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EXTROVERTED, NON-VERBAL, AND PSEUDO-DISCOMFORTING STIMULATORS FOR RECOGNIZING DESIGN TARGETS

Masayuki Nakao
nakao@hnl.t.u-tokyo.ac.jp
Department of Engineering Synthesis
School 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

Kenji Iino
kiino@sydrose.com
SYDROSE LP
475N. 1st St., San Jose, CA, 95112, USA

ABSTRACT

This paper proposes a method for recognizing design targets. We looked into the origin of the design process and found that stimulating the designer to feel discomforts can help the designer identify design targets. In other words, we propose extroverted (to receive stimulation from the external surroundings), non-verbal (not expressed with words), and pseudo-discomforting (to give the designer anxiety) stimulators (to make the designer excite internally) for recognizing design targets, and we confirmed the effect through design education and product design.

Keywords: Decision making, Innovation management, Product development.

1 INTRODUCTION: THE PROCESS OF HUNTING FOR DESIGN TARGETS

In the modern world, up to 2014, designers spend much time in identifying the design target [Lu and Liu, 2012], i.e., “what to design” in the beginning of a design project. Before this time, the design target was usually given to the engineer. As Suh explained, for example, in the thinking process of Axiomatic Design [Suh, 2001; Thompson, 2013], shown in the right side of Figure 1 (a), the engineer analyzes the given design target to find the followings; the customer’s needs at first, and the detailed functional requirements of “what to do” in the functional domain, the design parameters of “how to make,” and finally the process variables in the physical domain. And when a problem happens, the engineer goes back to the left side of the functional requirement or the design target with a kind of inspiration of “why not?”.

The thinking process in this paper, however, is at the origin of the whole process shown at the left in the figure. This upstream process is the engineer’s act of hunting the design target of “what to design”. In other words, it is that of finding what the “big-bang” is to start the design

n thinking process in the emotional domain. This paper looks a “beyond design basis” against Axiomatic Design for engineers. But according to the authors’ experience to teach young students, it is only a “piggy back” of the conventional design methods; namely, one of the extensional business applications in the all thinking structure of Axiomatic Design. Without the overall engineering knowledge of physics, chemistry, production technologies, and the conventional Axiomatic Design, any engineering products cannot be designed as explained later in the discussion of Chapter 5 of this paper.

The next example illustrates our proposal. Conventionally, as the right side of Figure 1 (b) shows, the design target is given in the defined form of a functional requirement, e.g., “rescue a physically handicapped person from the emergency stairs in case of an earthquake or fire.” The planner implied to the engineer a solution “evacuation chair” as a design parameter that is well accepted in the market. And then the engineer starts his task of designing a physical improvement. Recently, however, the boundary between the engineer and planner is fading out. The task given to the engineer is more abstract and comprehensive, e.g., “design a building tender to the physically impaired.” An engineer full of the engineering mind, cannot imagine such tender buildings. Finally, he or she fails to find the design target like evacuating chair, voice guide or smart cane.

The authors, in an effort to bring such ideas to the engineers’ minds, stimulated their brains in a manner not tried before. For example, as shown in the figure, we blindfolded half of the students so they can experience the anxiety of the vision impaired during evacuation. The other half, of course, guided the blindfolded partners for safety. Such discomforts that students would not experience in the normal course of school life stimulate their minds, and function as the driving force for developing design targets. Of course, candidates for a design target may be easily found on the Internet with logical and detail structures. In the case of such a product design, however, they often end up being the subject of patent infringement lawsuits. Or moreover, products that the human mind imagines without any experience are often blocked by unforeseen constraints. For example, the largest limitation with evacuation chair is its storage when not in emergency use. Caretakers often end up putting them in the back of the storage area if they cannot be folded up in a compact size.

