Title	An anatomy of shikakes
Author(s)	Yamamoto, Yasuhiro; Nakakoji, Kumiyo; Kawashima, Toshio; Kimura, Ken-ichi; Koike, Yasuharu
Citation	AI & SOCIETY (2015), 30(4): 431-442
Issue Date	2015-11
URL	http://hdl.handle.net/2433/202575
Right	The final publication is available under Open Access at Springer via http://dx.doi.org/10.1007/s00146-014-0559-2.
Type	Journal Article
Textversion	publisher

AI & Soc (2015) 30:431–442
DOI 10.1007/s00146-014-0559-2

ORIGINAL ARTICLE

An anatomy of shikakes

Yasuhiro Yamamoto · Kumiyo Nakakoji · Toshio Kawashima · Ken-ichi Kimura · Yasuharu Koike

Received: 9 December 2013 / Accepted: 18 August 2014 / Published online: 5 September 2014

Abstract We propose a framework to dissect a shikake to identify its fundamental aspect as a shikake. The framework consists of four elements: *mechanics* to cause the effect; *action* provoked, prompted, or inspired by the mechanics; *effect* observed as the result of the action; and *principle*, which explains how and why the mechanics lead to the effect through the action. By using these four elements, this paper presents the anatomies of three artifacts as shikakes: (1) a telescope-like cylinder in the zoo as a canonical example of a shikake; (2) a museum candle, which we have designed and studied as a probe to investigate the inspirational experience at a museum; and (3) an omni-viscosity string, which we have developed for communicating weight through visual interactivity by using pseudo-haptics. The anatomies demonstrate that a shikake's low-cost and simple but yet effective nature comes from the aspect that exploits human psychology, cognition, and perception, and that the *principle* element plays a key role to ascribe the way the *action* mediates the *mechanics* and the *effect* to human nature.

Keywords Shikake anatomy · Theoretical framework · Shikake principle · Design · Probes · Illusion

1 Introduction

A shikake is an embodied trigger to change behavior (Matsumura 2013). Matsumura has described that the trigger is designed to induce a specific behavior, which could then lead to solving a social or personal issue.

Shikakeology is the study of shikakes. The goal of shikakeology is said to "codify the cause and effect of Shikake cases from physical and psychological points of view, and to establish a Shikake design methodology" (http://shikakeology.org/).

Our research goal is to develop an understanding of the power and value of shikakes, and why shikakeology is interesting and promising as an academic research field. The aim of this paper, rather than to examine individual shikake instances, was to develop a theoretical framework to help us distinguish shikakes from non-shikakes, to understand how and why shikakes have social impact, and to design shikakes for particular social and personal problems.

The major part of the existing shikakeology research falls into the following three types: to analyze an existing artifact and interpret it as a shikake, to design an artifact as a shikake and analyze its effect, or to develop theoretical accounts for shikakes. Representative examples of the first

Y. Yamamoto
Graduate School of Education, University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo, Japan

K. Nakakoji (✉)
Unit of Design, Center for the Promotion of Interdisciplinary Education and Research, Kyoto University, Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501, Japan
e-mail: kumiyo@acm.org

K. Nakakoji
Key Technology Laboratory, Software Research Associates Inc., 2-32-8 Minami-Ikebukuro, Toshima, Tokyo, Japan

T. Kawashima · K. Kimura
Department of Media Architecture, Future University Hakodate, 116-2 Kamedanakano, Hakodate, Hokkaido, Japan

Y. Koike
Precision and Intelligence Laboratory, Tokyo Institute of Technology, 4259 Nagatsuta, Midori, Yokohama, Japan

type of research are that given by Matsumura (2013), which lists as shikakes a number of existing artifacts, such as a cylinder with a telescope-like appearance in the zoo to invite people to look at a replica of elephant dung, or a shrine gate drawn on the bottom of an outside wall of a public place, which reminds people of a holy place and functions to discourage people from littering. That paper treats such examples as the denotational definition of shikakes.

In addition, Hanamura (2013) presents three art installation projects that have changed people's awareness and perception of the world, including photo-taking of an outside environment with tiny figures placed in the environment ("Gulliver's scope"), nature-walking in the natural environment with embedded fake plants ("the Fourth Nature"), and artificial fog-making and fog-clearing in a hospital's courtyard ("Shining Spring after Clearing Fog").

A second type of shikake research demonstrates how a shikake changes people's behavior. Examples include wearable smart devices for increasing self-awareness of one's own health (Maeyer and Jacobs 2013), games for disaster education (Lin et al. 2013) or for creating new ideas (Hayashi and Ohsawa 2013), avaters for rehabilitating aphasia patients (Konnerup 2013), persuasive feedback mechanisms in a public environment to encourage people to avoid displaying problematic behavior (Huang et al. 2013), pattern language and storytelling to mediate and encourage learning about a town-walking experience (Suwa and Kato 2013), and the mutual understanding metric (MUM) and matrix of choices (eMOC) for promoting mutual understanding and creatively making collaborative decisions in global business meetings (Fruchter and Medlock 2013).

Some studies develop models and categorization for shikakes in general as a third type of shikake research. Matsumura and Fruchter (2013) present a categorization scheme for characterizing different types of shikake triggers. Triggers are first categorized as physical, psychological, or both and then further labeled in terms of how the trigger leads to a change in people's behavior. Priyadarshy and Nguyen-Ngo (2013) present so-called Trigger Piggybacking as a way to help design triggers. They argue for the importance of a value system associated with a trigger, which "reinforces values and leaves itself open to interpretation. This openness is the key to driving a user's desire to perform a behavior." Inclezan (2013) uses answer set prolog (ASP) to formally represent and explain how a shikake leads people to change their behaviors, such as "typically" do this and "normally" do that.

