*

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This paper presents an innovation pyramid that categorizes four different kinds of design-driven innovations in the product-design field. This pyramid is the final result of a long-term research process started at Politecnico di Milano in 2006 involving the three key disciplinary areas related to new product development: management, engineering and design. The disciplines were represented by the Indaco (INdustrial Design, Art and COmunication) and Mechanical Engineering departments of the Politecnico di Milano, and the Business School of Bocconi University. The first step of the research project attempted to determine how to better demonstrate the contribution design makes to product innovation. In order to answer this, a phenomenological approach was used, i.e. observing product innovation as a phenomenon. From this approach, three possible levers of a design-driven innovation process emerged: form, mode of use, and technology. Additionally, four possible types of results of a design-driven process emerged: aesthetic, mode of use, meaning, and typological innovation. The levers and results are systematized here into an innovation pyramid, which helps to clarify both their similarities and their differences.

Keywords **–** Product Design, Design-Driven Innovation, Design Value, Design Success.

Relevance to Design Practice **–** The results of this study serve to clarify the role of design in product innovation for all those who either are not aware of it or do not distinguish it from other professional approaches, from corporate management to national or international institutions.

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Introduction

It is now generally recognized that product innovation originates from different sources. Current thought on systemic innovation states that “innovation arises from complex long-term interactions between many individuals” (Kotelnikov, n.d.). Nevertheless, for a long time innovation was identified merely with researching new technological solutions. Even today, in most cases, innovation is referred to as introducing new technology into a product or into its manufacturing process in order to improve its performance and usability or to minimize its cost (Baglieri, 2003).

Since the early 1990s, thanks to the circulation of *total quality theory* (Deming, 1986; Galgano, 1990; Womack, Jones, & Roos, 1991), a new vision centered on customer satisfaction has arisen on top of the technological notion of product innovation. The idea that innovation may also be the result of new market demand was established as a result.

A third innovation concept incorporating the increasing attention to customer needs and requirements has recently emerged – design-driven innovation. Verganti (2002) says that this kind of innovation is not in contrast with technology and market-driven innovation, but complementary to them. Design-driven innovation may originate either from the need to meet new market requirements or from the integration of new technology into an existing product. Despite the presence of several successful examples and the growing number of publications on the theme (Candi, 2005; Dell'Era & Verganti, 2007; Ravasi & Lojacono, 2005; Verganti, 2002, 2003; von Stamm, 2003; Utterback et al., 2006), in comparison to other disciplines, the role of industrial design in product innovation processes is not easy to demonstrate. Here, we seek to explain the reasons for this difficulty, starting with a definition of what is meant here by industrial design.

Drawing inspiration both from the famous definition given by Maldonado in the 1960s – “Industrial design is the creative activity whose aim is to determine the formal qualities of manufactured objects” (Maldonado, 1991) – and from the semantic turn declared by Krippendorff in 2006, we define industrial design as *the creative activity that lends form and meaning to industrially manufactured objects, both for mass and limited production*. Form and meaning are, indeed, intrinsically correlated: “Something must have form to be seen but must make sense to be understood and used” (Krippendorff, 1989, p. 14). Therefore, the kind of innovation that industrial design proposes is defined as innovation in the *meaning of a product* (Dell'Era & Verganti, 2007; Verganti, 2002, 2003). Nevertheless, talking about meaning is never easy; the meaning of a product is something difficult to define, explain, control, and measure. As a result, it is difficult to precisely define industrial design's contribution to the product-innovation process.

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The situation is further complicated by the fact that, even in manufacturing sectors where industrial design is accorded an acknowledged role (for instance, in household appliances and consumer electronics), product innovation is usually managed by other departments in a company: R&D takes on the technological aspects while marketing handles the issues related to satisfying market demands. Industrial design also deals with the same issues (technology and satisfying market demands) but its contribution, as stated above, is harder to demonstrate and to quantify.

The problem of measuring the value generated by design innovation is a direct result of the difficulty in quantifying the meaning and cultural aspects of a product. From the financial aspect, a new product on the market can only be considered an innovation if it generates profit for the firm. The value of design-driven innovation, however, is not always measurable solely in terms of commercial success. There are certainly cases where a product derived from design-driven innovation has brought strong communicative value for the firm despite a lack of commercial success (as in the case of the Oz refrigerator designed by Roberto Pezzetta for Zanussi). In other cases, an innovation process led by industrial design may afford a firm the chance to experiment and to explore new market areas or manufacturing opportunities while exploring new languages or ways of interpreting user needs (Ravasi & Lojacono, 2005). Heskett (2008) states:

> Specific attempts to explain design in an economic context have generally sought to justify it in terms of the numerical, quantitative values that dominate business processes. Since the main arena of activity for designers is the firm, however, a major emphasis in discussing the role of design needs to be at the microeconomic level and encompass a greater degree of qualitative factors. (p. 83)

As such, it is supposed that the difficulty of demonstrating the innovative value of industrial design is due both to the fact that design deals mostly with qualitative issues and to the fact that traditionally, in all non-design-driven industries, innovation is managed by R&D and strategic marketing. How, then, can the contribution of industrial design to product innovation be better demonstrated?

This question was tackled during a research project titled "New Conceptual Models and New Tools for Design-driven Innovation in the Global Economy," carried out at the Politecnico di Milano from 2006 through 2008. In seeking an answer, we studied product innovation from a phenomenological point of view. Indeed, because our ultimate aim is to define a sharable method for categorizing design-driven innovation from a qualitative point of view rather than to obtain an unlikely scientific measurement of it, we decided to refer to phenomenology which offers a specific qualitative approach to the issue of knowledge creation. According to this current of thought, phenomena must be observed as they occur in order for general principles to be drawn from the observation (Bertola, 2004). But how are we to understand the term "phenomena"? Phenomenon, "that which appears" in the terms of its Greek etymology, can be defined as "things as they appear in our experience, thus the meaning things have in our experience" (Stanford Encyclopedia of Philosophy). The issue of meaning is central in phenomenology, as it is in design-driven innovation.