In the 21st century, many companies started to give abstract and comprehensive assignments to engineers. The reasons are sudden changes in the market caused by dramatic shifts in the customer taste, M&A of companies, or catastrophic natural disasters. Under such circumstances, that the market may suddenly change, manufacturers are always after new design targets as part of their strategies. Through

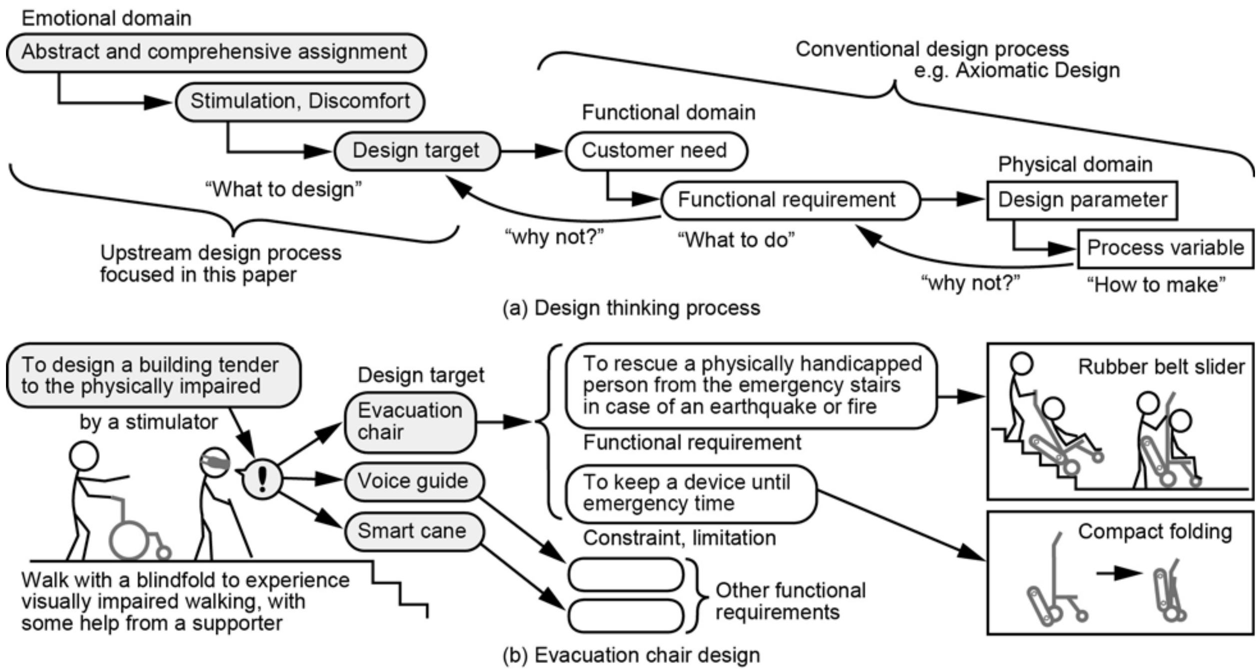

Figure 1. Upstream design process of hunting design targets.

our experience in education, however, the authors have found that new design targets are hard to recognize with conventional methods such as brain storming, market research, or portfolio analysis. The reason is, in many cases, collecting members that grew up in the same educational system and have spent lives in the same culture. It result in a homogeneous "same old same old" thinking pattern, and could only come up with ideas that are merely slight modifications over past products.

This trend led us to hire instructors who were industrial designers or art oriented creators. Such non-engineering minds trust their own emotions, feel inconvenience, pleasure, and discomforts that engineers would not even recognize. People with art-oriented work value emotional discomforts outside one's knowledge. In contrast, the engineer would search through past knowledge, apply standards, and aim for logically reliable designs. The mindsets are completely different.

In recent years of engineering, we started to study the originating process of design. Liefer in the d.school at Stanford University teaches the first steps in conceptual design to engineers [Liefer, 1998; Institute of Design at Stanford, 2011]. The school describes the design process with the 5 steps of empathize, define, ideate, prototype, and test. For the very first step of "empathize", the school lists the methods to observe (watch the user and his reactions), engage (communicate with the user through an interview), and immerse (experience for yourself). Looking at the design cases, however, this education is only effective after the design target has been set and the main user is known.