The study of the anatomy we present in this paper falls into the third category. To complement the existing macroscopic approach for understanding a shikake [such as the categorization scheme described above (Matsumura and Fruchter 2013)], we propose four elements as a way to provide an anatomy for a shikake from the microscopic view of understanding. In this regard, our approach is similar to that of Takatalo et al. (2013), which uses the experiential cycle to describe "how experience evolves in an active human–environment interaction process." The difference is that whereas their approach focuses on the interdependence and relationships between elements of human cognition and psychology (such as perception, motivation, emotion, attention, and body) when people interact with a shikake, our focus is on the elements of a shikake, which involves humans as well as physical and logical artifacts as essential components. We think the two approaches would complement each other in developing a macroscopic model for shikakes.

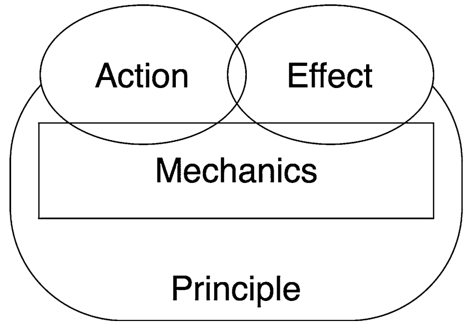


Fig. 1 Four elements for shikake anatomy: *mechanics*, *action*, *effect*, and *principle*

Section 2 of this paper presents our proposed framework to provide an anatomy for a shikake, consisting of the following four elements: *mechanics*, *action*, *effect*, and *principle*. These four elements are then used to dissect three artifacts as shikakes. Section 3 describes the anatomy of the canonical example of a shikake, the telescope-like cylinder in the zoo (Matsumura 2013). Section 4 describes that of the museum candle, which we have designed and studied as a probe (Boehner et al. 2007) to investigate the inspirational experience at a museum. Section 5 describes that of the omni-viscosity string (Nakakoji et al. 2012) we developed for communicating weight through visual interactivity (Nakakoji et al. 2010) by using pseudo-haptics (Lecuyer 2009), a type of haptic illusion.

2 The four elements for shikake anatomy

This section introduces a framework to dissect a shikake to identify its fundamental structure as its anatomy.

2.1 The four elements

The proposed anatomy for a shikake consists of the following four elements (Fig. 1):

(1) *mechanics* to cause the effect;
(2) *action* provoked, prompted, or inspired by the mechanics;
(3) *effect* observed as the result of the action; and
(4) *principle*, which explains how and why the mechanics leads to the effect through the action.

The *mechanics* element describes the physical and logical representations of artifacts, including devices, gadgets, hardware, and software objects. It also includes signs, text, symbols, diagrams, and other visual, audio, tactile, olfactory, or gustatory expressions, as well as how they are presented and situated in the real world.

The *action* element describes what a person does, perceives, and feels by interacting with, engaging in, or reacting to the *mechanics*.

The *effect* element describes what emerges, happens, and changes as the result of people taking the *action*. The effect may take place in people's posture, activities, movement, perception, beliefs, or knowledge.

The *principle* element describes the relationships among the first three elements. The principle accounts for how and why the *mechanics* leads to the *effect* through the *action* in terms of the perceptual, cognitive, ergonomical, and social nature of human beings.

2.2 How the anatomy helps us further study shikakeology

We assume that using the four elements to dissect a shikake would help us further develop shikakeology in the following four ways.

(1) Distinguishing *mechanics* from *actions* helps us to understand the intended design of an artifact versus what people actually do with it as a consequence of having the mechanics.
(2) Distinguishing *effect* from *actions* helps us to focus on the aim of the shikake and prevents us from being distracted by other resulting observable actions.
(3) Identifying the *actions* that mediate the *mechanics* and the *effect* helps us to understand the essential part of shikakes, which distinguishes shikakes from other types of behavior-inducing approaches, such as affordances (Gaver 1991), signifiers (Norman 2010), and persuasive technologies (Fogg 2002).
(4) The value and excitement of shikakeology lies in the *principle* element.

Fig. 2 Cylinder in the Tennoji zoo as a shikake

2.3 Anatomy of the three cases

We have used the four shikake elements to dissect the following artifacts:[1]

(1) the telescope-like *cylinder* in the Tennoji zoo,
(2) the museum *candle*, and
(3) the omni-viscosity *string*.

The first artifact is a canonical example of a shikake, which has been introduced by Matsumura (2013) and used by many researchers to communicate the concept of a shikake.

The second and third artifacts, which were not originally designed as shikakes, are what we have designed and studied in two different research contexts. We have found that the essential part of each artifact is a shikake in the sense that it triggered people to take different courses of action than originally intended. As examples, the museum candle was originally designed as a *probe* to gain understanding of how museum visitors would experience exhibited objects in a new manner, and the omni-viscosity string was a part of the project that explored the use of *pseudo-haptics*, a type of tactile illusion.

The following sections present the anatomies of the three dissected artifacts.

3 An anatomy of the cylinder in the zoo

This section starts with a brief description of the cylinder in the Tennoji zoo as a shikake. We then explain the shikake from the four elements of its anatomy.