In our research, 40 products deemed innovative in their industrial design were selected as the phenomena to be observed in qualitative terms. The research process, its methodology, and its findings are detailed below.

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The Research Process

The research process comprised the following five steps:

1. defining the research problem and establishing its methodology;
2. selecting and describing samples;
3. analyzing data and shaping hypotheses;
4. testing the categorization and refining it;
5. final testing and enfolding results with existing literature.

This overall research process fits with the humanities tradition as described by Archer (1995). This process first saw the gathering of "evidence produced by research" and then the gathering of "the judgments of other scholars" on the emerging research issues. On these "primary" and "secondary" sources of information, as Archer defines them, a logical argument was conducted by adding personal judgments in order to arrive at the final formulation of results. A detailed description of each step in the research process follows.

Step One – Defining the Research Problem and Establishing its Methodology

Our research group was made up of ten people: six design experts from the Indaco Department of Politecnico di Milano, two experts in management from Bocconi University, and two engineers from the Mechanical Engineering Department of Politecnico di Milano. The design experts included two full professors and four assistant professors, three of the six also working as professional designers. The challenge for the six design experts was to demonstrate, to both executives and engineers, industrial design's contribution to product innovation. Their ultimate aim was to classify such contribution so as to facilitate both understanding and communicating the contribution. This was our research problem.

We decided that the easiest way to tackle the problem was through a number of concrete examples to be observed and studied as "innovation phenomena." Starting from these examples, an induction approach based on qualitative data analysis (Miles & Huberman, 1994) was used. Its first objective was to suggest some propositions to be verified afterward, with both quantitative and qualitative methods, in order to reach a shared categorization.

Step Two – Selecting and Describing Samples

The first task for the six design experts was to select a number of products considered highly representative of design innovation. Each design expert proposed three products that, according to his or her knowledge of the design discipline, could be deemed innovative. Since no time frame had been previously established, the products could be either contemporary or part of design history. A list of 18 products was thus produced, from which the design experts selected ten. The main criterion for making the final selection was the products' renown. It was agreed that very well-known examples, such as the Tizio lamp by Richard Sapper, would make the exemplification more effective. As a result, the ten products selected came from typical design-driven industries: furniture, housewares and electric lighting.

For each product, one or two pictures were chosen from the many available on the internet. Then, the six design experts showed pictures of the ten products to the other four members of the research group. They also described the features that made each product worthy of being considered a design innovation. The two executives and the two engineers asked numerous questions, challenging the design experts' knowledge and beliefs.

Step Three – Analyzing Data and Shaping Hypotheses

The discussion that took place during the plenary session of the entire research group was recorded and transcribed by two young design researchers. The aim was to extract the variables that could be used to describe the essential structure of design-driven innovation. The use of language as the main analysis tool is a typical feature of phenomenological studies.

The two young researchers, each under the supervision of three of the six design experts, made an effort to group data. Key sentences describing the same innovative feature (for instance: "it's easy to use" and "it introduced a new way of handling the product" or "it's very recognizable" and "it has an unusual shape"), were grouped together in order to identify all possible innovation variables. This data-grouping process consisted of four steps:

1. gathering raw data from the research group's discussion;
2. interpreting the raw data in terms of innovative product features;
3. organizing the innovative features into a set of innovation variables;
4. reflecting on the results of the process.

This process is similar to the one described by Ulrich and Eppinger (2003, Ch. 4) for identifying a set of customer needs. It also drew inspiration from the "12 Basic Steps of the Vancouver School of Doing Phenomenology" described by Halldorsdottir (2000).

The first two innovation variables that emerged from the grouping and interpreting process were easy to predict: *form* and *function*; the third was *meaning*. During the data analysis, the need to distinguish between the final result obtained by the designer and the tools he used to obtain it also emerged. The research group reckoned that this distinction was important to include in the research proposition which, at this stage, was formulated as follows: *each design-driven innovation process can be described by a finite number of levers and results*. The term *lever* is used here to metaphorically describe the relationship of the designer, who pushes on it, to the object designed, which is lifted by it; the very discipline of design being the fulcrum. An initial proposal of three levers, form, function, and technology, and three innovation results, aesthetic, functional, and meaning, was made.

Step Four – Testing and Refining the Categories

The next step was to test and refine the emerging proposition. To do so, a longer list of 40 innovative products was drawn up and submitted for the consideration of five young design experts, all PhD candidates in design at the Politecnico di Milano.

To be more precise, another 30 products were selected and added to the initial list. To select these products, we applied a simple criterion of the product having been awarded a design prize, such as the Compasso d'Oro, the Red Dot or the IF Design Award. To challenge the emerging proposition, we also decided to include products from a broader variety of industries. In addition to furniture, housewares, and electric lighting, we also used products from household appliances, consumer electronics, automotive, and packaging. Again, each of the six design experts proposed a number of innovative products to produce a longer list. The group then selected 30 products to join the initial ten. For the final selection, the success of each product from the design point of view was evaluated by considering its presence in independent trade magazines and in domestic and international design museums and exhibitions. However, thanks to the contribution of the two professors from Bocconi University, during step two of the research process, it became clear that none of the design experts had a clear idea of the commercial success of such products when selecting the innovation examples. What they were able to assess was their innovation content in terms of cultural success within the design community. On the other hand, for the two Bocconi professors, it was important to establish how much each product had contributed to the financial success of its manufacturer. The difference between the design discipline, concerned with qualitative and cultural issues, and the business discipline, concerned with numerical value and financial results, once again came to the forefront. The research group's joint decision was to ignore commercial success as an influential element in determining a product's design-innovation content. At the same time, the two Bocconi professors deemed it worthwhile to conduct a spinoff study aimed at correlating the product's success in the design community with the financial state of its manufacturer. The results of this study are described in the paper "Design as a Strategic Competence for Continuous Innovation" (Baglieri, Zamboni, & Secchi, 2009).

