Technology Reports

# "Tomokaku": A Handwritten Communication Concept

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Intergenerational Communication 🖉 Design Thinking 🎽 Handwriting Devices

Since older generations and their children grew up in different eras, there is a gap between the ideas and tools that they use to communicate. This can make it difficult to achieve smooth remote communication between people of different generations. NTT DOCOMO is studying the use of design thinking as a means of resolving these issues. By focusing on handwritten communication, we have devised a concept called "Tomokaku<sup>®</sup>\*1" and we have made a prototype that puts this concept into practice. In user evaluations performed using this prototype, the concept was highly rated by the users, confirming its market potential.

# 1. Introduction

In recent years, Japan's population of elderly people (aged 65 and over) has been increasing, and the proportion of elderly people in the total population has also been increasing. On the other hand, as nuclear families become more common, fewer elderly people are living with their children, down from about 70% in 1980 to about 40% in 2015 [1]. Although the frequency of intergenerational communication within families is declining, NTT DOCOMO's own surveys connected with this article have shown that the potential demand for this sort of communication is increasing, and that the growing tendency for elderly people to live separately is making it more important for them to communicate remotely by such means as telephones and email in addition to face-to-face conversations.

However, the means that people use to communicate with other family members who live

\*1 Tomokaku®: A registered trademark of NTT DOCOMO. Inc.

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elsewhere differs between generations. The majority of the elderly generation prefer to use voice communication via fixed and mobile telephones, and hardly ever use social networking services such as LINE<sup>\*2</sup> [2] [3]. Meanwhile, the same survey found that the children of the elderly generation mainly use LINE's chat function to communicate.

At NTT DOCOMO, we used the design thinking method to study different device concepts in order to resolve this intergenerational communication gap and facilitate smooth communication among families. As a result, by focusing on the User eXperience (UX)<sup>\*3</sup> of handwriting, which is an activity familiar to all generations, we proposed a new form of communication called "Tomokaku," which is modeled on the concept of a whiteboard. It has only a single function, but allows users to communicate both synchronously and asynchronously depending on the situation.

This article discusses the background of this concept, describes the details of the proposed "Tomokaku" UX, and presents the results of user evaluations performed using prototype devices.

# 2. Concept Study

A variety of different approaches can be considered for the study of methods for implementing smooth communication by eliminating the gap in communication means between generations within families, but here we performed a study based on the methods of design thinking [4] [5] that have recently been talked about as an effective method for creating innovation. Design thinking seeks to develop products that truly satisfy the needs of their users by focusing constantly on users rather than objects or techniques. This is achieved by repeating three processes: (a) gaining inspiration from users by observation, (b) creating ideas based on this inspiration, and (c) rapid prototyping and verification in order to evaluate these ideas.

In this study, we refined the concept by repeating the process of design thinking as shown in **Figure 1**. An overview of the representative points in each phase is presented below.

#### 2.1 Inspiration: Extracting Insights from User Interviews

First, in order to observe and understand the users, we conducted in-depth interviews<sup>\*4</sup> with elderly users aged 70 to 80 years (the main target of this study) and users aged 40 to 50 years (the children of this generation). We also conducted similar interviews with extreme users<sup>\*5</sup> to gather hints on how to deal with issues from different perspectives.

These interviews included not only questions directly related to communication with distant family members, but also a wide range of other questions aimed at gaining a better understanding of the users, such as how they spend their time on an ordinary day. As a result of these interviews, we were able to gain insights<sup>\*6</sup> to help us further the aims of this study by resolving the intergenerational communication gap and facilitate smooth communication among families.

#### 2.2 Ideation: Studying Concept Creation Principles Based on These Insights

For each of the insights gained in the interviews, we came up with multiple ideas for solutions to

<sup>\*2</sup> LINE<sup>®</sup>: A trademark or registered trademark of LINE Corp. \*\*

<sup>\*3</sup> UX: A general term for the experiences gained through the

use or consumption of certain products or services.

<sup>\*4</sup> In-depth interview: An interview-based survey method where questioners explore the deep thoughts of the interviewees.

<sup>\*5</sup> Extreme users: Users with exceptional attributes and features who stand apart from ordinary target users.

<sup>\*6</sup> Insights: A user's essential desires and real intentions.

these issues, and we formulated concept creation principles by abstracting these ideas (**Table 1**).