[1] Note that by saying "artifact," we refer not only to a physical object but also to a total setting in which a set of physical and logical objects is presented in an environment in a particular manner. We refer to each artifact by the name of its core object, including its setting.

3.1 A brief description of the cylinder in the Tennoji zoo

The cylinder installed in the Tennoji zoo has been used as a canonical example in the field of shikakeology (Matsumura 2013). This subsection gives a brief depiction of the shikake; Matsumura (2013) discusses its detail.

The artifact is a cylinder with a telescope-like appearance, 50–60 cm long and positioned approximately 1.0 m above the ground. It has been placed by the pathway in the Tennoji zoo, a large zoo located in Osaka, Japan. One end of the cylinder is oriented to a point several meters away on the ground. A person looking through the cylinder sees a replica elephant dung (Fig. 2).

Matsumura (2013) provides a detailed argument about why and how this simple mechanism of a cylinder installed in the environment effectively invites people to focus on the small object, gets them interested in it, and possibly encourages them to know more about elephants and their biology. Matsumura states that the underlying mechanisms of the cylinder include the telescope metaphor, signifier of a hole, curiosity, and social effect.

3.2 The *cylinder* anatomy

We have dissected the cylinder shikake from the four elements introduced in Sect. 2.

Mechanics:

A telescope-like cylinder is laid approximately at the height of the average person's eyes. One end of the cylinder is oriented toward an imitation of elephant's dung placed on the ground. The cylinder is set up at the side of a pathway where people pass by.

Action:

A person walks up to the cylinder and peeps through the cylinder. A person who walks by the site and sees someone looking into the cylinder stops and takes a turn at looking into the cylinder in a similar manner.

Effect:

People find and look at the replica of elephant dung through the cylinder with a bit of excitement.

Principle:

People instinctively look inside the telescope-like cylinder out of curiosity. A person looking into the cylinder would almost always see what is located in the pointed direction of the cylinder. A person who sees someone looking into the telescope-like cylinder near the pathway would also become interested in trying it out, come closer to the cylinder, and take a turn looking into the cylinder (the so-called snowball effect). A person looking through the cylinder and finding something on the other side of the cylinder would get the feeling of finding and discovering something.

Fig. 3 Museum candle without the paper cover (*left*) and in front of the painting (*right*)

4 An anatomy of the museum candle

This section describes the museum candle as well as the museum candle workshop we have conducted with ten participants at a museum and explains how the participants interacted with and engaged in the use of the museum candle in the workshop. It then presents the anatomy of the museum candle based on the workshop experience.

4.1 An overview of the museum candle

The museum candle is an LED-lit imitation candle used to look at exhibited old Japanese paintings at the Hakodate City Museum (Fig. 3).

The museum candle was originally designed as a *probe* to investigate how a museum experience inspires a visitor in our museum experiences and service science (MESS) project. A probe is a type of instrument used in designing human–computer interaction (Boehner et al. 2007; Gaver et al. 2004). Probes are typically simple devices and gadgets, and are introduced and set up in a practical setting to invoke surprises, reveal unexpected reactions, and capture the "aha moment" in the in situ environment. We have designed and set up a set of objects and a course of actions as probes in a physical museum space to observe how visitors interact with or react to them, how the objects and activities affect what the people do, and how they perceive the objects and activities.

The idea of using candle light as a probe for looking at Japanese paintings came about through a conversation among a few of our project members and a museum curator. The curator mentioned that when the paintings were originally drawn, candles were the only available means for lighting, and that the painters probably produced such drawings assuming that they would be appreciated with candle light in the evenings. We proposed that the authenticity of the environment for an exhibited object would be a key element for an inspirational museum experience.

Because using a real candle flame in front of priceless old paintings is not allowed, the project members came up with the idea of using a simple LED light. After testing different colored LED lights, we installed the desired light on top of an actual candle holder. We placed a heavy paper cover in front of the lighting part to prevent any direct glare to the user. We also set up a little motion sensor at the bottom of the candle holder to collect data on where and in what direction the candle was held.

Fig. 4 Using the museum candle in the workshop

4.2 Workshop using the museum candle

We held a workshop using the museum candle at Hakodate City Museum in Hokkaido, Japan, on May 26, 2013. The museum has a tea house as an archival object in the basement, and we decided to use the tea house for exhibiting old paintings because those paintings were often drawn for the purpose of being hung and shown in a tea ceremony.

We installed the old Japanese painting *Yamazakura to Mejiro* [Wild cherry blossoms and a Japanese white eye] by Hakyo Kakizaki in the tea house's Tokonoma (the dedicated corner of a tea ceremony room for hanging a thematic painting and placing a seasonal flower arrangement for the tea ceremony). We then made the entire tea house dark by turning off the ceiling lights, generating the evening ambience.

The ten participants in the workshop consisted of seven women and three men, whose ages ranged from their thirties to their seventies. Their sessions consisted of looking at the painting and participating in semi-structured post-workshop interviews, which were videotaped.

In this paper, we primarily focus on how the museum candle was used and how the participants interacted with it. This paper does not include the analyses of the data collected at the workshop, which is outside of the scope of this paper and will be presented elsewhere.

4.3 How people interacted with the museum candle

The painting was exhibited on the wall of the Tokonoma area of the tea ceremony room of the tea house, and each participant was initially seated on the Tatami floor (Fig. 4).