Having clarified the definition of success in design-driven innovation, we created a questionnaire to check our proposed three levers and three innovation results. In the questionnaire, each of the 40 products was presented with a picture and brief description. When creating the questionnaire, the research group first identified, through group discussion, which of the three innovation results each product represented and which levers the designer had used. The aim of the questionnaire was to check if the five young design experts would confirm the *products-levers-results* match made by the research group. In practical terms, the young experts had to answer a number of yes-no questions. The questions were divided into two groups, one for the three innovation levers and the other for the three innovation results. Examples of the questions from the innovation-results set include:

- **Aesthetic Innovation**:
  "Is the product easily recognizable?"
  "Is the product far from the dominant morphological archetype?"
- **Functional Innovation**:
  "Is the product intuitive to use?"
  "Has the product introduced new functions?"
- **Meaning Innovation**:
  "Is the product exciting?"
  "Can the product be defined as a status-symbol?"

The PhD candidates were also invited to freely add comments. The results of their endeavor were: 15 products were recognized as having aesthetic innovation, 14 as functional innovation, and nine as meaning innovation. Two products, the Grillo telephone and the Sacco armchair, created a categorization problem in that three of the five respondents had trouble categorizing them as simply aesthetic innovations, as the question "Is the product far from the dominant morphological archetype?" seemed to suggest. In order to overcome this classification issue, a new category, typological innovation, was added, thus giving a fourth possible innovation result. As will be better explained below, typological innovation is a radical but rare innovation phenomenon. Its rarity is the reason why a larger number of samples was needed to correctly identify it. We decided to add this new possible innovation output to the questionnaire to see what would change. The new version of the questionnaire was submitted to the same five respondents, providing new results: 14 products deemed as having aesthetic innovation, 12 functional innovations, nine meaning innovations, and five typological innovations. No further categorization problems arose, so the four categories proved sufficient to describe all 40 products involved. These questionnaire results also enabled us to reason about the relationship between levers and results. What emerged is discussed in later sections. At this stage, the research group had a formulation of the research result and a proposition stated as: "each design-driven innovation process can be described by three levers: form, function, and technology; and by four results: aesthetic, functional, meaning, and typological innovation." This proposition, along with the examples that had been selected, created the sought-after categorization.

Step Five – Final Testing and Framing Results in the Literature

Over the subsequent two years, relevant literature was reviewed seeking both references and new stimuli, all the while applying the classical humanities research method that, as Archer (1995) puts it, "advances by the conduct of logical argument. Propositions are validated or refuted by exemplification and citation." (p. 9) Accordingly, the classification yielded by the four research steps described above was challenged by considering other scholars' judgment on design-driven innovation. The result of this endeavor is the "innovation pyramid."

At the same time, classroom investigations were also carried out. The innovation variables that had been identified were presented to a total of 34 master's degree students. They were asked to propose examples of innovation that fit the variables given. The students were thus spurred to test whether the categorization could actually be applied to describe product innovation in a straightforward and exhaustive fashion. The examples supplied by students were gathered and classified so as to enlarge the 40-product sample. As a matter of fact, 40 products are not enough to be statistically significant, so 50 examples were added (30 suggested by graduate students and 20 chosen from literature review). The final sample, comprising 90 products, validates the "three levers and four results" proposition.

It should be noted that, as a result of the literature review, the term "function" was replaced with "mode of use" and, consequently, the expression "functional innovation" with "innovation of use." The concept of *function* focuses on the operation of the product, the concept of *use* adds a cultural and social dimension that is pivotal to design. The final outcome of this research process is presented below.

The Design-Driven Innovation Process

During the third step of this research, which was devoted to shaping hypotheses, one issue that emerged was whether to consider design-driven innovation a process. Discussion on the first ten examples had clearly shown the need to distinguish between the result obtained by the designer and the tools he or she used to reach it. Therefore, the research group decided to assume the following definition of innovation, which is now widely accepted and underlines its procedural nature: innovation equals creativity plus a successful implementation process (von Stamm, 2003, p. 1). According to von Stamm, this definition brings two consequences, which the research group shared. First, an innovative product is not the result of any new-product-development process: a creative leap is needed to talk about innovation. Second, the creative idea needs to be put into practice in that we face innovation only when

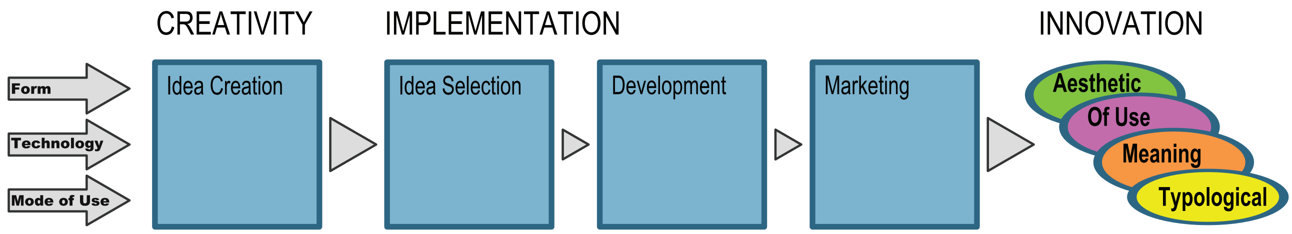

Figure 1. Levers, phases, and results of the design - driven innovation process.

a creative idea is built into a product and launched on the market. In this definition, no reference is made to the commercial success of the product. This absence of reference was important to the research group, for the reasons explained previously.

Figure 1 illustrates the proposition that resulted from our research process, which was: *each design-driven innovation process can be described by three levers and four results*.

The Three Levers of the Design-driven Innovation Process

Design-driven innovation can have three possible levers, meaning three possible starting points of the creative process, which are noted here as being form, mode of use, and technology. Before giving a specific definition for each, some examples are in order.

A good example of a design that uses product *form* as its main lever is the Pipedream Seating System designed by Robert Öhman and manufactured by LYX Furniture. This unusual seating system is composed of two parallel tubes, one serving as seat, the other as backrest. In 2008 this product was awarded the Red Dot Design award. Obviously, the form lever is very popular among design-based companies, that is those that compete in industries with a high aesthetic content (fashion, furniture, electric lighting).