# 2.3 Rapid Prototyping and Verification: Devising Concepts Based on Creation Principles

As an embodiment of our concept based on the



Figure 1 The design thinking process

| Table 1 | Our insights and the | corresponding | concept policies |
|---------|----------------------|---------------|------------------|
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| Insights   | Concept creation policy   |
|--|---|
| When the elderly generation learns how to use new ICT equipment,<br>they have difficulty in learning lots of new information at the same<br>time, and this makes them feel uncomfortable with the deterioration<br>of their learning ability.  | Must be simple to operate without learning 1)   |
| The elderly generation prefers physical things that they can manipu-<br>late by hand, because in digital systems they are unable to experi-<br>ence real objects.  | Must present itself as an analog device that<br>can be operated manually by physical interac-<br>tion 2)  |
| The elderly generation and their children want to communicate more<br>with each other, but tend to concentrate on different points and dif-<br>ferent means of communication. For example, the elderly generation<br>prefers synchronous modes of communication like the telephone,<br>while their children prefer asynchronous modes of communication<br>such as email.   | Must have a means of choosing between syn-<br>chronous and asynchronous communication<br>according to circumstances 3)  |
| The children of the elderly generation want to improve the quality of<br>their parents' lives, and are positively disposed towards introducing<br>ICT equipment for this purpose. However, they are hesitant to do so<br>because they are concerned that this sort of technology is too com-<br>plicated for the elderly generation, who will only be able to use it<br>with a lot of support from their children. | Despite having simple functions, the device<br>must be specified so that the children of the<br>elderly generation can perform the required<br>setup operations before presenting it to their<br>elderly parents 4) |

above principles, we concentrated on the UX concept of using handwritten communication as a familiar motif for users of all generations, and we implemented this concept by creating the rapid prototype shown in **Photo 1**. As a result, we finally arrived at the concept of Tomokaku, which involves remote handwritten communication via a whiteboard-type terminal.

Tomokaku is a very simple concept that allows

users to share handwritten content on a whiteboard terminal in real time via the Internet. If one terminal is installed in the home of an elderly user and another in the home of this user's child, this allows them to communicate just as if they are both writing on the same whiteboard (**Figure 2**).

The correspondence between the creation policy shown in Fig. 1 and the Tomokaku concept is as follows:



Photo 1 Rapid prototyping for verification



Figure 2 Overview of the Tomokaku concept

1) Must Be Simple to Operate without Learning

By concentrating on the simple function of using a pen, we made it possible to communicate by simple handwriting — an action that is familiar to all generations and does not require them to learn any new skills.

 Must Present Itself as an Analog Device that Can Be Operated Manually by Physical Interaction

By making every effort to ensure that the product not only looks like a whiteboard but also functions like a whiteboard, we arrived at a design that gives users the real feeling that they are communicating through handwriting. Also, by having the external appearance resemble an ordinary whiteboard, we aim to avoid having it look like a "complicated piece of electronics" so as to eliminate psychological obstacles to using this product.

 Must Have a Means of Choosing between Synchronous and Asynchronous Communication According to Circumstances

Since the handwritten input is just displayed synchronously on the receiving side, it is possible to choose between an asynchronous mode where the receiver can read the input when convenient like a written memo, and a synchronous mode where the pen input details and paths are displayed in real time on the receiving terminal (**Photo 2**), making it appear just as if the person at the transmitting side is writing directly on the terminal at the receiving side. Therefore, without users being particularly aware of it, a single function can be used to switch between synchronous and asynchronous communication as and when convenient.

4) Despite Having Simple Functions, the Device Must Be Specified so that the Children of the Elderly Generation Can Perform the Required Setup Operations before Presenting It to Their Elderly Parents

As described in 1) above, we made the overall functions simple. However, some functions such as initial settings can still seem complicated to elderly users. We therefore made it possible for children to perform the bare minimum of initial settings before presenting the terminal to their elderly parents. After completing the initial settings such as pairing the two terminals on the sending and receiving sides, the terminals can be used immediately, and the child can hand the terminal



Photo 2 Handwriting entered via the sending terminal is displayed in real time on the receiving terminal

over without having to explain how to use it.

### 3. Prototyping

After several iterations of rapid prototyping, we performed technical studies and verifications to implement the abovementioned Tomokaku concept, and we made a prototype to evaluate its ultimate marketability. An overview of the prototype is presented below.

