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# Designing products and safety based on knowledge of human characteristics

## Pursuing ideal conditions for humans through engineering

The human palm is generally about 17 to 19 cm in size, and this has been made the standard for deciding smartphone sizes. In addition to physical size, there are many other characteristics that are common to humans in the physiological, cognitive, and psychological aspects. Nakanishi researches how to apply these human characteristics when creating products and services, managing safety, etc., from an engineering perspective and makes outstanding proposals to the real world.

### UX (user experience) sought by products and services

Human factors is an academic field that attempts to deeply understand the physiological, cognitive, and psychological aspects of human characteristics shared among people to propose better designs for tangible and intangible products. There are two main research themes at Nakanishi's laboratory: "UX," which supports lifestyle, and "safety management."

One important keyword when creating products and services is UX (user experience). "In the past, functional aspects such as "functioning properly without errors, achieving the objective faster, etc., were desirable as key values, but as a result of all manufacturers

pursuing these values, it has become harder to differentiate products and services from this perspective. Today, it can be said that there is a need to realize various experiences for the user (UX), such as a sense of accomplishment or psychological adaptation," says Nakanishi (figure 1).

One factor of UX is "attachment." Nakanishi says that "products with attachment bring joy and richness to our lives." In fact, car and consumer electronics manufacturers are striving to create brands that are loved. So, how can products that foster attachment be created?

### The science of "attachment"

Nakanishi has been attempting to understand the psychology of "attachment to products" and root these into products. The first thing she did was to construct a measure to quantify "attachment." Examining the physiological responses of people when they look at objects to which they have strong attachments, she statistically confirmed that the concentration of oxyhemoglobin in specific brain regions increases and the finger plethysmogram (volume fluctuations in fingertip blood vessels)

amplitude becomes smoother.

The British psychologist John Bowlby's "attachment theory" was adopted as a guide to understand the psychology behind attachment. According to this theory, attachment has 4 functions characterized by "proximity maintenance," "safe haven," "separation distress," and "secure base." By supplying these 4 functions in a well-balanced manner, the formation of attachment can be prompted (figure 2).

Taking an ordinary "eraser" as a test object, Nakanishi carried out an experiment, considering interactions with the user to prompt these 4 functions. Specifically, procedures were put in place so that messages such as "nice to meet you" or "please write your name" were sent from the eraser to the user through a smartphone app.

When changes in the cerebral blood volume and finger plethysmogram were measured between the group that used and didn't use the app 30 days, 60 days, and 90 days after the start of the experiment, it was found that the group using the app had a greater attachment to the eraser. The outcomes of this research are being put into practical use through joint research on "speaking home appliances" with a company.

### Thinking of ways for things to "go well" in safety management

Using human characteristics in this way is also useful in safety management. For example, safety in aviation greatly depends on the responses of the flight and ground crews in addition to the performance of the aircraft. "The current trend in safety management research is to clarify how humans should behave for a complete system to function well and what the conditions for this are," says Nakanishi.

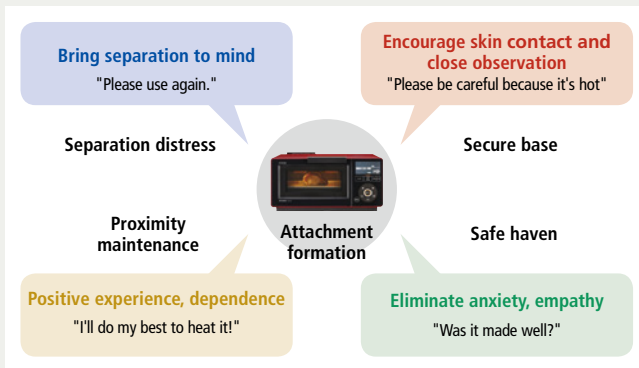
When working in a high-risk situation, it is difficult to make judgements on site. Although "safety first" is specified in manuals, upon what, for example, should rescue workers at a scene of a fire base their judgement on whether or not they should run into a fire to save lives, and if they do, how great the risk will be to their own lives?