An example where the innovation lever was *mode of use* is the collapsible kitchen funnel manufactured by Normann Copenhagen and designed by Boje Estermann in 2004. This example was included on our initial ten-product list. Compared to a standard kitchen funnel, this product has the advantage of saving space. When not in use, it collapses enabling it to be put away easily in a drawer. In 2005, this product won three design accolades: the Good Design Award, the Design Plus Award, and the Red Dot Design Award.

An example of design innovation that used *product technology* as a starting lever is the Pluma gas cylinder, manufactured by the Portuguese company Brandiacentral and winner of the Red Dot Award in 2006. This example was uncovered by a Portuguese graduate student. The Pluma's organic appearance is based on a symbiosis of different materials and their specific properties. Due to this combination of materials, the inner liner is endowed with greater strength, as well as superior safety performance.

Figure 3. Left: Brandiacentral Pluma butane gas cylinder, design by Monteiro, Mendes and de Faria, (winner Red Dot Award: Product Design, photo: Red Dot Online); **Right: Serralunga Santavase vase**, design by Denis Santachiara. (Reprinted with permission)

An example of design-driven innovation with the main starting lever of *process technology* can be seen in the rotomolded pots manufactured by the Italian company Serralunga. This example was among the initial list of ten products. Compared to injection molding, rotational molding has more constraints, in terms both of size and of finish. However, it requires less manufacturing investment. Industrial design played a seminal role in dignifying this technology, and most of the credit goes to Serralunga. In 2000 the company asked some famous designers to design either a pot or a planter to be rotomolded. The objects yielded by this experiment took advantage of the potential of rotomolding technology to avoid imitating existing earthenware pots and to delineate new shapes and set out new ways of use. The example illustrated is the Santavase by Denis Santachiara, a plastic flowerpot that can be screwed halfway into the ground.

In light of this exemplification of the use of the three levers, some initial remarks are in order. First, it is interesting to note how the three levers line up along an objectivity/subjectivity axis, from *technology* to *form*. Stated in greater detail:

- *Technology*, whether process technology or product technology, is an external, objective fact that defines a series of requirements while opening a number of opportunities the designer has to make the most of.

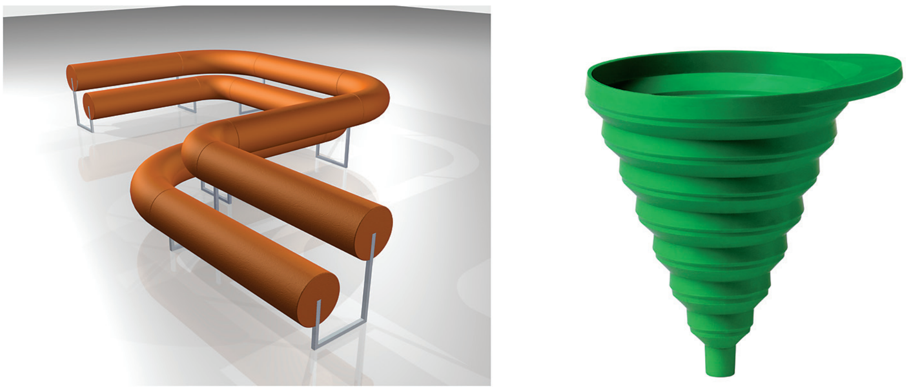

Figure 2. Left: LYX Pipedream seating system, design by Robert Öhman; **Right: Normann Copenhagen collapsible kitchen funnel,** design by Boje Estermann. (Reprinted with permission)

- *Mode of use* can be defined by the designer but still rests on a series of objective data related to human beings' sensory and cognitive abilities and to anthropometric measures.
- *Form* is the most subjective lever, the one that brings design closest to art, for the same function may be embodied in different forms, thus leaving it to the designer to chose the best one.

The latter is undoubtedly the most distinctive lever in the design discipline, but it is also the most difficult to master. It covers two connected but separate levels: the figurative level and the level of meaning. Rindova and Petkova (2007) state that a product's formal features can lead both to visceral reactions (the domain of aesthetics), and to cognitive and emotional reactions (the domain of meaning). Our decision to include both these levels in the same lever originated from the belief that, during the creative process, the designer cannot perceive a clear-cut distinction between aesthetic choices (proportion among parts, alternation of empty and full volumes, color, texture, etc.) and choices related to the meaning of the product. This "unitary" decision finds confirmation in Kubler (1972) who asserts that when studying *objets d'art*, it is dangerous to separate formal aspects (morphology) from meaning (iconology), since no meaning can be transmitted without form.

In light of the foregoing remarks, we can give a clear definition for each of the three levers:

- *Form*: The designer starts the design process by considering the product's morphological attributes in order to define a new form (figurative level) and a new language (meaning level) for it.
- *Mode of use*: The designer starts the design process by considering the product's mode of use in order to define the unsatisfied needs that might be better met with new usage and/or new functions.
- *Technology*: The designer starts the design process by considering an opportunity to apply a new process technology or a new product technology to a type of artifact that does not presently use it.

Using technology as the starting lever does not mean that a designer has to play engineer. Quite the contrary, there are several examples of design objects with high aesthetic content that result from a process rooted in purely technological issues. Here, the Pluma butane gas cylinder and Santavase pot are offered as examples. Moreover, when it comes to technology, industrial design can act as an interpreter giving technology new meaning. This is shown especially in the Santavase pot. Thanks to design, plastic pots now have their own identity and are not just cheap imitations of traditional earthenware pots.

Naturally, because industrial design tends to give a synthetic answer to several issues related to new product development, it was often difficult to define which lever had inspired the whole design process. Moreover, since issues of a product's *form* and *mode of use* are strictly related, the designer has, in many cases, used more than one lever at the same time. Nevertheless, distinguishing among these three levers enhances our capacity to explain the role industrial design can play to the other company divisions involved in new product development process. Identifying these levers is also useful in teaching, for it helps clearly define the knowledge a design student must master in order to obtain innovation and to lend value to the project.

