

A SUPERB INDUSTRIAL DESIGN HAS SPECIAL FRs OR DPS THAT GO BEYOND THE CUSTOMER'S IMAGINATION

Masayuki Nakao

nakao@hnl.t.u-tokyo.ac.jp
Department of Engineering Synthesis,
Faculty of Engineering
The University of Tokyo
Hongo 7-3-1, Bunkyo-ku, Tokyo 113-8656, Japan

Satoshi Nakagawa

info@tripoddesign.com
tripod design Co., Ltd.
2nd Floor Sanbancho Annex, 1-4 Sanbancho,
Chiyoda-ku, Tokyo 102-0075, Japan

ABSTRACT

This paper reports our analysis of 475 products that have won the Japan Good Design Award (GDA). The results show that 20% of the award winning products included special FRs and DPS beyond the consumer's imagination. These products need to keep their special FRs and DPS free of interference with other general FRs to maintain their popularity for an extended period of time.

Keywords: design, axiomatic, industrial, aesthetic.

INTRODUCTION

Industrial design has hardly been a subject of engineering design research in Japan due to its aesthetic and ergonomic nature. When we, however, turn our attention to automobiles or cellular phones, we realize that the key factors for hit products in 2010 are their aesthetics and ease of use, not engine power or communication functions. The service function has also been left out of the realm of engineering research in Japan, but now is a subject of analysis by extending conventional engineering methodologies into service science. In such studies, functional requirements (FRs), for example, are called prior expectations, and are recommended to be listed, like with quality function deployment (QFD), in a mutually exclusive and collectively exhaustive (MECE) manner.

This study applies axiomatic design to analyze FRs and design parameters (DPS) for industrial design. In the field of industrial design, some say "Form follows the function so FRs are essential," while others say "Aesthetic forms give value to products and the fact that consumers buy them places more importance on DPS." So which is the more decisive factor: FR or DPS?

Our studies review the design process to extract FRs and DPS and analyze interference among the FRs.

When we carried out a preliminary study of products that stand out from an industrial design standpoint, hardly any had newly invented or discovered technology with either FRs or DPS. An example is SUICA which is the East Japan Railway Company's prepaid boarding card. The communication IC chip FeliCa used in it by SONY had been well known. The industrial designer in this case, came up with the clever DPS of having the card holders press SUICA against the green circle as they pass the ticket gate to satisfy the well known FRs of "have the passenger pay for the ticket," and

"avoid clogging up the ticket gate." SUICA now assumes the function of having the customer make payments for their purchases at some retail stores.

The power electronics and mechanisms with Toyota's hybrid car PRIUS had also been known. The key to the success in this case was the newly stated FR of "be kind to the environment" in response to the overall DPS that combined all of these functions. The industrial design team came up with the characteristic triangular body which contributed more to the sensing FR of "ideal from the ecological standpoint" rather than the engineering FR of "smaller aerodynamic resistance."

As we see above, fine industrial design produces superb DPS and FRs that last for an extended period by moving back and forth among different FRs and DPS. Are all good industrial designs characterized that way?

This paper analyzes successful industrial designs and extracts FRs and DPS from them to formulate a generic design methodology that proves useful for future product development.

ANALYSIS OF GOOD INDUSTRIAL DESIGN

1.1 ANALYZING GDA WINNING PRODUCTS

We picked out 475 general everyday products that won Good Design Awards (GDA) in Japan in 2008 and 2009. GDAs are presented to a variety of designs including buildings like train stations, theaters, or individual houses, industrial products like motors or printers, and even software, packages, and office equipment. Our analysis narrowed the scope to products in our daily life so the authors could easily understand the FR.

Figure 1 shows the analysis of the GDA winning products based on the authors' standards.

First, we decided whether the key process of the big sale was an FR or DPS. For example, the key for a table spoon that allows those handicapped with trepidation to hold it firmly is an FR, whereas a bamboo product with a traditional Japanese form owes the sale to the DPS. The results show that 39% of the products had FR key factors and 61% DPS. So the key to success for these products was about 50/50 for FRs and DPS. The strict count was 22% higher for DPS factors, but that owes to a large number of dinner table utensils and furniture. They mostly had the same FR with slight variations in forms and colors, contributing to the large number of winners with DPS key factors. If we had included buildings and packages which

are also aesthetic products, we would have added to the ratio of products with DP key factors.