Riel et al. called this initial process the fuzzy-front-end and derived the success factors from manufacturing literature review and expert interviews [Riel et al., 2013]. They claimed that success factors for ideation, for example, are involvement of top management, defined focus, stakeholders networks, resources with high creativity and entrepreneurship, and organizational orientation. These factors are clearly effective for fast corporate product development once the design target has been set, however, the study does not address if they are important in the originating process of finding the design target.

The authors studied the design motivation for products that had won the Good Design Award and found that 67% of the designs originated from negative discomforts of "hard to use," "dirty," or "cumbersome," and 33% from positive feeling of "beauty", "health," or "ecology" [Nakao, 2012]. That is to say the artists find design targets from such weak stimulation to their bodies like discomfort. Engineering education, on the other hand, does not systematically describe which stimulator can arouse such recognition for the designer.

The rest of this paper has the following chapters; Chapter 2 proposes three methods for engineers to improve their skills in recognizing design targets, namely extroverted, non-verbal, and pseudo-discomforting stimulators, Chapter 3 shows case study results of our education in our university and Chapter 4 the results with industrial product design.

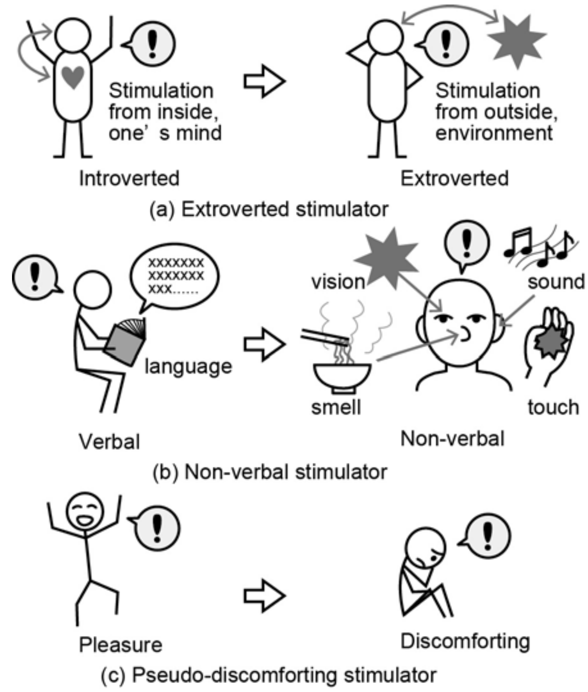

Figure 2. Effective stimulators in hunting design targets.

2 PROPOSAL: EXTROVERTED, NON-VERBAL, AND PSEUDO-DISCOMFORTING STIMULATORS

This chapter proposes three stimulators so engineers can feel the sensation to better recognize design targets as shown in Figure 2.

(1) Extroverted stimulator: We call this method "extroverted" because the origin is in the outside environment which stimulates the brain to generate sparks to recognize design targets. The most effective extroverted stimulator is to travel around in foreign countries to receive influence from different cultures. Many of us have the experience of an exciting walk in a foreign country where we find everything new and different. Introverted stimulator, on the other hand, hardly raises discomforts in the mind, except for maybe highly trained artists, because its origin is within one's mind. Stimulations that originate from the inside are usually dull because our emotions are so used to them.

(2) Non-verbal stimulator: Engineers go through a thorough education to verbalize concepts and think logically. Artists, on the other hand, value such non-verbal qualities like sound, color, shape, sent, and touch that directly affect human minds. Non-verbal stimulator takes advantage of such non-verbal qualities. A sketch, illustration, photograph, or rhythm can directly stand for general concepts that describe the stimulation. If the target product is a piece of art, the design solution can stay non-verbal; however, in case of an industrial product, the design target has to be described verbally in detail, so others can produce it on the factory floor.