The Four Results of the Design-Driven Innovation Process

The previous sections discussed the startup input to the design-driven innovation process. Let us now focus on the end result. Through our phenomenological analysis, four possible results were distinguished:

- Aesthetic Innovation
- Innovation of Use
- Meaning Innovation
- Typological Innovation

The essential features of each of these are described below.

Aesthetic Innovation

Aesthetic innovation is related to product recognition, i.e. to how much a product's appearance differs from that of the competitors' products. It deals with the product's external appearance, those attributes (shape, size, proportion of elements, and color) that can be judged at first sight with no need to interact with the product or understand it.

This is the level of design that Norman (2004) defines as "visceral," since it stimulates our instinctual sphere and our senses. He affirms that it can be studied simply by observing people and their reactions to an object. In the luckiest cases, visceral reaction to external appearance works so well that people, after merely a quick glance, decide they want the product. Only then do they ask themselves what the product is used for or how much it costs. *Aesthetic innovation* can thus be defined as the result of a new formal interpretation of the product. The term "aesthetic innovation," though not so widespread as one might expect, does encounter some references in the literature on new product development. Eisenmann (2007), for instance, defines it as a series of incremental adjustments to the physical appearance of a product, adjustments that neither alter its archetype nor influence its performance or technology.

Many authors, such as Dreyfus (1967), Kotler and Rath (1984), and Ulrich and Eppinger (2003), stress the importance of appearance (intended as the sum of shape, proportion and color), in order to attain differentiation. We can affirm that the aim of *aesthetic innovation* is to make the product recognizable at first glance and, thus, attractive. Obviously, this kind of innovation is easy to communicate since in most cases a picture is sufficient. For this reason, *aesthetic innovation* has gained importance in modern society, where the appearance of a product, usually gleaned from the internet or other form of media, is all the consumer knows about a product and what spurs the initial desire to buy.

A good example of aesthetic innovation is the AP-1008BH Air Purifier manufactured by the Korean company Woongjin Coway. In 2008, the product won the Red Dot Award with the following citation: "With its organic and soft stylistic expression,

Figure 4. Left: Air purifier AP-1008BH, design by Hun-Jung Choi and Bum-Jeong Baik, (winner Red Dot Award: Product Design, photo: Red Dot Online); **Right: La Cie Golden disk**, design by Ora Ito. (Reprinted with permission)

this air purifier is a fashionable object that fits harmoniously into any living space" (Red Dot, 2008). Yet another example is the Golden Disk USB terabyte hard drive designed by Ora Ito. In accordance with what Eisemann (2007) claims, from the technological point of view the Golden Disk is not superior to competitors' products; it is simply a product with greater aesthetic content that allows the end user to recognize it at first glance.

Naturally, the main application fields for aesthetic innovation are usually the traditionally design-based sectors (fashion and furnishing). Nevertheless, aesthetic innovation can also play an important role in technology-based sectors, including computers, mobile phones, and even automobiles. Recent studies show that a growing number of tech manufacturers invest in aesthetics, deeming it an important competitive lever that can assure financial success (Gemser & Leenders, 2001; Gemser & Wijnberg, 2002). It is indeed widely understood that aesthetics of technical appliances gains importance as technologies mature. This occurs because appearance affords companies an alternative way of differentiating their products (Eisenman, 2007; Ulrich & Eppinger, 2003). Given the importance ascribed to product aesthetics in many industries, several scholars analyzed the connection between aesthetics and consumer choice: Berkowitz (1987), Creusen and Schoormans (2005), Yamamoto and Lambert (1994), Candi (2005).

Innovation of Use

Innovation of use involves the degree to which a product improves or modifies its usage, perhaps adding new functions, as compared to products already on the market. Thus, it deals with the way people interact with a product. This sensitivity to the moment of interaction is the main difference between the designer's and the engineer's methods for resolving a function: "An engineer who calculates the strength of a bolt does not make reference to what someone thinks about it and in fact avoids his or her own thinking in favor of established calculations" (Krippendorff, 2008).

In other words, as noted, while the concept of function centers on the operation of the product, the concept of use brings a cultural and social dimension to it. Therefore, *innovation of use* is designated here as a substitute for *functional innovation*, since the latter more precisely refers to innovation as proposed by technological disciplines.

The industrial designer's aim, when designing the shape of a product, should be to attempt to make explicit its functions and the way it is used (Bürdek, 2005; Dreyfuss, 1967; Papanek, 1983). Nevertheless, designers should concentrate not only on the moment of use, but also a product needs to be designed to be easily installed, repaired, and stocked. In some product categories, such as ceiling fans and lamps, the installation moment is much more complex than the moment of use, usually limited to switching the item on and off with a switch. In such cases, the industrial designer needs to bear in mind the requirements of two different users, the consumer and the installer.

Dealing with products' usability and maintainability means dealing with their quality of use. Anselmi (2004) maintains that quality of use coincides with user-product interaction in a given context. It is the relationship that a specific user has with the product, with its characteristics, way of use, safety and reliability. This level of design, based on product use, is termed "behavioral design" by Norman (2004). Designers and ergonomists handle it collaboratively.

A good example of *innovation of use* is the Riverso drawer system, winner of the Red Dot Award in 2007. The drawers pull

Figure 5. Left: Riverso drawer system by peka-system AG; **Right: Arnolfo di Cambio Smoke glass**, design by Joe Colombo. (Reprinted with permission)

out from either side. The system can be used as a room divider in kitchens and living rooms or as a shop fixture.

Interaction with a product and the perception how to use it are both related to the variability of cultural contexts. *Innovation of use*, like every design-driven innovation, is thus a phenomenon related to cultural context. The Smoke glass, designed by Joe Colombo for Arnolfo di Cambio in 1964, is a good example of what is being discussed here. The designer's idea was to enable a person to hold both the glass and a cigarette in a single hand, leaving the other hand free. The cultural context surrounding this object (parties where everyone smokes a lot) now seems outdated. If this glass were launched on today's market, it would have little chance of favorable reception.