In other words, product areas covered by designers with art degrees tend to show more DPs as the key factors. A significant number of products in the overall industrial design area, however, have FR key factors with creative concepts that lure consumers to use them. Those who graduated with engineering degrees, with maybe less artistic talent, still can work as industrial designers.

We next categorized the award winning products into those that produced excitement beyond the consumer's imagination and those with reassurance to expectation. The judgment of course was subjective, however, we checked the market evaluation of the former group on the Internet and they all had reputations of 4 stars or higher out of a possible 5 stars. The fact verified that the authors made reasonable evaluations. As for the results, 20% of all of the products produced excitement beyond imagination, and 15% (75% of the 20%) of them had FR key factors and the remaining 5% (25% of the 20%) DP. The lesser number of DPs is probably due to the authors being engineers that place more value on functions.

The remaining 80% of all of the products gave assurance to meet the customer's expectations. We looked at all of the award winning products to check if they were

improvements of existing products or not, and we found that many of them were improvements, like miniaturizing a cyclotron vacuum cleaner to 3kg so they suit small Japanese houses, or placing the same ornamental pattern on a saucer to a cup to make a set. GDA accepts product applications for the awards and judges if they meet the award standards, thus, the novelty of the product is not as important as it is with academic papers.

The later products with assurance to expectation are superior to other general products in terms of aesthetics or ease of use. Figure 1 shows the breakdown of the 80%: 24% modified shapes and colors of existing products like the above dinner table utensils or furniture for better aesthetics, 14% combined existing products like the above saucer and cup, 12% added special functions to conventional products like the above spoon for the handicapped, 12% improved FRs with conventional products without a specific common scenario, and 18% improved the DP.

All of these targeted longer or wider markets by implementing minor improvements to past popular products, however, they did not quite give unexpected excitement to the consumer. The internet, however, shows that these successors to past popular products have won 3 or more stars. These results suggest the effect of extending life or expanding the market of products by changing the appearance, making set arrangements, or specializing the FR. Customers that are aware of the product are satisfied with the brand image or assurance even when the changes are minor.

For our study, however, we excluded such products with minor changes and the following sections will concentrate on the 20% with excitement beyond imagination.

1.2 ANALYZING PRODUCTS WITH EXCITEMENT BEYOND IMAGINATION

Figure 2 shows the well-known products that people in town talked about, from the 20% that the authors judged to have produced excitement beyond imagination. The figure shows: an asymmetric umbrella that stands the severest typhoon, a motor driven horseback riding fitness machine, a lure fishing bait that produces an insect sound, a swimsuit with small water resistance from ultrasonic sewing, tissue paper free of bleach, a spatula that allows turning food from any direction, an LED light bulb that lasts 10 years, a rotary cultivator that runs with fuel from a gas cartridge for portable gas stoves, plastic soft drink bottles that crush with minimal force, a rice cooker free of steam to avoid burn injuries, closet doors that do not jam fingers, silicon lids for plastic soft drink bottles that open when bitten, a sunshade with fractal shape, a fire extinguisher that uses only edible material, and crime-preventing wall spikes made of aluminum instead of glass.

The last three items had no change in FRs compared to conventional products, thus we categorized them to cases that gave excitement with new DPs (5% in Figure 1). The remaining 12 cases produced excitement with new FRs (15% in Figure 1). For example, the asymmetric wing-like umbrella SENZ from Holland is not fashionable by itself, however, it proves to be functional in storms. The next horseback riding fitness machine has a complex mechanism that will only attract an engineer, however, ordinary users are excited at the fitness effect by training their muscles in the stomach and legs.