(3) Pseudo-discomforting stimulator: Placing an engineer in an artificial situation that he feels anxiety, and forcing him to find his way out, or move on within the awkward state often enlightens him to find a design target. It is probably due to the human nature that never gives up and always strives to move upwards. Placing him in a happy situation may have the same effect, however, most people would feel their hearts fulfilled and would no longer seek for discomforts.

3 EDUCATIONAL RESULTS OF STIMULATORS

This chapter reports our results of actually applying stimulator in machine design lectures. The tasks that we gave to student were, unlike making minor improvement on existing products, targeted at developing new major advancement in arbitrary product fields, e.g., "to design a new transportation to ease your commute," or "design a system so elderly can enjoy meals." As shown in Figure 1(b), the customer, in most cases, lays out some constraints in the assignment like "tender to the physically impaired". Without such constraints, like a project to "design a city that keeps every member happy" would be too broad and the engineer's brain would just keep turning without anywhere to land. It is the role of top management to confine the target within an appropriate range.

(1) Extroverted stimulator: The previous chapter discussed the effect of having an engineer first experience life in a foreign country. Through our classes, we found that similar effects can be obtained by forcing the class into situations that are first experiences for them.

For example, we blindfolded the student so they can experience blindness while trying to make their ways through and around buildings as mentioned in Figure 1[b]. All five groups in the class found Braille blocks along the aisles were insufficient and they wanted more directions about what was in which way and where there was a door to a classroom. Two out of the five groups reached the design target of notifying the vision impaired with voices activated by signals from their canes about orientations and which classroom they were in front of. This simulating exercise to feel the anxiety from blindness was also an application of pseudo-discomforting stimulator.

Another example was to simulate an elderly when he tries to have a meal. We had the students put thick gloves on and take a meal. All of the students found difficulty handling thin chopsticks, and wanted spoons with thick handles and plates that stay in place even when they were pushed by the spoon.

(2) Non-verbal stimulator: For our hands-on sessions, we had the students express their ideas and thoughts with sketches and photographs. These exercises lower the psychological block the students have about hunting for design targets.

Two of the authors Nakao and Iino offered a design class to about 30 graduate students. The first assignments were to take five photographs of subjects the students felt discomfort with to present to the class. The authors were more intrigued by the findings photographs of the foreign students, probably because the homework had them experience the extroverted stimulator. They presented some discomforts; e.g., many Japanese people wearing surgical masks in the winter, or sliding and pivoting doors having the same handles in our