# 3.1 Setting Requirements Based on the Concept

It is important to set the requirements so that they embody the Tomokaku concept. The above concepts 2) and 3), which are related to hardware specifications, are particularly important for formulating specifications and must be studied carefully. The key points of the requirements we studied and formulated are as follows:

The terminal must take the form of an analog device with a physical feel that encourages manual operation (2.3 2))

(a) It must have the appearance of a whiteboard

- Its external appearance from the front must not include anything apart from the screen (i.e., no power buttons or the like)
- It must be capable of showing a full screen white display, without any icons or indicators
- The pen tip and shaft should resemble those of a whiteboard marker pen
- (b) It must implement the same sort of functions and uses as an ordinary whiteboard
  - As much as possible, the terminal must

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be as comfortable to use as an ordinary whiteboard (including high-precision detection of the pen tip, etc.) (1)

- It must not respond to the user's hand touching the screen (palm rejection) (2)
- It should not be necessary to switch the pen on, so it must always be in a state where writing can be performed immediately (3)
- When functions such as changing the pen color or using an eraser are provided, this must be done by using a different pen instead of navigating a menu system or the like (4)
- When using the pen to write on the terminal, it must emit the same sort of squeaking noise as a felt marker on a whiteboard
- The terminal must be battery powered so it can be easily carried around the home
- Must have a means of choosing between synchronous and asynchronous communication according to circumstances (2.3 3))
  - Although the terminals basically communicate asynchronously like handwritten notes, they must also have a function whereby the transmitting and receiving terminals update their displays synchronously in real time, in which case the receiving and transmitting terminals both emit squeaking whiteboard sounds when a user is writing on the transmitting terminal (allowing for synchronous communication if the user at the receiving end notices the sound)

We formulated the specifications of the prototype by considering the above requirements.

#### 3.2 Selecting Technologies and Implementing Specifications to Realize These Requirements

This section describes the whiteboard-like pen operation and the implementation of the display screen, which were regarded as particularly important when formulating the specifications.

 Simulating the Behavior of a Whiteboard Marker Pen

In embodying the requirements that we drew up for the prototype, the most important factor is to implement pen operations that resemble writing on a whiteboard. **Table 2** presents a comparison of the main digital pen sensing technologies. As this table shows, the electromagnetic induction method<sup>\*7</sup> [6] is very effective for realizing this concept when considering benchmarks (1) through (4), which are listed as important requirements in the previous section.

We therefore adopted Wacom's EMR<sup>®\*8</sup> for this prototype, since it has the advantage of not requiring

a battery and has already performed successfully in the drawing tablet market.

2) Implementing a Display Screen Like a Whiteboard

The abovementioned digital pen sensing technology and display technology are essential for detecting what is being written on the transmitting terminal and displaying it synchronously on the receiving terminal. For this prototype, we decided to use liquid-crystal displays, which are widely used in general-purpose products.

Furthermore, for the creation of a display screen with the appearance of a whiteboard, it is important to not only choose a display film that facilitates comfortable writing, but also to ensure that the background color is white. Therefore, it is assumed that the liquid crystal display is always completely white. However, in order to keep down the power consumption and prevent image burn-in, we incorporated a motion detection sensor and luminance sensor in the main unit so that the screen can be automatically turned off when there is nobody around or the surroundings are dark, thereby saving power when the equipment is not being used and at night.

|   | Electromagnetic induction method             | Capacitive sensing<br>+ Active pen           | Capacitive sensing<br>+ Passive pen | Resistive sensing |  |
|---|--|--|-------------------------------------|-------------------|--|
| (1) High detection accuracy                       | 0  | 0  | ×                                   | ×                 |  |
| (2) Palm rejection                                | 0  | ×  | ×                                   | ×                 |  |
| (3) No batteries required                         | <ul> <li>△ (Only in some methods)</li> </ul> | ×  | 0                                   | 0                 |  |
| (4) Can change functions by using a different pen | 0  | <ul> <li>△ (Only in some methods)</li> </ul> | ×                                   | ×                 |  |

 Table 2
 Comparison of digital pen sensing technologies

Capacitive sensing: Pen coordinates detected from a weak current change that occurs when touched by a human.

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\*7 Electromagnetic induction method: A method for the detection of coordinates by electromagnetic waves.

\*8 EMR®: A registered trademark of Wacom Co., Ltd.

#### 3.3 Outline of the Finished Prototype

**Photo 3** shows the Tomokaku prototype. This prototype has a liquid crystal display and looks like a whiteboard with a handle. The main specifications of this prototype are listed below (**Table 3**).