Participants held the museum candle in front of their bodies, as seen in Fig. 4. The luminance of the museum candle light had been set rather weak (to mimic real candle brightness), and participants typically brought the candle very close to the painting (10–20 cm away from the surface of the painting). At the same time, they leaned forward to look at the painting from a short distance. (The lit area looks much larger in Fig. 4 than the actual visible area due to the camera's sensitivity). Because the floor of the Tokonoma is raised (about 12 cm high), and people are not supposed to step into the Tokonoma area (according to Japanese culture), viewers typically balanced on one knee on the Tatami area and leaned their upper bodies toward the painting.

With the museum candle, the lit area of the painting was rather limited. The visible part was about 15–30 cm in diameter, depending on how close the candle was placed to the surface of the painting. Because of the diffusion of the light, the brighter it was made, the smaller the visible area became. Some participants kept moving the candle over the surface of the painting. They moved their heads according to where the candle was held. Some of the participants held the candle with their right hand and leaned sideways toward the left to look at the lit part of the painting at the back of the handheld candle.

In the post-workshop interviews, we found that the participants appreciated the experience of using the museum candle because, as one participant said, "it allowed me to look at the painting more carefully with more detail instead of looking at the whole painting at once purposelessly" (uttered originally in Japanese).

Fig. 5 Museum candle as a shikake

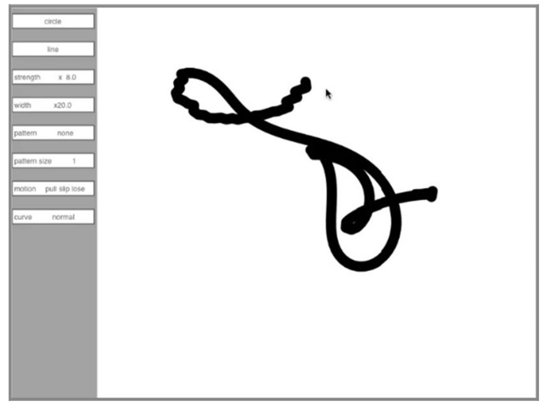


Fig. 6 Omni-viscosity string on a tablet device (the mouse cursor added on this figure shows the position of the fingertip when dragging the string)

4.4 The *museum candle* anatomy

Based on our experience of designing the museum candle, installing it in the workshop, and observing how people engaged in the experience of viewing the painting by using the museum candle, we have analyzed the museum candle as a shikake in terms of the four elements (Fig. 5).

Mechanics:

A painting is hung on a wall in a dark room. An LED-lit candle about 15–20 cm in length is set on the candle holder, and a sheet of thick paper is half-wrapped loosely around the candle holder so that the glare of the candle flame is not directly visible to the person who holds the candle.

Action:

A person who is given the museum candle in the dark room to look at the painting on the wall holds the candle chest high and moves closer to the painting to light up the surface of the painting. The person may lean forward to have a better look at the part of the painting that is lit in the glow of the candle. The candle position is then moved to light up different areas of the surface of the painting, and the person's head moves accordingly to get a closer look at the lit area.

Effect:

The person moves very close to the painting and focuses on a small part of the painting at a time. The viewer looks at the painting in a more actively engaging manner, deciding where to look by moving the candle position.

Principle:

Because the room is dark and the glow of the candle is rather faint and limited, the person holding the candle up moves very close to the painting. The lit-up and thereby visible area of the painting is small, leading the person to focus on one particular part of the surface of the painting at a time rather than looking at the entire painting from a distance. A person can freely move the candle along the surface of the painting with full control over which area of the painting to view, which then invites more active engagement in the browsing experience. Holding the candle as the single light source gives the candle holder an excuse to move very close to the painting, which may not be a socially acceptable in a public space if the person were not holding the candle.

5 An anatomy of the omni-viscosity string

The omni-viscosity string is a visual thin thread-like shape displayed on a touch-based tablet device (Fig. 6). The string is designed to produce a type of haptic illusion, where the user would feel stiffness or weight in interacting with displayed objects (Nakakoji et al. 2010, 2012; Yamamoto and Nakakoji 2013).

This section describes the mechanism of the omni-viscosity string and a preliminary user study that uses the string to investigate whether the displayed string communicates weight with users. It then presents the anatomy of the string as a shikake based on our observations from the study.

5.1 The mechanism of the omni-viscosity string

As a user touches any part of the omni-viscosity string displayed on a tablet device and drags it with the fingertip, the touched part of the string follows, which then changes

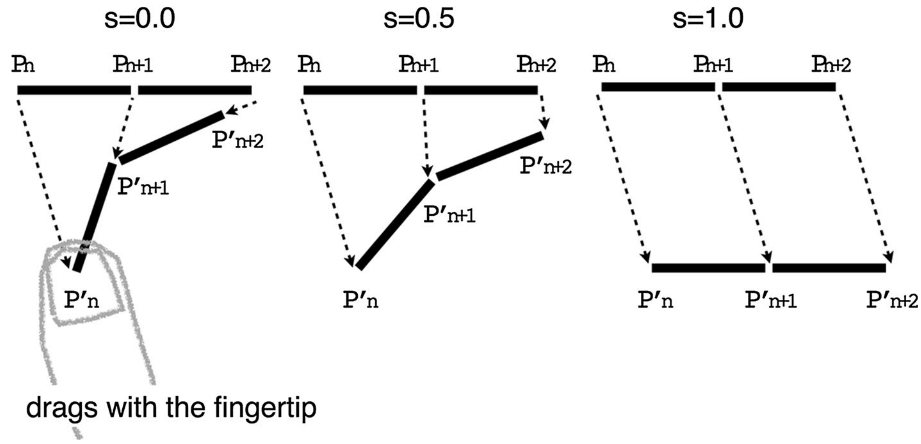


Fig. 7 Underlying algorithm for different viscosities (soft to hard, from the left)

the string shape (Fig. 6). The string is assigned a variety of "visual" stiffnesses. When the string is set to the hardest stiffness, the dragged string behaves like an iron wire. When the string is set to the softest stiffness, the dragged string behaves like a silk thread. This is the origin of the name of the string as omni-viscosity.

