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Guidelines for Designing Human Interfaces for Children and their Application to the Koron-net Communication System

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When information is used for communication, it becomes what we at Fujitsu refer to as "information media." These days there are many opportunities for children to use information media such as e-mail and BBSs. A designer of a human interface (HI) for children must understand the gap between an information media and its users. We have developed human interface design guidelines to bridge this gap from the cognitive and ethnological viewpoints. We applied our guidelines to the design of Koron-net, which is a communication system designed for children. This paper describes our guidelines and a trial use of Koron-net between three primary schools that was conducted to examine our design approaches.

1. Introduction

In the classroom and at home, children now have many opportunities to use PCs and the Internet. We believe that in the near future the Internet will also be used daily for communications such as telephone and mail communications and become a universal media just like a human language. The purpose of our research is to develop design guidelines for communication tools that can be used safely and easily in everyday life.

In this paper, we formalize a user's interaction with a field by using a "3-stage field model" based on the proxemical approach. Then, we take a look at human interface (HI) design from the viewpoints of cognition and ethnology. Next, we describe the application of our HI design guidelines to "Koron-net," which is a communication system for children. Lastly, we examine the effectiveness of our HI design guidelines based on a trial use of Koron-net between three primary schools and outline an approach to overcoming various problems regarding the design of information media.

2. Definition of terms and some problems

We can consider that WWW browsers and e-mail systems are themselves a form of information. When such information is used for human communication, the information can be regarded as media which can convey the users' intentions and expressions; we therefore call this type of information "Information media." In this paper, we focus on the use of information media on the Internet.

When designing information media for children, various points must be taken into consideration. For example, information media are not tools that are used everyday like the telephone and they are not easy for beginners to use. In addition, some children have had little experience communicating using information media.

3. Proxemical viewpoint

In the Japanese business environment, 60 percent of workers tend not to leave messages using voice mail;[1] whereas in the U.S., people tend to use voice mail for most of their verbal business

Stage 1: Entrance into the field
Stage 2: Behavior in the field
Stage 3: Exit from the field

Figure 1
Field model.

communications. In offices in the U.S., workers usually have their own telephone and callers think it normal to leave messages. Therefore, the user's attitude toward the telephone as a communication tool determines how the information medium is used and generates a distance between the communicating persons; this distance is the subject of inter-personal relations and human proxemics.

Because computers penetrate into every aspect of life and business in the same way as telephones, the ease with which they can be used, peoples' attitudes toward them, and cultural conditions will shape how they are used. Thus, we should not only think of the human-computer interface, but also of the proxemical viewpoint; that is, how inter-personal relations are adjusted via the medium.

4. Field model

We formalized a user's participation in a field on the Internet from the proxemical viewpoint using the field model shown in **Figure 1**. This model has three stages: "Entrance into the field," "Behavior in the field," and "Exit from the field."

The problem in the first stage is how the designer can attract children to the field. In this stage, children try to recognize the new world. We must help them to do this intuitively instead of using words to explain abstract concepts. It is also important to appeal to children's imagination and to motivate them.

The problem in the second stage is how to make children feel that they have a high degree of freedom to experiment and explore by themselves. Therefore, we should provide them with choices and items which they can manipulate. It is also important for children to be able to maintain the proxemics with other people by using a tool for adjusting inter-personal relations.

The problem in the third stage is how their experiences in an information medium can be connected to the real world; that is, how to ensure that the children recognize in the real world the elements of their experiences. Also, we hope that their experiences in the information medium can help educate them about the real world.

Hints about creating the human interface (HI) design guidelines can be obtained by solving problems in the field model from the cognitive and ethnological viewpoints described in the next chapter.

5. Human interface design from two viewpoints

5.1 Cognitive viewpoint

The first thing a user does when establishing a relationship with an object is to perceive it. However, in most cases, we cannot directly perceive by ourselves, so we have to accept a relationship made by other people. In this sense, we can define the human interface of an information medium as an interface for supporting the user's perception and awareness.

The user has three usage processes corresponding to the above three stages of the field model. These processes are, respectively, "Search for usage," "Decision for usage," and "Actual usage."