#### 4. Verification

#### 4.1 Evaluation of Commercial Acceptability

To confirm the commercial acceptability of the proposed concept among its target users, we conducted user evaluations using the prototype described above. For this evaluation, considering the main target users of Tomokaku, we chose pairs of monitor users consisting of elderly people with poor IT skills (aged in their 60s and 70s) and their children (in their 40s) who lived in separate homes. They were asked to try out the terminals in their homes for about ten weeks (**Photo 4**).

For the duration of the verification test, the monitor users had prototypes installed in parts of their homes where they spend a lot of time, such as in their living rooms. Also, in order to evaluate the terminals in situations close to actual use, the users were given no particular instructions regarding when or how often to use them.



Photo 3 Our prototype Tomokaku device

| Table 3 Key specifications of the Tomokaku pro | ototype |
|--|---------|
|--|---------|

| OS               | Windows 10 IoT Core                       |  |
|------------------|---|--|
| RAM capacity     | 1 GB                                      |  |
| Storage capacity | 8 GB                                      |  |
| LCD size         | 14 inch                                   |  |
| Resolution       | 1,366×768                                 |  |
| Wireless LAN     | Wi-Fi 802.11 a/b/g/n (2.4 GHz, 5 GHz)     |  |
| Sensors          | Luminance sensor, motion detection sensor |  |
| Battery capacity | 1,500 mA                                  |  |
| Input method     | Electromagnetic induction (Wacom EMR)     |  |
| Dimensions       | 385 × 267 × 16 mm                         |  |



Photo 4 Evaluation at the home of a monitor user

#### 4.2 Results and Discussion

After the trial period, we also interviewed the monitor users. They were asked to evaluate their overall satisfaction with the terminals with a score out of 10, and 80% of the users gave it high scores of 7 or more. To confirm the commercial acceptability of this concept, we also analyzed the comments from users in these interviews. The results are summarized for each concept creation policy below.

1) Must Be Simple to Operate without Learning

The users were highly appreciative of the fact that this prototype's single function and simple pen input method allow it to be used by family members of any generation, including grandchildren and the elderly people's own parents. On the other hand, some of the users with more experience in the use of ICT equipment were not as attracted to the simple single-function device of this concept, and did not see the need for dedicated equipment for this purpose. Therefore, it might also be effective to extend the target to include not only users who are unfamiliar with the use of ICT equipment but also users who are familiar with ICT equipment, allowing the tablet to run apps, for example, so that it can be used effectively according to the user's skill level.

 Must Present Itself as an Analog Device that Can Be Operated Manually by Physical Interaction

Many users, especially those of older generations, were appreciative of the fact that Tomokaku provided them with a familiar means of communicating thoughts and ideas that might not seem important enough for a phone call or email.

 Must Have a Means of Choosing between Synchronous and Asynchronous Communication According to Circumstances

The users liked the fact that Tomokaku shares handwritten notes directly, allowing the person at the receiving end to read finer nuances from the sender's handwriting compared with other asynchronous communication means.

Furthermore, Tomokaku was rated more highly as a synchronous communication means than as an asynchronous communication means, and the users particularly appreciated the feeling of closeness they obtained through the function whereby the sender's handwriting is displayed in real time. Some users said it gave them a stronger feeling of interacting with a real live person, making them more inclined to respond quickly and express their true feelings.

4) The Device Must Be Specified so that the Children of the Elderly Generation Can Perform the Required Setup Operations before Presenting It to Their Elderly Parents

Since this prototype was designed to connect to the Internet via a wireless LAN, it was not possible for the children to perform the initial settings all by themselves, and their elderly parents had to perform some setting operations too. Some users seemed to have difficulty in completing these settings, so when studying refinements of this product for commercial use, we must consider specifications that can be set up more easily.

As stated above, we have confirmed that this concept — which was studied and proposed as a method that implements smooth communication by eliminating intergenerational gaps among families — is effective with regard to the insights, hypotheses and creation policies focused on at the study stage. Although there are still some issues to resolve, the proposed concept has been highly rated by users and appears to have strong market potential. communication concept called "Tomokaku" that was proposed for the purpose of resolving intergenerational communication gaps and facilitating smooth communication among families. On November 9– 11, 2017, a prototype of this concept was exhibited at the docomo R&D Open House 2017 in Tokyo, where it was also well received and featured prominently in the visitor feedback questionnaires.

In the future, we will continue to study the commercialization of this design while addressing issues that came to light during the evaluation.

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#### 5. Conclusion

In this article, we discussed a handwritten