The design of the string is composed of hundreds of line segments of equal length, each of which connects two adjacent points of a sequence of points. When a user touches and drags a part of the string with the fingertip, the closest point touched by the user follows the location of the fingertip. The locations of the rest of the points are then calculated based on the strength parameter, which is used to express the variety of stiffnesses of the string.

Figure 7 illustrates the algorithm. Let us call the point on the string closest to the touched part P_n, the controlled point. Let the adjacent point be P_{n+1}, and its adjacent point be P_{n+2}, and so on.

When the user drags the controlled point $P_n(x,y)$ to $P'_n(x,y)$, its adjacent point $P_{n+1}(x,y)$ moves to $P'_{n+1}(x,y)$. The distance and the direction of the movement of P_{n+1} are determined by the movement of P_n (or $P'_n(x,y)-P_n(x,y)$) and the strength parameters, and those of P_{n+2} are determined by those of P_{n+1} and s. The movement of each point is thus propagated from the controlled point toward the two terminal points of the string on the two end points while the distance between each two adjacent points on the string remains constant.

When the strength parameter s is set to 1.0, the distance and direction of the movement of the controlled point $P_n(x,y)$ are propagated equally to $P_{n+1}(x,y)$, $P_{n+2}(x,y)$, and all the other points. Thus, the string keeps the exact shape as the user drags a part of the string on a touch screen. The string feels very hard, similar to an iron wire.

When s is set to 0.0, the propagated movement to adjacent points is a minimum while keeping the distance between the two adjacent points constant. The visual transformation of the string shape then becomes very smooth, and the string feels very soft, similar to a silk thread.

By dynamically changing the strength parameter while the user drags the string, the algorithm demonstrates different degrees of visual viscosity of the string.

5.2 A preliminary user study using the omni-viscosity string

We have conducted a preliminary user study to investigate whether a user feels a different weight according to the different visual stiffnesses the omni-viscosity string demonstrates on the tablet display.

Figure 8 shows screen images of the experimental setting we have built and used. In this environment, an omni-viscosity string is initially vertically drawn like a stick in the middle of the display. The bottom of the string is attached to a small area where we asked a study participant to softly or firmly hold it with a fingertip.

Each trial task consisted of two experimental sessions, the *base* session and the *comparison* session. In the base session, we asked the participant to *firmly* touch the small area at the bottom of the string, and in the comparison session, we asked the participant to *softly* touch the same area.

When each experimental session starts, a gray box slowly moves down from the top of the screen toward the bottom. When the bottom of this box starts to touch the top of the stick-like omni-viscosity string, the string starts to bend as though the box is pushing the string and the string is trying to hold the box up. In about 10 s, the box stops moving down. In the base session, the gray box always stops at the base position (level 3, which is the middle one in the bottom row of Fig. 8). In the comparison session, the gray box stops at a randomly selected level of string bending (levels 1 through 5). Note that how the box moves down on the touch screen is not affected by how firmly or softly the participant holds the bottom part of the string.

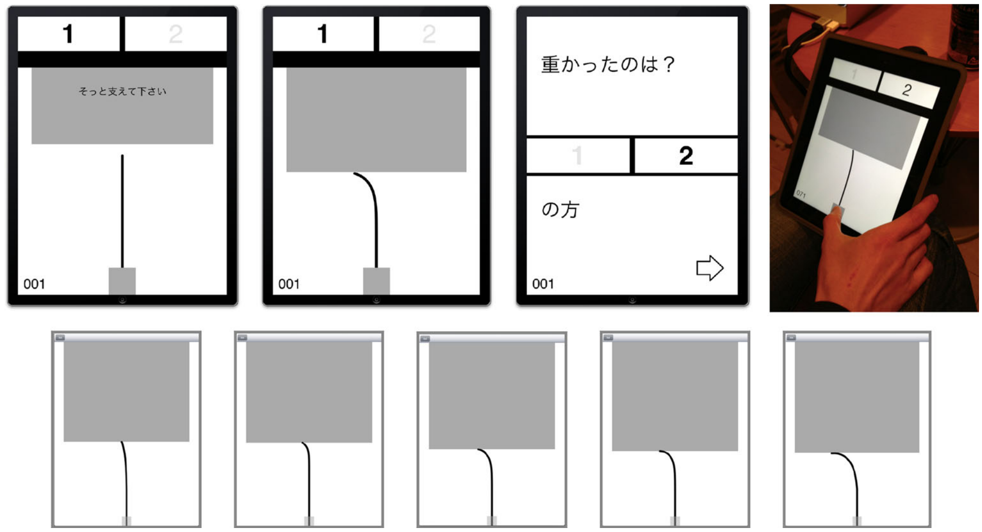


Fig. 8 Experimental setting using the omni-viscosity string

The box moves down and stops constantly for the base session and randomly for the comparison session, and how the participant holds the string is due only to the instruction we gave to the participant at the beginning of the session. This user study is designed to see whether the changing shape of the held string affects how people behave depending on how firmly or softly they are instructed to hold the string.