Naturally, *innovation of use* is a very popular competitive lever throughout industries whose products demand intense interaction with the end user, such as tools, kitchenware, office appliances, and baby products. A good example is the series of kitchen utensils called Good Grips produced by Oxo, an American firm founded in 1990 and based on the concept of "design for all."

Meaning Innovation

Meaning innovation concerns the emotional and symbolic aspects of a product, i.e. what a product is able to communicate. For a long time, scholars have recognized the semantic dimension of industrial design. Buchanan (1985), for instance, writes that "There seems to be little question that some kind of communication exists in designed objects. This is evident not only in the influence of rhetorical themes in shaping methodologies in the history, theory, and criticism of design, but also in the growing body of specific information about how rhetorical considerations actually guide the practice of design" (pp. 18-19).

Recently, the idea that the essence of industrial design consists of making sense of objects has been becoming established (Krippendorff, 2006). Accordingly, *meaning innovation*, which applies to the meaning an end-user attributes to a product, can be seen as the kind of innovation that best expresses the nature of design. In regard to this, Heskett (2002) uses the term "significance," defined as the meaning that forms acquire depending on how they are used and on the role they are given. Ulrich and Eppinger (2003) discuss "emotional appeal," a quality obtained after adding in factors such as product appearance, color, sound, and consistency, as well as the sensations that the product transmits to the user and the symbolic universe it refers to.

Norman (2004) defines this level of design as "reflective" since it deals with the meaning of a product and with the memories it evokes and, at the same time, with our self-image and with the messages the product conveys to other people. In brief, the reflective level of design concerns the satisfaction we get from possessing, showing, and using a product, and is therefore strongly influenced by individual culture and experience. In order to be innovative in terms of meaning, a product should express not only quality but also be attractive, be able to tell a story, and be displayed with pride by its possessor. To obtain this kind of innovation, industrial designers must be able to master all the tools of product semantics, particularly those relating to symbolic functions. Bürdek (2005) states that the difficulties of approaching symbolic function in the practical designer's task are more obvious where there are neither vocabulary nor rules for products' meanings: "symbolic meanings can be interpreted only from their given socio-cultural context" (p. 323). Krippendorff (1989) warns that there is a contradiction between the quest for innovation and the wish to lend meaning to products: "Making sense always entails a bit of a paradox between the aim of making something new and different from what was there before, and the desire to have it make sense, to be recognizable and understandable. The former calls for innovation, while the latter calls for the reproduction of historical continuities" (p. 9). Therefore, to achieve *meaning innovation*, designers need to successfully resolve this paradoxDell'Era and Verganti (2007) define design-driven innovation as radical innovation in which the novelty of product semantics prevails over functional and technological novelty. It is, therefore, what was just defined as *meaning innovation*. According to Verganti (2003), this kind of innovation is typical of Italian design companies, Alessi, Kartell, and Artemide.

A very good example of *meaning innovation*, included on our 40-product list, is the Muji Cd player designed by Naoto Fukasawa. Launched at the end of the 90s at a time when technological products tended to bear as many switches as possible, it possessed a stunning simplicity. As shown in Figure 6, it consists of a wall-mounted box resembling a ventilation fan that is turned on with a simple pull cord, just like a fan.

Another example from our 40-product list is the Eva Solo garbage can, designed by Tools Design and winner of several design prizes. It reinterprets the garbage can's cultural assets, lending it both new aesthetics and new functionality. Its appearance is austere – conical, clear, and made entirely of stainless steel. The way the can opens and closes, however, reveals a functionality possessing fascinating logic. When the can is opened, the lid balances on its edge, thanks to a sophisticated mechanism, and hovers there, open, of its own accord. Only when the lid is nudged down slightly does it shut smoothly.

Meaning innovation, as employed here, is very close to the concept of "design icon" already found in the literature. Griffith and Skibsted (2009) define icons as "products that gather a cultural meaning that is greater that the sum of their specifications" (p. 151). According to the two authors, this new meaning becomes more prominent than the product's purpose and outlasts prescribed product lifetime. As a result, the product becomes culturally successful and is celebrated with media exposure and critical acclaim.

It is often difficult to define when a product represents *meaning innovation*. According to Dell'Era and Verganti (2007), because this kind of innovation involves a significant reinterpretation of a product's meaning, it needs time to penetrate the market and achieve success. It is therefore possible to assert that *meaning innovation* has been achieved only when the market shows it has understood the new meaning, making the product successful. The need to wait for public judgment brings *meaning innovation* close to art; the value of both of them, indeed, can be acknowledged only after a while.

Figure 6. Left: Muji CD player, design by Naoto Fukasawa; **Right: Eva Solo garbage can**, design by Tools Design, (winner Red Dot Award: Product Design, photo: Red Dot Online). (Reprinted with permission)

It is important to stress that since the meaning of a product is strictly linked to its cultural context and the respective value system, *meaning innovation* can be such only within a given context, as in one particular country or in a specific region. It bears repeating that the success of *meaning innovation* does not necessarily happen in terms of sales, but, generally speaking, in terms of notoriety. In fact, "culturally successful products can become, but are not always, blockbusters that sell more than any other product" (Griffith & Skibsted, 2009, p. 151). Despite this, many companies make the mistake of confusing *meaning innovations* with commercial success.

Typological Innovation

Typological innovation relates to the deviation of a product from its formal archetype. As Heskett (2002) remarks, people have been creating ranges of suitable forms for specific purposes since antiquity. Accordingly, some of these forms fit certain needs so perfectly as to become archetypal (for instance, the shape of a vase, a glass, or a fork). Nevertheless, during the course of history, objects' forms evolve due to new technological opportunities, cultural changes, and so on. This leads to the creation of new archetypes.