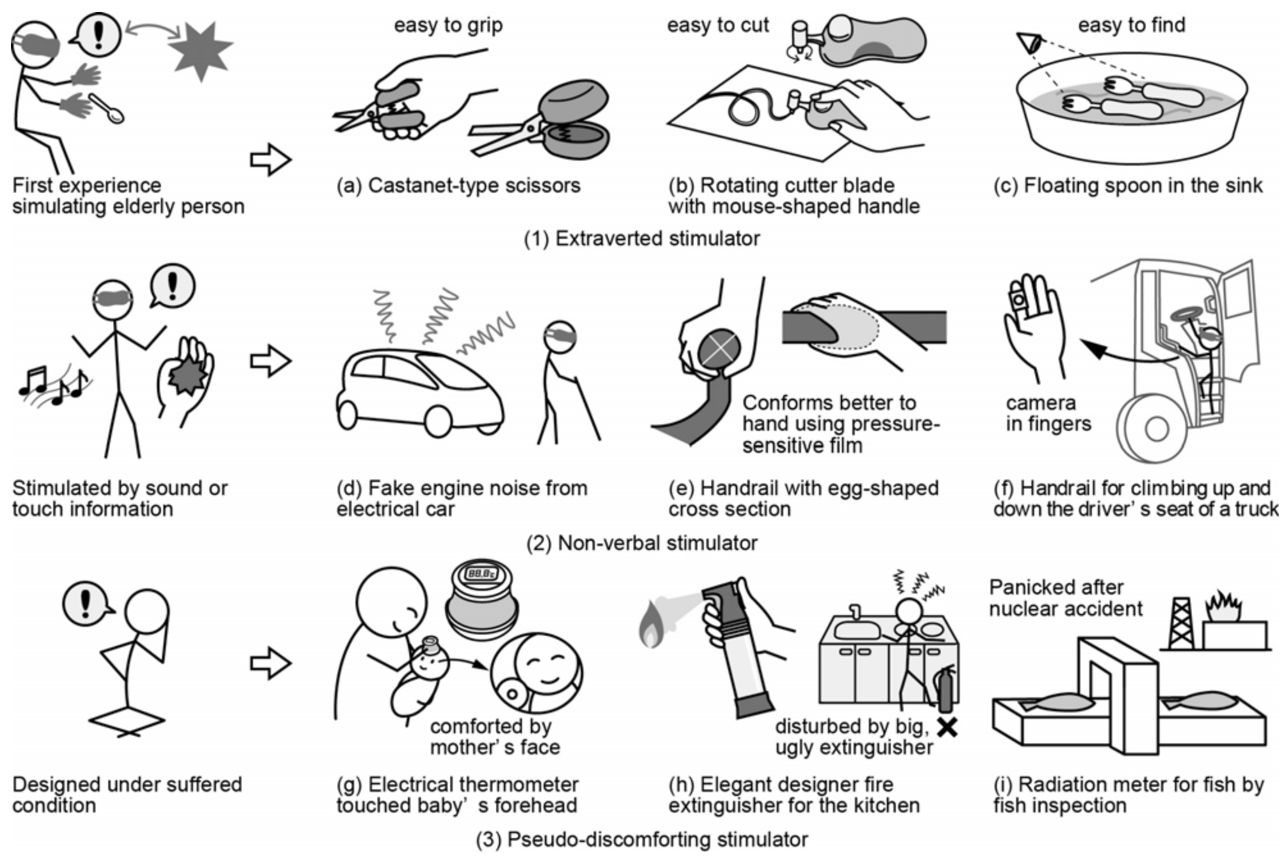

Figure 3. Designed products used by the processed stimulator.

university. When told, natives would also feel the same awkwardness; however, we probably have gotten used to the discomfort and not even recognize them. We then had the students analyze their discomforts to come up with design targets. Some prototyped a transparent surgical mask saying that the awkwardness came from hiding most of the face, and others designed different door handles for different type actions; flat plate when to push, easy to grab handles when to pull, and vertical handles when to slide.

Most Japanese students, in contrast, found discomfort in subjects from their state of mind at the time, e.g., flowers on the sidewalk when heartbroken, or red traffic-light when late to an appointment. These subjects were largely affected by the observer's state of mind at the time, and were hard to explain to others, thus, mostly inappropriate as design targets.

One of the authors Nakagawa was in charge of a 30-student freshman class. He demonstrated that even engineers could brush up their five senses. For example he had students sniff a flagrance and express it with color, had them listen to music and shape it with wire bending art, had them form the feeling of superiority or envy with clay, and sketch the transition of time with lamp shades. At the end of this course, the students found themselves, equipped with keener sensitivity; e.g., some noted discomfort with too many power cables that blocked the sky view, or annoying echoing sound in the student cafeteria. It would have been ideal if they could set the design targets of running the cables underground or installing sound absorbing walls in the cafeteria, however, we also found that, without the basics of engineering, the students' thinking process stopped upon only finding the problems.

(3) Pseudo-discomforting stimulator: Since the 2011 Great East Japan Earthquake, it is now realistic to assume circumstances that will give us strong anxiety, e.g., "what action can we take in case Mt. Fuji erupts," or "how can we survive a direct earthquake in Tokyo" and hunt for design targets that will ease our minds. With such natural disasters in mind, we assigned a project to "design a system so we can survive a week of power outage." All the students remembered what happened at the time of the great earthquake and realized that, with the power outage, they could lose water supply, gas, traffic lights, or ways of remote communication. Almost half of the 130 students of a junior class, listed design targets: e.g., installing solar battery panels on residence housing, or designing a private vehicle mounted communication systems.