The Search for usage occurs as soon as the user encounters a target. Some cognitive actions start within one minute as a top-down process. The proxemical distance between the user and the information medium is adjusted for the progression to the second and third processes. In addition, the user has experiences such as surprise, awareness, and behavior modifications which form the basis of perception and help the user establish a relation with the information medium. Therefore, the interface for supporting the user's perception should be built into the first stage.

5.2 Ethnological viewpoint

Humans have used audio and visual media

not only for language communication, but also for forms of communication that represent our nonverbal communicative attitude, for example, gestures. We can learn participants' intentions and attitudes, for example, their desires and expectations of communication, and we also can learn their natural, historical, and social fields. In short, the proxemical distance is used in these socio-cultural fields or contexts as prescriptive deeds to represent our desire to maintain physical and psychological distances. Therefore, the development of software products for human-machine interactions requires a deep consideration of the relationship between actual communication and expected communication supplied by the information medium. We should therefore adopt an ethnological approach for creating a wide world of information media.

6. Human interface design guidelines and Koron-net

6.1 Overview

6.1.1 Human interface design guidelines

We created HI design guidelines to support each stage in the field model from the cognitive and ethnological viewpoints.

First, the overall guidelines were established. Two of these guidelines are as follows.[1)]

- Design work should be started by determining the purpose, the function/object/interaction, and the method/interface.[2)]
- It is important to recognize the structure of relations between the designer and user and between users, and keep these relations consistent.[4)]

Next, we will describe the 1-minute model used for the first stage of the field model and four principles for the second stage (the principles are Idea of background, Design of background, Principle of interaction, and Channel of interaction). Lastly, we look at problems associated with the third stage of Koron-net.

6.1.2 Koron-net

Koron-net is an information medium based on the standard electronic bulletin board system. Children can exchange multimedia messages such as hand-drawn pictures input by scanner, voice messages input by microphone, photos input by digital camera, and paintings created using Koron-editor, which is a paint tool built into Koron-net. Children as young as about five years old can immediately enjoy communicating using Koron-net.

6.2 Design of entrance

The purpose of design in this stage is to create the power to attract children to the field. In the 1-minute model shown in **Figure 2**, children are attracted within the first minute to the field provided by the information medium. In this stage, it is important to stimulate their senses and imagination using sound and video.

When children use Koron-net, they first are shown a 1-minute movie. This movie consists of three parts based on the 1-minute model. At the beginning, many balloons with a message card flying around the earth are shown to impress and attract the children. Next, scenes from the real

Step 1: 5-second duration
Main function: Induces moderate excitation of autonomic nervous system.
⇒ *Heart beats faster and blood pressures rises.*
HI technique: Use characters that are novel and attractive to children.
· Promote reality of pictures and motions using vivid colors and simple operation.

Step 2: 30-second duration
Main function: Make users feel they can successfully execute operations by themselves to build self-confidence.
⇒ *Users gain confidence.*
HI technique: Use a rhythm and rules to make the operations comprehensible.
· Use short screen switching times so users do not have to wait.
· Ensure that users successfully execute an operation at their first attempt
(Guarantee success to increase self-confidence).

Step 3: 25-second duration
Main function: Arouses expectations for the next use.
⇒ *Users proudly show others that they have been successful.*
HI technique: Maintain the rhythm and tempo.
· Maintain consistency in the design concept of each part.

Figure 2
1-minute model.

Figure 3
Screen image of Koron-net.

world are shown to make associations with daily life and make the children relaxed. In addition, the spatial relationship between the childrens' home position (base point for use) and the external field (virtual world provided by Koron-net) is shown. Last, the procedure to be followed from message reception to message sending is shown to help motivate the children.

6.3 Design of behavior

The purpose of design in this stage is to give children a sense of freedom in the field. Here, it is necessary to clarify the following points:

The overall image/function of the field,
how children can interact with each other in the field, and
what items children can use as a channel for interaction.

In this section, we show how these points relate to the design of Koron-net.

6.3.1 Idea of background

The Idea of background is the purpose of the design; that is, the underlying idea, thought, or message of the design. For example, the idea of background could be "affection." The Idea of background in Koron-net is described below.

A computer enables us to do things we otherwise could not do. For children, computers open up a world of the future where they can live with their friends. On the other hand, the designer, who is an adult, lives in the present. The designer must be aware of this when designing media for children. Designing media for children can be thought of as communicating with children who live in the future. This future enables children to look at the world from another point of view and carry out their intentions.