"People whose job involves saving lives

Peaceful experiences	01. Having abundance
	02. Feeling at ease
	03. Reliable
	04. Nostalgic
Connective experiences	05. Helping someone
	06. Understanding each other
	07. Feeling attachment
Self-fulfillment experiences	08. Achieve a sense of accomplishment
	09. Enhancing of abilities
	10. Feeling of superiority
	11. Trustworthy
	12. Do as one wants
Caring experiences	13. Physically comfortable
	14. Get a taste of luxury
	15. Attentive
Feel right experiences	16. Just right
	17. Good
	18. Beautiful
Mood-lifting experiences	19. Having expectations
	20. Be overcome with laughter
Special and limited experiences	21. Fresh
	22. Original
	23. Beneficial
	24. Own

Fig.1 24 types of UX (user experiences)

Surveying 2556 ordinary users about valuable experiences they gained through life with home appliances, it was found that they could be classified into 24 UX types. Similarly, a survey of 616 ordinary users on valuable experiences they gained through life with a car found types of UX that were almost the same. It is therefore thought that UX in people's daily lives can in general be explained universally through these UX categories. Based on the design factors of home appliances and cars, in this research, an evaluation method to calculate the probability of each UX being created was established, and these are being shared with home appliance manufacturers and manufacturers in the automotive industry.



**Fig.2 Attachment theory in practice**

Through an attachment formation strategy with the "4 functions of attachment" as axes, products that can provide psychological value to users over a long period of time are proposed. Example: This is used in the audio guide built into a microwave grill (RG-HS1) manufactured by Mitsubishi Electric Corporation.

becomes greater than 6, switching to resilience mode increases the chances of success (figure 3). This means that when a situation is about 6 times worse than normal, better outcomes can be attained by acting resiliently as the circumstances dictate rather than by following steps as outlined in the manual.

### Human characteristics are universal

What motivated Nakanishi to engage in this research was a comment that was voiced at a site, saying "things don't necessarily go well just because you follow the instructions in the manual, but resilient judgements are also difficult to make." At sites where failure is unacceptable, there is a great deal of pressure on taking actions for which judgments have been intentionally made that are not in accordance with the manual in the hope of reaching a successful outcome. "I don't think that we can quantitatively understand everything, but resilience is a human characteristic, and I believe that we can make suggestions to a certain standard. The reason for this is because, on the whole, human characteristics should be universal," says Nakanishi. This outcome, which will be presented soon in a paper, will support judgements made on sites, and furthermore, will contribute to management functions at organizations.

From enriching our everyday lives to supporting social systems, human factors is expected to make various contributions to society.

(Interview and text writer: Yuko Hiratsuka)

do not work just thinking about safety. In their work, there is a trade-off between efficiency and thoroughness. I think 'safety first' means ultimately being able to choose safety without hesitation in these tight and difficult situations."

For this, she says that it is necessary to not only consider "accident prevention" to eliminate failures, but also to investigate how things should be done such that things go well (and safely), and carry out studies with the goal of increasing such cases. "If safety is secured by restricting your actions, then not flying or not rescuing people when fires break out would be the safest course of action. To keep this from happening, I want to study how things should be done for them to go well and through this, support those working on site."

### Indicating the time to go beyond the instructions "outlined in the manual"

At the worksite, people acting in accordance with a set procedure (manual) is a basic premise. However, when a situation that cannot be dealt with in accordance with a manual arises, flexibility (resiliency) is required to make judgements. At what point should you switch from following the manual (manual mode) to making your own judgement (resilience mode) to ensure

a high probability of success? Can a scientific approach be taken to reproduce the ability to make these judgements, nurtured through experience gained and intuition developed on site?

Taking a fire scene as an example, Nakanishi carried out simulation experiments. By making various changes to the wind speed, wind direction, and firefighting resources (water, fire trucks, equipment, personnel), different situations were created. As the fire progressed and the situation worsened in these simulations, she noted the point at which the subjects switched from manual mode to resilience mode to extinguish the fire, and whether they were successful or not.

Taking the area a fire spreads in 30 seconds under conditions of calm winds and sufficient firefighting resources as 1, how bad a situation is when conditions change (situation variability index) can be expressed in terms of how many times greater the area in which the fire spreads is in the same span of 30 seconds. From the results of this experiment, it was found that when the situation variability index

**Fig.3 Simulation experiment to observe human decision-making by modelling fire scenes**

- ① It is fundamental to follow the manual under standard conditions.
  - ② Acting in accordance with the manual gives satisfactory results.
  - ③ When the situation is 6 times worse than standard conditions, a resilient response that is not in the manual will increase the success rate.
  - ④ When the situation is about 15 times worse than the standard condition, success will be difficult whether the manual or resilient response is adopted.
- A When the wind is calm (3m/s or less) and sufficient firefighting resources are available during initial firefighting.
  - B When the spread of fire grows, winds become stronger (7 m/s on average), and fire trucks are delayed due to heavy traffic.
  - C When the spread of fire grows even more, winds become stronger (11 m/s on average), and fire trucks and equipment have been depleted.