We asked participants to engage in 50 trial tasks in a row. In the first session of each trial task, the user is instructed as to how to hold the string (firmly if it is for the base session or softly if it is for the comparison session). As soon as the participant touches and holds the bottom of the string, the gray box starts to come down from the top of the screen and then stops. In the second session, the participant is instructed to hold the string the opposite way (softly or firmly). After the two consecutive sessions, we asked the participant to choose which one was heavier (the first session or the second session). The right-most picture on the upper row of Fig. 8 shows a snapshot of one session. The order of the *base* and *comparison* sessions was randomized and balanced for each participant. Each study took about 45–60 min per participant, depending on how quickly a participant made choices.

We collected results on which of the two sessions the participant chose as heavier in each of the 50 trial tasks—the base setting or the comparison setting—and then analyzed the distribution of the levels of the comparison setting.

If there were no visual or behavioral effect at all, the result would be that each comparison setting chosen as heavier would be 50 %, as though they are chosen randomly.

If there were a visual effect (i.e., the different amount of bending of the string) but no effect of the holding strength (i.e., firmly or softly), the result would be that levels 1 and 2 would be chosen more (or less), levels 4 and 5 would be chosen less (or more), and that level 3 would be chosen 50 % because the base session was level 3.

Figure 9 shows the results from the two study runs, where 100 % for each level indicates that the participant said that the base session was heavier in all ten trials in which the comparison session had that particular level. It is interesting to see that in both cases, firmly or softly held, the results show that not only levels 4 and 5, but also levels 2 and 3 are chosen as always or almost always heavier, that is, whether the participant held the bottom of the string firmly or softly affected their choice, in addition to the visual differences.

The result indicates that when the participant sees that a string bends in a certain manner, the participant finds the falling box heavier if the participant is holding the string firmly, and the falling box lighter if the participant is holding the string softly. Note that whether holding the string firmly or softly does not affect the system behavior, and it is merely a matter of feedforward information to the participants (Nakakoji et al. 2011).

With the omni-viscosity string implementation, we have found that visual interactivity has led people to behave differently in making choices regarding which is heavier. This effect is a type of pseudo-haptics, a type of tactile illusion (Lecuyer et al. 2004; Lecuyer 2009). The illusion in haptics has been studied for quite a long time, and the size–weight illusion is well known: if two objects have the same material look and the same weight, people tend to perceive the smaller one as heavier (Ross 1969). With the virtual reality implementation for testing the size–weight illusion, it has been found by using electromyography (EMG) that people in fact not only say that they think the smaller object is heavier, but they use more force on their

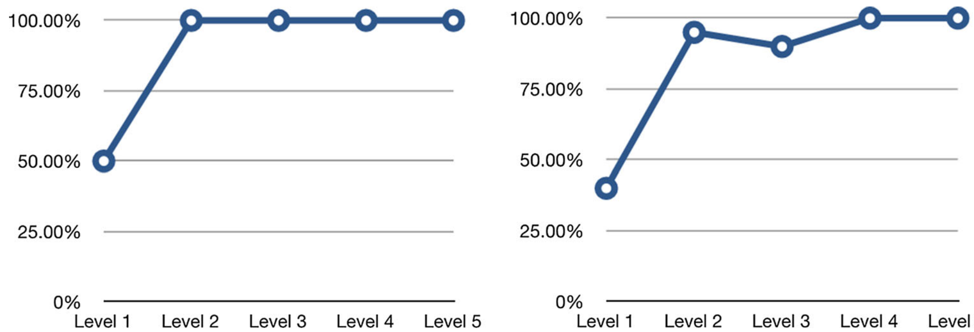


Fig. 9 Results of the two preliminary user studies

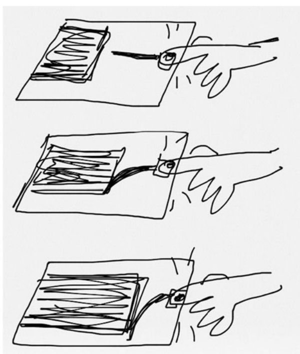


Fig. 10 Omni-viscosity string as a shikake

Table 1 Mechanics: the cause and effect (content is repeated from Sects. 3, 4, and 5)

The *cylinder* in the zoo 	The museum *candle* 	The omni-viscosity *string* 
A telescope-like cylinder is laid approximately at the height of the average person's eyes. One end of the cylinder is oriented toward an imitation of elephant's dung placed on the ground. The cylinder is set up at the side of a pathway where people pass by	A painting is hung on a wall in a dark room. An LED-lit candle about 15–20 cm in length is set on the candle holder, and a sheet of thick paper is half-wrapped loosely around the candle holder so that the glare of the candle flame is not directly visible to the person who holds the candle	A large box appears in the upper part of the display of a touch-based tablet device, and one end of a vertical string, the length of which is about one-third of the length of the area, is anchored at the bottom of the display. The box slowly moves down toward the top of the string, and as the bottom of the box touches the tip of the string, the string starts bending as though it is being pushed by the box and is pushing back. A person is instructed to keep touching the bottom of the string either firmly or softly to support the string. How the person touches the string is actually ignored and not taken into account for what is displayed, but the person is not told that. The box stops falling at a certain amount of bending of the string

forearm (Koike et al. 2006). They are changing their behavior through the illusion.