6.3.2 Design of background

The Design of background expresses the Idea of background concretely. The Background should show the relations to other related worlds and the external world. In Koron-net, the boundary between a private world and a public world is expressed as a window. Through these windows, children can get a glimpse of the future, feel the presence of friends, and become acquainted with the concept of receiving and sending messages (see **Figure 3**).

6.3.3 Principle of interaction

Interaction is acquired by a good balance of the sender's expressions with the receiver's understanding. The simplest type of expression is a selection. The important points regarding interaction are as follows.

A child should be able to operate the system easily while watching, listening, and understanding ("Principle of direct manipulation").

The system should be able to maintain a child's expectations and participation by reacting to the child's inputs ("Principle of expectation and reaction").

The results of an action made by the user must always be indicated with an icon, etc., for easy confirmation ("Principle of directness").

Operations on the screen should be done at the same time and place, and the same task should be accomplished by the same method ("Principle of consistency").

In Koron-net, sound effects and animated guidance are used to show what the user is doing and has already done.

6.3.4 Channel of interaction

The Channel of interaction consists of the interface and the items which the children can operate and manipulate independently. The im-

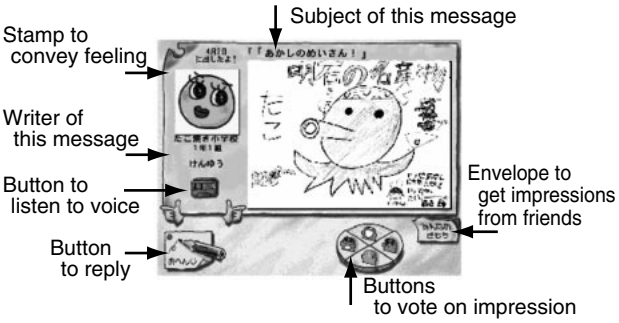

Figure 4
Screen image of message exchanged using Koron-net.

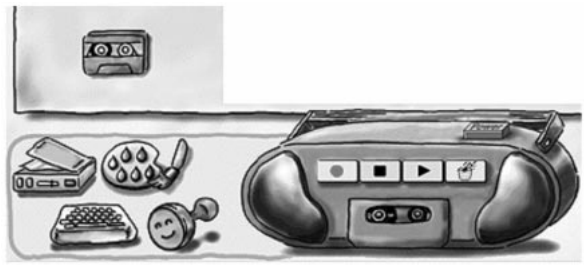

Figure 5
Everyday items.

portant points for constructing the Channel of interaction are as follows.

The children should be able to feel sympathy for the target world ("Principle of sympathy").

The children should be able to select their favorite color, sound, and mode ("Principle of selectivity").

The children should only be asked to operate one thing at a time ("Principle of simple operation").

The operation, presentation, procedure, and method of various scenes should be designed so that they are interrelated and acceptable to children ("Principle of acceptability").

Icons, audio symbols (e.g., well-known tunes) and visual symbols for articles in everyday use should be used to directly encourage the children to imagine the target world.

In Koron-net, the items for interactions, for example, scanners, microphones, digital cameras, and editors are presented as ordinary everyday items (**Figures 4** and **5**). The framework for "exchanging impression buttons" is shown in **Figure 6**. Using this framework, even young children can exchange impressions easily. In this framework, the childrens' impressions are totaled on the server machine and attached to each message in an envelope.

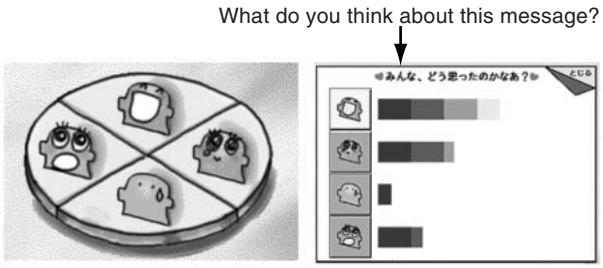

Figure 6
Framework for exchanging impressions and envelope contents.

7. Trial use between three primary schools

7.1 Purpose

As already described, the design of the Entrance into the field and the design of the Behavior in the field were taken into consideration when Koron-net was designed. To examine these ideas and evaluate our HI design guidelines, we then conducted a trial use of Koron-net.