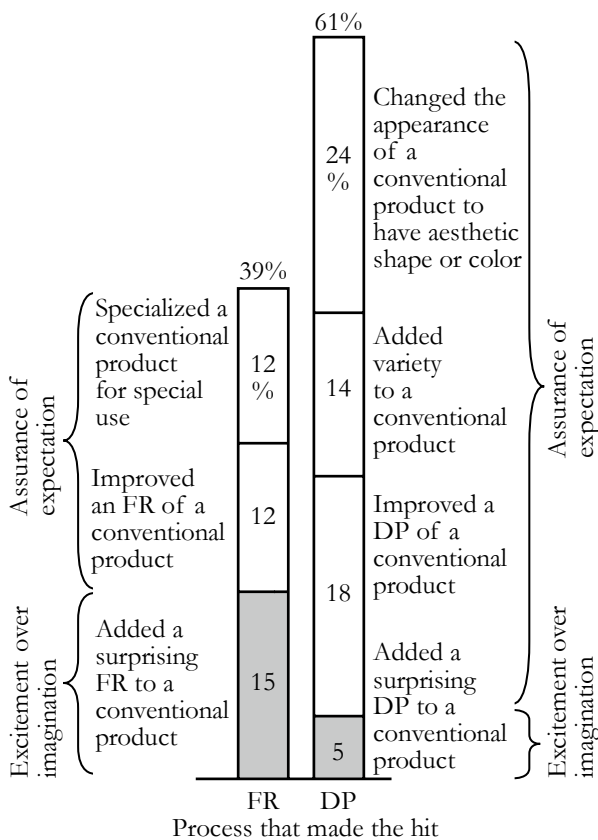
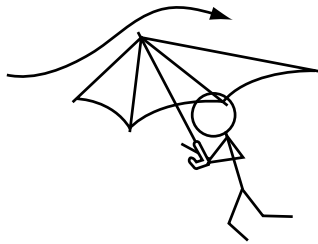
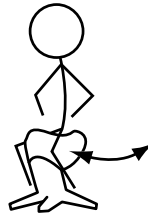


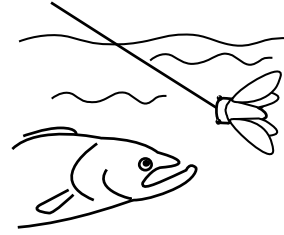
Figure 1. Categories of superb industrial designs.
Source: Analysis of 475 daily life products with GDA (2008 and 2009)



Asymmetric umbrella that stands a typhoon



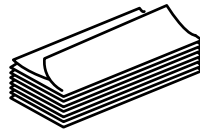
Motor driven horseback riding fitness machine



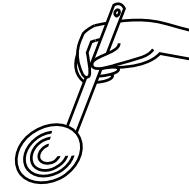
Lure fishing bait that produces insect sound



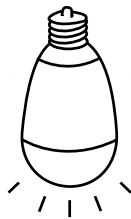
Swimsuit with small water resistance from ultrasonic sewing



Tissue paper free of bleach



Spatula that allows turning food from any direction



LED light bulb that lasts 10 years



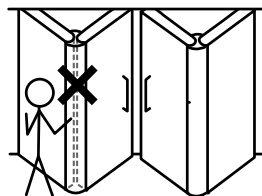
Rotary cultivator that runs with fuel from a gas cartridge for portable gas stoves



Plastic soft drink bottles that crushes with minimal force



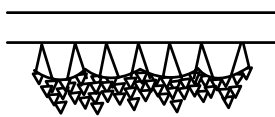
Rice cooker free of steam to avoid burn injuries



Closet doors that do not jam fingers



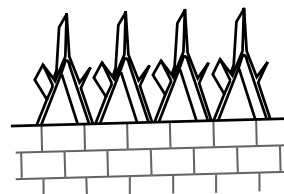
Silicon lid for plastic soft drink bottles that open when bitten



Sunshade with fractal shape



Fire extinguisher that uses only edible material



Crime-preventing wall spikes made of aluminum instead of glass

Figure 2. GDA products with excitement over imagination.

1.3 ANALYZING THE MIND PROCESS OF DESIGNERS WITH SUCCESSFUL INDUSTRIAL DESIGNS

We next analyzed an article by an industrial designer to gain quantitative evaluation from another source. The article “Brand Improvement Committee” was a serial in NIKKEI DESIGN (Nikkei BP, since 1987), and it analyzed products through questionnaires of products. We picked out 34 products from the articles.

The results showed that when fun, novelty, or beauty exceeds the customer imagination from experience, the products produce excitement. And to really produce great excitement the product improvement should step inside the hazardous region that may raise concerns over anxiety to the consumer. Like in Figure 3, when we venture out from the stability region to go over the mind block, we may experience some agitation, however, a new world with excitement, surprise and fun lies ahead.