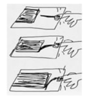
5.3 The anatomy of the omni-viscosity string as a shikake

Based on our observation and analysis of how people interact with the omni-viscosity string in the preliminary user study, we have analyzed the string as a shikake from the four shikake elements (Fig. 10).

Mechanics:

> A large box appears in the upper part of the display of a touch-based tablet device, and one end of a vertical string, the length of which is about one-third of the length of the area, is anchored at the bottom of the display. The box slowly moves down toward the top of the string, and as the bottom of the box touches the tip of the string, the string starts bending as though it is being pushed by the box and is pushing back. A person is instructed to keep touching the bottom of the string either firmly or softly to support the string. How the person touches the string is actually ignored and not taken into account for what is displayed, but the person is not told that. The box stops falling at a certain amount of bending of the string.

Table 2 Action: provoked, prompted, or inspired by the mechanics (content is repeated from Sects. 3, 4, and 5)

The *cylinder* in the zoo 	The museum *candle* 	The omni-viscosity *string* 
A person walks up to the cylinder and peeps through the cylinder. A person who walks by the site and sees someone looking into the cylinder stops and takes a turn at looking into the cylinder in a similar manner	A person who is given the museum candle in the dark room to look at the painting on the wall holds the candle chest high and moves closer to the painting to light up the surface of the painting. The person may lean forward to have a better look at the part of the painting that is lit in the glow of the candle. The candle position is then moved to light up different areas of the surface of the painting, and the person's head moves accordingly to get a closer look at the lit area	The person who is instructed to keep holding the bottom of the bending string firmly or softly as the box falls down feels the weight. The more the string bends, the more weight the person feels. The person who keeps touching the bottom of the string firmly feels more weight, even if the amount of bending is not so much

Action:

The person who is instructed to keep holding the bottom of the bending string firmly or softly as the box falls down feels the weight. The more the string bends, the more weight the person feels. The person who keeps touching the bottom of the string firmly feels more weight, even if the amount of bending is not so much.

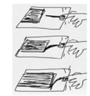
Effect:

The person, who is asked to keep holding the string, feels more weight with the increased bending of the string, which is displayed as though the string is being pushed by the falling box and is pushing back. The person feels more weight if instructed to hold the string more firmly, although the amount of bending of the string remains the same.

Principle:

The display is of a box falling from the top and a short vertical string from the bottom appearing to be

Table 3 Effect: observed as the result of the action (content is repeated from Sects. 3, 4, and 5)

The *cylinder* in the zoo 	The museum *candle* 	The omni-viscosity *string* 
People find and look at the replica of elephant dung through the cylinder with a bit of excitement	The person moves very close to the painting and focuses on a small part of the painting at a time. The viewer looks at the painting in a more actively engaging manner, deciding where to look by moving the candle position	The person, who is asked to keep holding the string, feels more weight with the increased bending of the string, which is displayed as though the string is being pushed by the falling box and is pushing back. The person feels more weight if instructed to hold the string more firmly, although the amount of bending of the string remains the same

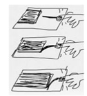
supporting the box with different amounts of falling and bending. The instruction to the person is to keep touching the bottom of the string either firmly or softly to hold the string, which makes the person feel different weights as the result of pseudo-haptics, a type of tactile illusion. The person feels weight differently by changing the visual stiffness of the string, as well as by changing the instruction to keep touching the bottom of the string either firmly or softly. The pseudo-haptics comes from the nature of human perception, in which vision dominates touch, and the perception of weight depends on the feed-forward mechanism.

6 Discussion

Tables 1, 2, 3, and 4 summarize the anatomies of the three shikakes depicted above. The framework helps us to compare the three shikakes from each of the four elements.

We think that the *principle* element (Table 4) plays a key role in establishing a shikake as a low-cost, effective, human-centered means to solve a personal and social problem. Matsumura states that the beauty of a shikake is that "low-cost and easy-to-implement" mechanics results in behavior change. Matsumura (2013) explains that "the fundamental mechanism underlying a shikake is simple. This merit of a shikake is [that] it enables ordinary people

Table 4 Principle: explains how and why the mechanics leads to the effect through the action (content is repeated from Sects. 3, 4, and 5)

The *cylinder* in the zoo 	The museum *candle* 	The omni-viscosity *string* 
People instinctively look inside the telescope-like cylinder out of curiosity. A person looking into the cylinder would almost always see what is located in the pointed direction of the cylinder. A person who sees someone looking into the telescope-like cylinder near the pathway would also become interested in trying it out, come closer to the cylinder, and take a turn looking into the cylinder (the so-called snowball effect). A person looking through the cylinder and finding something on the other side of the cylinder would get the feeling of finding and discovering something	Because the room is dark and the glow of the candle is rather faint and limited, the person holding the candle up moves very close to the painting. The lit-up and thereby visible area of the painting is small, leading the person to focus on one particular part of the surface of the painting at a time rather than looking at the entire painting from a distance. A person can freely move the candle along the surface of the painting with full control over which area of the painting to view, which then invites more active engagement in the browsing experience. Holding the candle as the single light source gives the candle holder an excuse to move very close to the painting, which may not be a socially acceptable in a public space if the person were not holding the candle	The display is of a box falling from the top and a short vertical string from the bottom appearing to be supporting the box with different amounts of falling and bending. The instruction to the person is to keep touching the bottom of the string either firmly or softly to hold the string, which makes the person feel different weights as the result of pseudo-haptics, a type of tactile illusion. The person feels weight differently by changing the visual stiffness of the string, as well as by changing the instruction to keep touching the bottom of the string either firmly or softly. The pseudo-haptics comes from the nature of human perception, in which vision dominates touch, and the perception of weight depends on the feedforward mechanism

as well as experts to make their own shikakes to solve their own issues with their best efforts."