7.1.1 Evaluation of design of Entrance into the field

To evaluate our design of Entrance into the field, the effect of a movie based on the 1-minute model, which is a device used in the first stage in the field model, was examined. Children of about 10 years old watched this movie with no explanation about this trial or Koron-net. Then, we tried to determine what the children were thinking at the beginning by analyzing their answers to a questionnaire called "What can you do using Koron-net?"

7.1.2 Evaluation of design of Behavior in the field

To evaluate the design of Behavior in the field in Koron-net, we examined the effect of the framework for exchanging impression buttons. This framework is a device used in the second stage of

the field model and is also a communication channel.[5)]

We compared the access log of Koron-net with those of 1390 BBSs on a PC network in Japan, the users of which are mostly adults.[6)] In the comparison, we assumed that if the Koron-net children could also use the BBSs on the PC network, their access logs and the access logs of the adults would show similar tendencies. In this trial, the children could use Koron-net for arbitrary purposes, so in one sense, the user environments of Koron-net and the BBSs were similar.

Using the results, we then considered how much the framework for exchanging impression buttons simplified participation.

7.2 System configuration for trial

The system configuration set up in the three primary schools is shown in **Figure 7**.

8. Results and analysis

8.1 Design of Entrance into the field

The childrens' responses are shown in **Table 1**. The table shows that the children mostly regarded Koron-net as an inter-personal communication tool. We would like to emphasize here that the children also thought that Koron-net could help them make friends and deepen existing friendships. This suggests that the movie based on the 1-minute model stimulated their imagination.

8.2 Design of Behavior in the field

Table 2 shows a summary of activity on Koron-net and on the 1390 BBSs.[6)] Since the execution periods are different, the numbers of messages exchanged per day were compared.

Table 3 shows the percentages of active participants in Koron-net and the BBSs. Generally, in the BBSs, there are more "Read Only Members" (ROMs) than message senders. We call the message senders "active participants." As Table 3 shows, the number of ROMs is much higher in the BBSs than in Koron-net.

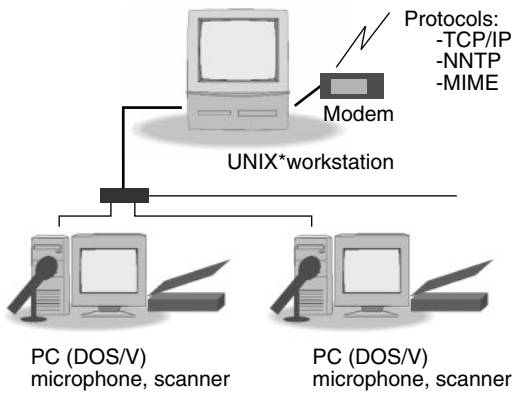

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Figure 7
System configuration used in trial.

Table 1
Childrens' answers to question "What can you do with Koron-net?"

Answers	Number of answers
Communication · I can talk with friends all over the world. · I can have a lot of friends. · I can receive letters. ..., etc.	44
Learning · I can learn what is happening in the world. · I can learn about the world and foreign languages. ..., etc.	7
Others · I can introduce my school. · I can play games. ..., etc.	6

Table 2
Activity on Koron-net and BBSs.

	Koron-net	BBSs
Period	162	254.6
Messages	667	210.5
Senders	79	41.1
Messages per day	4.1	2.6
Senders per day	0.5	0.6
Messages per member	8.4	6.2

Table 3
Active participants in Koron-net and BBSs.

Koron-net	BBSs
77.5%	12.2%

We call the members who sent the largest number of messages "first-rank participants," the members who sent the second largest number "second-rank participants," etc. We call the members who sent only one message "1-time participants," the members who sent two messages "2-time participants," etc. **Figures 8** and **9** show the distributions of active participants in Koron-net and the BBSs, respectively.

In the BBSs, there is the tendency for a few members to send many messages and for the majority of the members to send only a few messages, so the percentage of members who are actively engaged in the community is quite small. In the case of Koron-net on the other hand, the difference between the number of first rank participants and 1-time participants is small. Therefore, most of the members of Koron-net were engaged in the community at a similar level.