Figure 4 shows further analysis with products that reached this new world. For example, beer cans traditionally were colored with the beer color gold or yellow, the foam color white, or the hop color green. When they used a blue

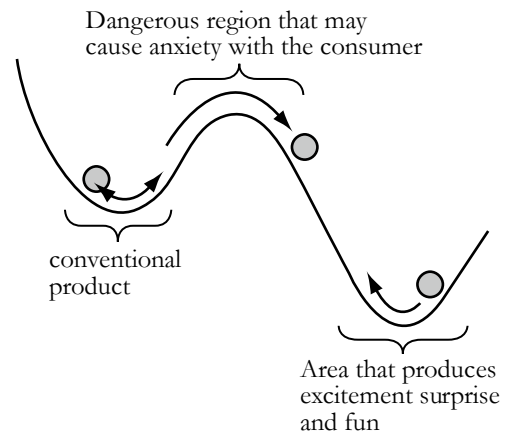


Figure 3. Stepping into the dangerous region with anxiety which produces excitement, surprise and fun.

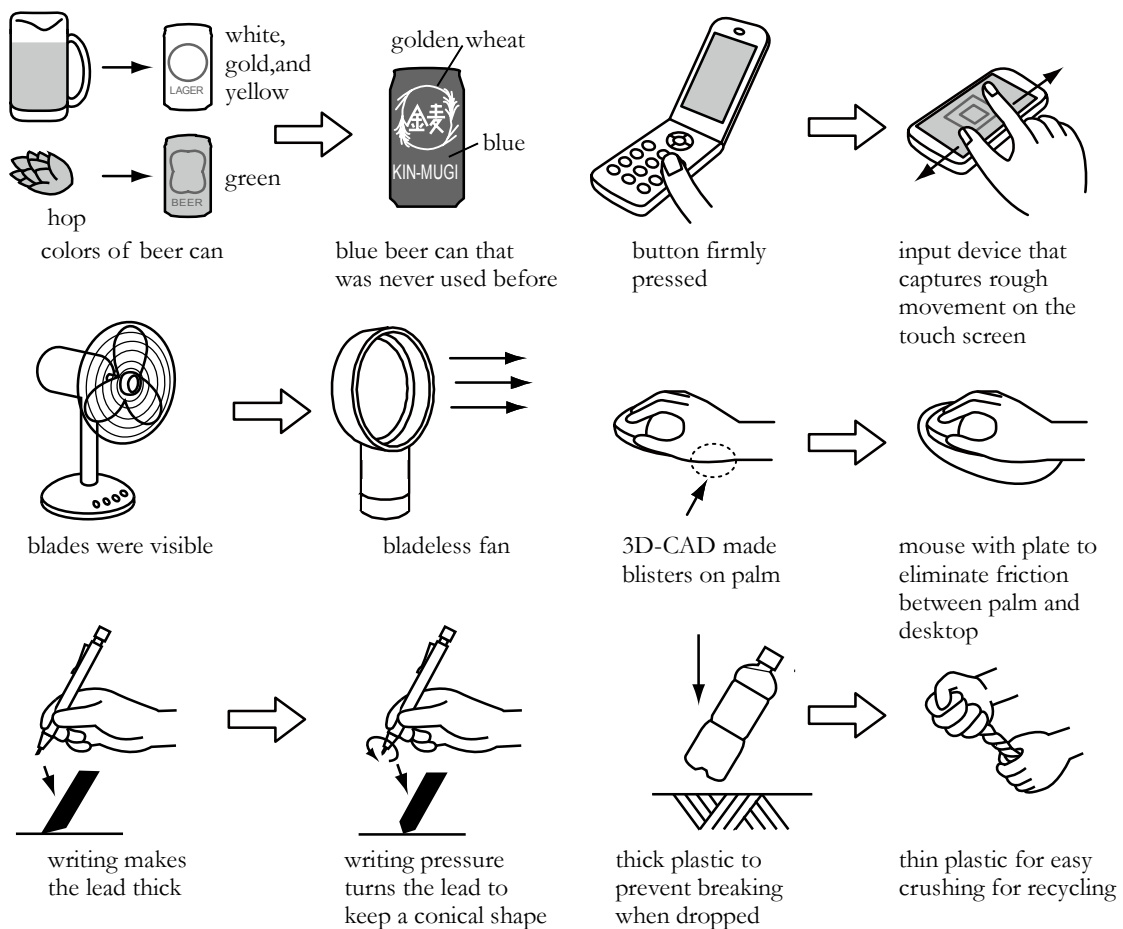


Figure 4. Producing excitement in the area beyond customer imagination from experience.