4 DESIGN RESULTS OF STIMULATORS

This chapter shows industrial design results by one of the authors Nakagawa. Figure 3 shows some samples after applying stimulators discussed in Chapter 2.

(1) Extroverted stimulator: Nakagawa simulated an elderly life as described above for an extended time and produced (a) castanet-type scissors that do not require sticking fingers in

the holes, and (b) a paper cutting knife with a rotating blade and a computer-mouse-like body to hold so the user can just trace curves to make cuts, and (c) floating silverware so you do not have to search for sunken knives and forks inside the sink with elderly weak vision during dishwashing.

(2) Non-verbal stimulator: Electrical vehicles are quieter than gas-engine ones and pedestrians, without noticing their approaches, get hit by them more frequently. We tested if blindfolded pedestrians, relying more on audible sound in the surroundings, would recognize (d) fake engine noise. We found the negative side effect that the monotonous sound makes the driver sleepy. To prevent elderly from dropping from stairs, we designed (e) a handrail with egg-shaped cross sections. An engineer pasted pressure-sensitive film on gloves to find the feel of contact to design gloves with bigger contact area. Next, drivers of large trucks sometimes fall from the high driver's seat when they try to climb up to it. We experimented with a test driver with eye-masks and camera on their fingers to check where or how to grab something, and found that he tried to hold the steering wheel as a handle for climbing to the driver's seat. We then produced (f) a steering wheel/handrail for climbing up and down the driver's seat of a truck.

(3) Pseudo-discomforting stimulator: When a baby is crying, it is hard to measure its temperature. We cannot ask a baby what the matter is, so we put a camera in a baby figure to find how the mother's face eased the baby's mind. Our study led to producing (g) an electrical thermometer that takes measurement within 1 second with the mother holding her hand against the baby's forehead. We spent time in an experimental setting with the anxiety of having to extinguish a kitchen fire. We then, like the aforementioned evacuation chair, found discomfort at times when the tool was not in use. Consumers would want to get rid of products that were hard to store, and we produced [h] an elegant designer fire extinguisher that looked nice in the kitchen. Next one is a realistic anxiety; we helped a fisherman town suffering from the threat of radioactivity after the Great East Japan Earthquake for (i) a 100% radiation inspection of captured fish without damaging them. After setting this design target, we found a high sensitive radiation sensor for breast cancer and were able to push the development into a product.

5 DISCUSSION

We applied three stimulators in classroom assignments and confirmed these stimulations enhance the sensitivity of all students against discomforts. Some students, however, still weak with their engineering background, could not extract design targets from their experiences and we could not reach quantitative conclusions. For examples, in the evacuation project of Figure 1, some non-engineering students introduced a parachuting "umbrella" for jumping from the window, or a flying "carpet" to slide even on the stair. They were interesting, but some mere imaginary tools in a cartoon without any concrete designs for material, power or control. Our stimulators cannot improve their ability for the product design without any engineering knowledge.

We also found that these stimulators are more powerful for experts. For example, young researchers often struggle with the search of "what to research" to win grants. The most effective trigger in such searches is extroverted stimulator of visiting overseas research labs or researchers in different fields and have discussions. Other effective sparks include non-verbal stimulator of looking for discomforts in sound, heat, color, or flow when watching experiments, and pseudo-discomforting stimulator of trying a challenging project like aiming at 10 times better results.

6 CONCLUSION

Three types of stimulator, namely, extroverted, non-verbal, and pseudo-discomforting mildly stimulate the engineer and help him at the very origin of the design process, i.e., hunting for a design target. Successful applications have been demonstrated with university courses and product development.

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