A form that perfectly matches a certain function is not the only reason why a formal archetype consolidates. A product's form can also become archetypal as the result of industrial choices. This is the case with the establishment of a product's dominant architecture. It refers to the concept of "dominant design" introduced by Abernathy and Utterback in 1978. According to their definition, a dominant design is a product's basic architecture that has become the accepted market standard in a specific product category. Utterback (1994) asserts that a dominant design is the design that earns the market's loyalty. Competitors must refer to it if they expect to achieve significant market share. Before the emergence of a dominant architecture, firms try proposing different solutions. Once dominant architecture has been established, product variety tends to decrease and, for a time, incremental innovations based on the same architecture follow one upon the other (Dell'Era & Verganti, 2007). As a result, all products in a given category tend to be similar: table fans, washing machines, refrigerators, televisions, and cellphones are some examples. In this regard, the innovative role that industrial design can play is to offer radical new solutions and put them into action through new forms that were unthinkable previously and become obvious afterward. The most successful forms become new formal archetypes. Consequently, products that result from typological innovation are always easily recognizable.

One example of *typological innovation* is the USB hub designed by Ora-Ito for La-Cie (see Figure 7) which has a round base that enables it to rotate in every direction. The product won several design awards. Elica's Om hood (see Figure 7), the Sacco armchair by Zanotta (see Figure 8), and the Grillo telephone designed by Zanuso and Sapper (see Figure 8) for Sit-Siemens Italiana are further examples of products that, once launched on the market, established changes to the dominant formal archetype. The Sacco armchair, for instance, has an unshaped structure that hugs the user who sinks into it upon sitting. Compared with archetypical armchairs, it represents a revolution. It was because of this armchair and the Grillo telephone that the concept of *typological innovation* emerged during our research process. Indeed, these were the examples that three out of five young researches had trouble categorizing.

It should also be noted that *typological innovation* does not always produce commercial success. When it breaks with the dominant archetype, a product often has trouble dominating the market and does not, therefore, represent a major source of profit for its manufacturer. Indeed, marketing studies show that when a product's form is entirely new or highly unusual, the end-user struggles to categorize it and attempts to map it onto an existing product category. This difficulty often results in the product being rejected (Rindova & Petkova, 2007).

Bloch's research (1995) confirms that consumers prefer products similar to those that already exist. Moderate difference makes the product stand out from its competition and, at the same time, allows the consumer to categorize it successfully. Explained further:

> When introducing a new product in an established market, whether to stay within or deviate from established categories is a strategic question. Raymond Loewy's MAYA principle suggests that designers should propose what is "Most Advanced Yet still Acceptable". It acknowledges the existence of categories and suggests that their boundaries may be movable but not without stakeholders' collaboration or advertising expenditures. (Krippendorff, 2006, p. 155)

However, a product that never achieved commercial success may nevertheless define a new formal archetype. Although the Sacco armchair, for example, did not sell well, it is so recognizable as to have become part of the Italian collective imagination, affording a new formal archetype for armchairs.

Innovation Pyramid

Considering the four kinds of innovation just described, it is possible to draw a distinction based on their higher or lower degree of novelty. *Aesthetic innovation* and *innovation of use*, then, are incremental innovations, while *typological innovation* and *meaning innovation* are, by definition, radical innovations.

It can be stated that *aesthetic innovation* corresponds to what Dell′Era and Verganti (2007) term "incremental semantic innovation." This involves products that, though highly recognizable, do not break with the past but utilize a style aligned to aesthetically and culturally dominant models. Typically, since incremental innovations do not differ so much from a product's consolidated archetypes, they do not require interpretative effort by the end-user, who perceives them as certain and stable (Fredrickson, 1998). As a result, incremental innovations elicit low-intensity positive emotions based on familiarity and predictability. Radical innovations, rather, introduce big changes which alter the product's configuration (Henderson & Clark, 1990), and consequently may make end-users unable to interpret the product through the interpretative models they already know. The greater the difference between a product and its dominant design, the harder it is for the consumer to evaluate its impact on his or her health meaning consumer reaction will be more emotive. Therefore, radical innovations are likely to cause strong emotional response. These emotions may be negative, when innovation leads

Figure 7. Left: LaCie USB hub, design by Ora-Ïto; **Right: Elica Om Evolution hood**, design by Elica Design Center. (Reprinted with permission)

Figure 8. Left: Zanotta's Sacco armchair, design by Teodoro, Gatti and Paolini (Reprinted with permission); **Right: Grillo telephone for Sit-Siemens Italiana**, design by Marco Zanuso. (DIGITAL IMAGE © data, The Museum of Modern Art/Scala, Florence)

to disorientation and frustration (Mick and Fournier, 1998), or positive, when the differences in the innovation are successfully solved and the user can recognize the new product's potential (Rindova & Petkova, 2007).

As noted, the results of the 40-product categorization were as follows: 14 aesthetic innovations, 12 innovations of use, nine meaning innovations, and five typological innovations. After another 50 products had been added, yielding a sample of 90 products, the results were: 32 aesthetic innovations, 31 innovations of use, 18 meaning innovations, and nine typological innovations. As shown in the following two charts, the proportions were consistent.

In light of the percentages shown, the four kinds of innovation were systematized into a pyramid with incremental innovations (aesthetic and use) at the bottom and radical innovations (meaning and typological) at the top. Indeed, the pyramid shape fits the given percentages perfectly, reflecting the fact that the stronger an innovation, the more rarely it happens. In particular, *typological innovation*, as intended here, is an innovative phenomenon that represents a real breakthrough and, therefore, happens quite rarely (10% of the total design-driven innovation phenomena analyzed). For this reason, it is placed at the vertex of the design-driven innovation pyramid.

Analysis of the relationship between starting levers and results reveals, both in the case of *aesthetic innovation* and of *use innovation*, a direct correspondence between lever and final output. Indeed, results for the 40-product analysis, as well as the 90-product analysis, shown in Table 1, lead us to the following conclusion: *innovation of use* always results from the *mode of use* lever, while *aesthetic innovation* results from the *form* lever. In either instance, the industrial designer may also apply the *technology* lever.