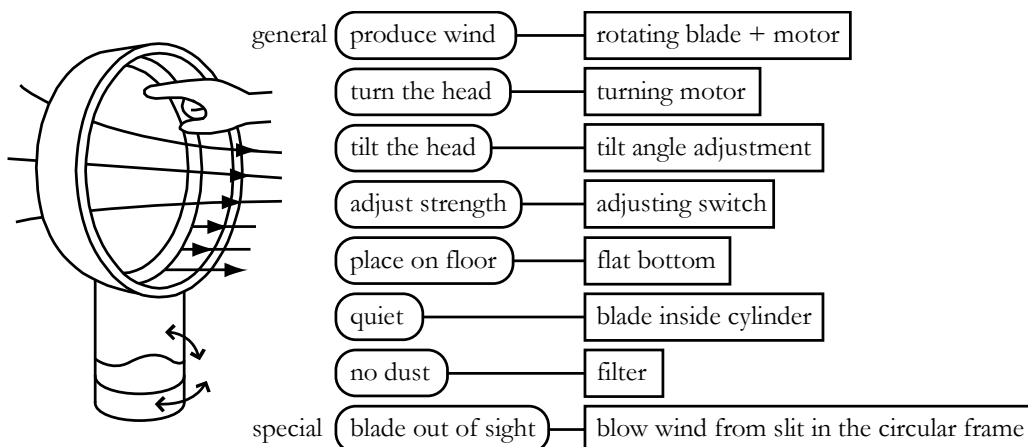


Figure 5. Hit products with special FR that produced excitement over imagination.

color that was never used before, it stood out in the market floor and turned out to be a big hit (Kinmugi). Blue is not popular in the Japanese food industry as it is perceived to be a color that causes loss of appetite. 300 people answered the questionnaire of what color combination suggests “good taste of wheat with rich flavor” and 53% of them answered gold letters on blue, 31% gold on red, 9% blue on yellow, and 7% black on white. Maybe the gold had a complementing effect on the blue.

Cellular phone users would want to precisely press images on the touch panel, however, capturing rough finger movements on the panel led to the big hit of a new phone (iPhone). Only 16% out of the 300 answered that they must have a keyboard. Everybody knows that an electrical fan has blades and a surprising one without any (bladeless fan) made a big hit. A female 3D-CAD operator had troubles with blisters on her palm. She experienced a great relief when a new mouse with a thin plate attached on it hit the market to eliminate friction between her hand and the desktop (Expert Mouse). Mechanical pencils target low writing pressure to keep the tip sharp, but a new model with high writing pressure uses the pressure to rotate the lead to keep the tip in a conical shape (Kurutoga, means turn and keep sharp). Plastic soft drink bottles should have enough strength not to break when dropped but a new one with a thin skin realized a bottle that is easy to crush for recycling (Irohasu).

All of these products produced expectations beyond the consumer imagination and made big hits. Such excitement, however, does not last very long. To keep a long life for such a product, the design most likely has to shift towards reassurance of expectation.

We explained that a product to make a big hit requires a special FR that produces excitement, and in addition, we found that this special FR must not interfere with other general FRs. Let’s take the above bladeless fan as an example. In fact, the blades exist inside the cylinder at the bottom, as Figure 5 shows, to meet the functional requirement of “generate wind”. All other functions required for fans are also

in place; “Turn the head,” “Tilt the head,” “Vary the wind strength,” “Place on floor,” “Quiet sound,” and “Do not blow dust.” The special functional requirement to “Keep the blades hidden” was added to the list and did not interfere with any of the other general functional requirements. If it did, it would have not made it to the market.

Figure 6 shows cases that did not sell as expected because the special FR interfered with a general FR. For example, a spherical TV remote control is interesting aesthetically, however, it lost its market attraction for interfering with the functional requirement of emitting infrared rays towards the TV without looking at the remote. A flat plastic soft drink bottle that is easy to place inside a small handbag (Karadameguricha, means tea that runs around your body) was popular among female consumers. However, the shape prevented it from easily falling inside a vending machine which interfered with the functional requirement of making sales with a vending machine. A folding umbrella that opens and closes with a touch of a button was really convenient, however, its weight interfered with the functional requirement of portability and people stopped using them. A new phone targeted at the elderly with a minimum set of functions and buttons (Rakuraku-phone, meaning easy-to-use phone) hit the market, however, the user always had to answer the confirmation command and its operation time took longer so consumers shied away from it.