The anatomies demonstrate that a shikake's low-cost and simple yet effective nature come from the aspect that exploits human psychology, cognition, and perception, and that the *principle* element plays a key role to ascribe the way the *action* mediates the *mechanics* and the *effect* on human nature.

7 Conclusion

This paper presented our proposed framework to dissect a shikake to understand its anatomy. We have demonstrated the uses of the framework by presenting the anatomies of the three artifacts. Our future work includes analyzing other shikake examples as well as non-shikake examples in terms of the four principles, and to further develop the theoretical framework for shikakeology.

Acknowledgments This work was partially supported by CREST, JST, and S3FIRE, RISTEX, JST. We appreciate people who participated in the workshop and the user studies.

References

Boehner K, Vertesi J, Sengers P, Dourish P (2007) How HCI interprets the probes. In: Proceedings of the SIGCHI conference on human factors in computing systems 2007, ACM, New York, pp 1077–1086

Fogg BJ (2002) Persuasive technology: using computers to change what we think and do. Morgan Kaufmann, Burlington

Fruchter R, Medlock L (2013) A journey from island of knowledge to mutual understanding in global business meetings. In: Proceedings of the AAAI Spring Symposium 2013, Stanford, pp 17–21

Gaver W (1991) Technology affordances. In: Proceedings of the SIGCHI conference on human factors in computing systems (CHI '91). ACM, New York, pp 79–84

Gaver W, Boucher A, Pennington S, Walker B (2004) Cultural probes and the value of uncertainty. Interactions 11(5):53–56

Hanamura C (2013) Study on landscape ostranenie from the perspective of persons exposed to "sikake". In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 21–26

Hayashi T, Ohsawa Y (2013) The efficient method for creating ideas: Innovators marketplace as role-based game. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 27–32

Huang Y-C, Tsai B-L, Wang C-I, Yu S-Y, Liang C-W, Hsu J-Y, Selker T (2013) Leveraging persuasive feedback mechanism for problem solving. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 33–38

Inclezan DA (2013) Logic-based methodology for the formalization of shikake principles and examples. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 39–44

Koike Y, Kim J, Duk S (2006) Role of stiffness in weight perception. Jpn Psychol Res 48:174–187

Konnerup U (2013) Might avatar-mediated interactions rehabilitate people suffering from aphasia? In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 51–56

Lecuyer A (2009) Simulating haptic feedback using vision: a survey of research and applications of pseudo-haptic feedback, presence. Teleoper Virtual Environ 18(1):39–53

Lecuyer A, Burkhardt JM, Etiennne L (2004) Feeling bumps and holes without a haptic interface: the perception of pseudo-haptic textures. In: Proceedings of CHI2004, Vienna, pp 239–246

Lin S-C, Tsai M-H, Chang Y-L, Kang S-C (2013) Game-initiated learning: a case study for disaster education research in Taiwan. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 57–61

Maeyer CD, Jacobs A (2013) Sleeping with technology—designing for personal health. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 11–16

Matsumura N (2013) A shikake as an embodied trigger for behavior change. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 62–67

Matsumura N, Fruchter R (2013) Shikake trigger categories. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 68–73

Nakakoji K, Yamamoto Y, Koike Y (2010) Toward principles for visual interaction design for communicating weight by using pseudo-haptic feedback. In: Proceedings of create 10 conference, Edinburgh, pp 68–73

Nakakoji K, Yamamoto Y, Matubara N (2011) Delicate interpretation, illusion and feedforward: three key concepts toward designing multimodal interaction, TEI'11 Work-in-Progress Workshop Proceedings. Madeira, Portugal, pp 37–42

Nakakoji K, Yamamoto Y, Matubara N (2012) Toward visual interaction design for supporting decision making. Proceedings of the Annual Conference of the Japanese Society for Artificial Intelligence (JSAI2012), 4F1-OS-5-6, Yamaguchi, Japan, pp 1-4 (in Japanese)

Norman DA (2010) Living with complexity. The MIT Press, Cambridge

Priyadarshy A, Nguyen-Ngo D (2013) Understanding and applying trigger piggybacking for persuasive technologies. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 79–82

Ross HE (1969) When is a weight not illusory? Q J Exp Psychol 21(4):346–355

Suwa M, Kato F (2013) Pattern language and storytelling: a methodology for describing embodied experience and encouraging others to learn. In: Proceedings of the AAAI ##spring symposium 2013, Stanford, pp 89–94

Takatalo J, Miller D, Häkkinen J (2013) Experience, engagement, and shikake. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 95–100

Yamamoto Y, Nakakoji K (2013) Designing pseudo-haptic feedback mechanisms for communicating weight in decision making tasks. In: Proceedings of the AAAI spring symposium 2013, Stanford, pp 107–112