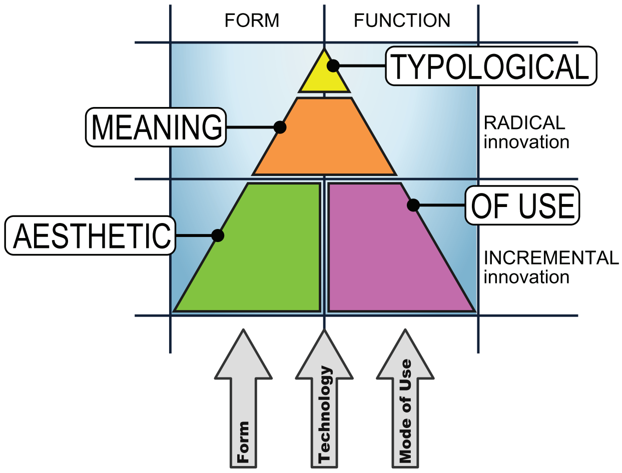

Figure 10. The innovation pyramid.

On the other hand, as shown in Table 2, in most cases (67% in the 90-product sample), *meaning innovation* and *typological innovation* result from using two levers at once. *Meaning innovation* may result from a combination of using new technology and defining unusual form, as in the case of Bookworm, a bookcase made of methacrylate designed by Ron Arad for Kartell. In two plus one cases, the innovation was the result of using three levers at once. In five plus one cases, the innovation was the result of using just one lever.

Table 1. Correspondence between levers applied and output.

	40 PRODUCTS		90 PRODUCTS	
Levers Applied	**Aesthetic Innovation**	**Innovation of Use**	**Aesthetic Innovation**	**Innovation of Use**
Form	11	0	26	0
Form + Technology	3	0	6	0
Mode of Use	0	11	0	26
Mode of Use + Technology	0	2	0	5

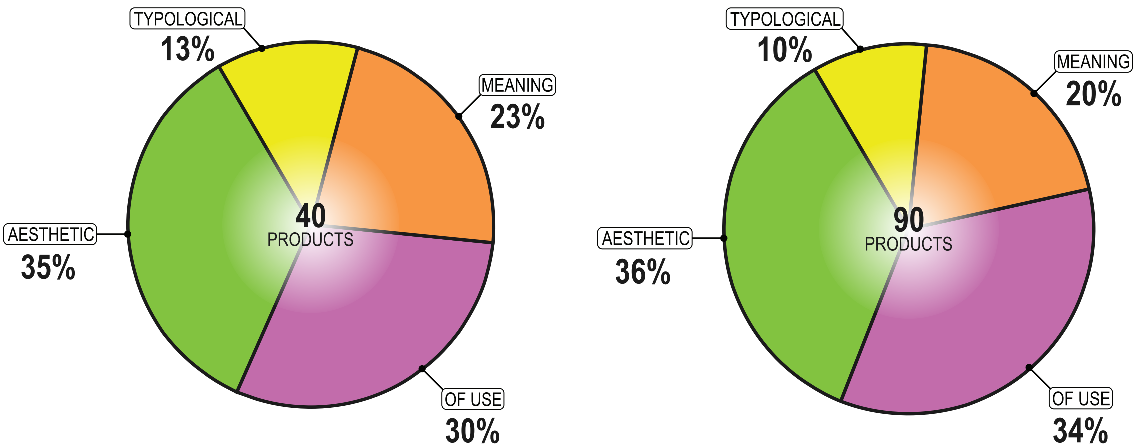

Figure 9. Left: Shares of the four kinds of innovation among the 40 products; Right: Shares of the four kinds of innovation among the 90 products.

Table 2. Number of levers and innovation type.

N. of Applied Levers	Meaning Innovation	Typological Innovation	Meaning+Typological	Total Percentage
1 lever	5	1	6	22%
2 levers	11	7	18	67%
3 levers	2	1	3	11%

In the dialectics between *function*, "the use the object is intended for," and *form* "the external configuration of an object resulting from shape, proportion and color," dialectics that have long characterized the history of industrial design, *aesthetic innovation* concerns *form* while *innovation of use* concerns the *function*. Conversely, no such clear-cut distinction between *meaning innovation* and *typological innovation* can be drawn. These two, in fact, may apply mainly either to a product's *form* or to its *function* but can also apply to both at once. Just think, in the case of *meaning innovation*, of the well-known lemon squeezer by Starck for Alessi, an object that attained new meaning due to the designer's ability to alter its formal attributes. The new meaning of the Eva Solo garbage can, however, was reached by focusing mainly on product use. In the case of *typological innovation*, consider the Om range hood by Elica where, in functional terms, the product adds nothing to traditional hoods, yet it still stands far apart from traditional hoods in morphological terms. Likewise, the designer of the Grillo telephone, Marco Zanuso, reasoning about use, defined a new typology.

Conclusions

In his book "The Shape of Time" (1972), Kubler affirms that the only way for human beings to catch the universe is to simplify it and to reorganize the endless continuity of non-identical events in a finite system of identities. According to this scholar, it is in the nature of the universe that no event can ever be repeated, while it is in the nature of man's thought to understand the aforesaid events only by means of identities that we suppose should exist among them (p. 83). This statement looms heavily on the present research, bringing about an as-yet-unexpressed doubt. Is such a categorization for product innovation, as set forth here, really true to life? And, by proposing it, are we not likely to constrain the results of creative activity into too rigid a model?

Kubler's words, though inspiring these fears, at the same time suggest a possible solution to the dilemma. Yes, of course, defining a number of categories that describe the phenomenology of an event implies a need to ignore certain details and to find clear-cut identities and differences among the phenomena under consideration. This is the way human thought grasps worldly events. As such, identifying the three levers and the four results for the design-driven innovation process mandates foregoing certain differences and obliging certain resemblances. Nevertheless, over the last three years, the proposed categorization has enabled the author of this article to clearly explain the design-driven innovation phenomenon both to students and to manufacturers, which is no small feat.

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