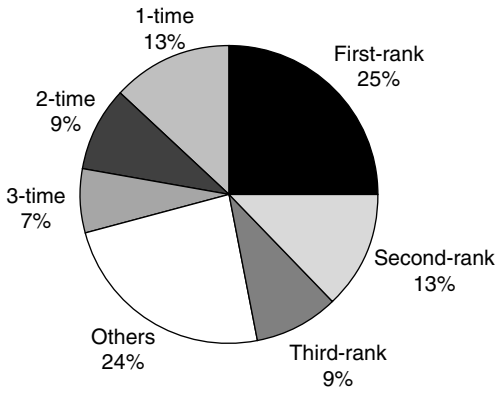

Figure 8
Distribution of active participants in Koron-net.

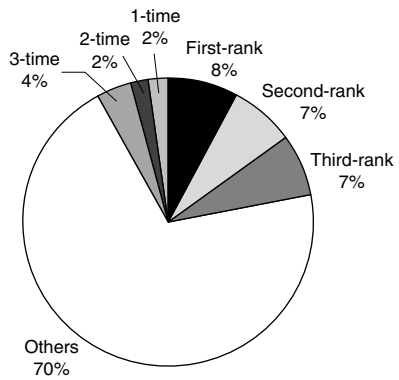

Figure 9
Distribution of active participants in BBSs.

Table 4 shows the number of message replies in Koron-net that were made using text and the number of replies made using only impression buttons as percentages of the total number of replies sent in the system. The table shows that the percentage is much higher for the "impression button only" replies. **Table 5** shows the percentage of children who said they replied to messages using text and the percentage who said they replied using only the impression buttons. About 95% of the children indicated that they replied to messages by selecting impression buttons, which is a higher rate than the total rate of active participants in Koron-net (Table 3).

In the BBSs, there were only two choices: to write a message or not. Perhaps, therefore, providing a framework for exchanging impression buttons encourages ROM members to participate in the community.

The fact that more children exchanged impression buttons than text in Koron-net suggests that the framework for exchanging message buttons satisfied the needs of many of the children who wanted responses to their messages.

A framework for exchanging impression buttons appears, therefore, to promote activity in an information media field.

8.3 Design of Exit from the field

In this trial, a girl in one of the primary

Table 4
Message reply types sent in Koron-net as percentages of total number of replies.

Text	Impression buttons only
17.7%	47.7%

Table 5
Percentages of children who said they replied to messages using text or impression buttons only.

Text	Impression buttons only
52.7%	94.5%

schools read a melody that a boy of another primary school had composed and then sent to the girl using Koron-net. In response, the girl composed her own original melody and sent it as a threaded message. This girl could, therefore, connect her experience on the Internet to her real world. She did something on the Internet that she could not otherwise do and recognized this Internet experience as a real experience.

Exiting from the field usually means returning to the home environment. The exit from the field should be designed so that children can smoothly return to their real world from the virtual world created by the information medium. The children themselves should be able to freely access the field, actively communicate with another person via the field, and then return to the real world when they want to. The system, therefore, should maintain a balance between the quantity and quality of messages exchanged between the system and the children.

However, because children may want to leave the field at any time, we cannot use an exit from the field that is designed only for a predetermined time. A good system design, therefore, allows the participant to leave the field at any time.

9. Several design problems and how to overcome them

It is especially important to realize that when we encourage children to communicate with each other without restraint via an information media, we inevitably appear as adults. Also, it could be argued that by wanting children to enjoy their freedom in the virtual world, we are just game providers. Conversely, if we want to teach children how to be respectful towards other people while communicating in the field, we may implicitly introduce the real world into the field, which may prevent the discovery of open, global, and novel worlds provided by the information media and prevent encounters with anonymous people.

To avoid these problems, we should design communications not by using a real-world approach but by using an ethnological approach for a world that is novel and expansive. If we do this, we can expect children to make their own tales in the information world, which will help them recognize other people as equals to themselves.

10. Conclusion

This paper described our approaches to designing information media for children and described our human interface design guidelines and Koron-net as example implementations of our approach. Then, we described a trial use of Koron-net between three primary schools which verified the effectiveness of using human interface design guidelines based on the three stages of Entrance into the field, Behavior in the field, and Exit from the field. Lastly, we described an approach to overcoming various design problems.

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