As we have seen, no matter how attractive the new special functional requirement is, if it interferes with other functional requirements, the consumer will not use it for an extended time, making the life of the product extremely short. This is what axiomatic design states in its independence axiom which also applies to industrial design.

3. DESIGN METHODOLOGY TO PRODUCE SUPERB INDUSTRIAL DESIGN.

From our analyses, we reached the following design methodology to produce superb industrial design.

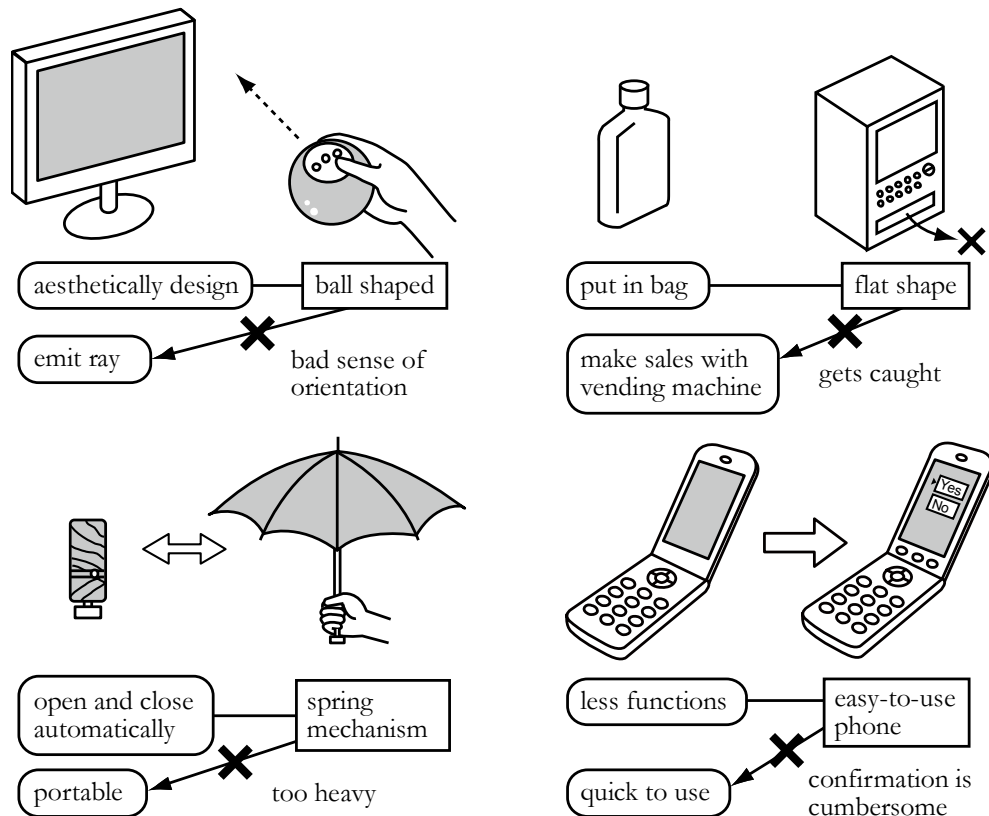


Figure 6. Special function aimed for the hit interfered with a general FR.

- (1) Extract general FRs and DPs from conventional products.
- (2) Jump over the mind block that were thought natural for these FRs and DPs to reach a special FR or DP that will produce excitement beyond the consumer's imagination.
- (3) Confirm that the special FR or DP does not interfere with general FRs.
- (4) When the special FR or DP becomes less exciting over time, implement minor changes to the product, for example change its shape or color, combine it with other products to make a set, or specialize the product to a narrowly targeted functional requirement.

Among these steps, the second one to come up with an FR or DP to produce new value is not an easy task for everyone. We have to, however, jump out of the conventional inertia if we want to produce something new.

4. CONCLUSION

Our report qualitatively analyzed industrial design by applying axiomatic design. We found that a superb industrial design has an FR or DP that goes beyond the consumer imagination, the FR or DP does not interfere with other general FRs of the product, and to make a big hit, the designer has to search in the area avoided with conventional design by jumping over the conventional FRs and DPs.