

## 4. The Personal Agent-oriented Virtual Society

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### 4.1. Introduction

In the previous chapter, we described the system architecture, components, and multi-user application programming models of CP system and how the system works to realize a large-scale 3D MUSVE in the Internet. As we described, the CP system provides an underlying system for realizing the MUSVE in the Internet. It allows many people to participate in the same virtual environment, meet with via an avatar, and interact with other people in several ways. Such interactions include the ability to communicate with each other, visit locales with each other, and participate in events (happenings) in the same virtual environment. However, this environment is necessary for realizing a society but is not enough. It is not obvious to realize social spaces based upon the environment. The next important step is to extend these environments into a “virtual society” which enables many people to organize social activities. As research on realizing the virtual society is still on-going, it is still unclear what is important to realize the virtual society. Therefore, it is important to investigate its various functions and interfaces experimentally with a large number of people.

To investigate the functions/interfaces, it is important to attract and maintain a lot of people in a MUSVE and evaluate them in the environment from user’s perspective. Because, if few people enter in the world, it is hard to maintain a social system and the environment becomes a ghost town due to a sparse population. Only the Internet environment makes it possible to realize such environment and allows us to evaluate the environment populated by many people. Therefore, we decided to take the following approach: we construct a 3D MUSVE which enables attracting and maintaining many people. Then, we release it into the Internet to allow all

Internet users to access the environment freely. After maintaining many people in the environment, we will conduct several social experiments based upon the environment to evaluate it from several aspects. For this purpose, we decided the design on design policies for developing a virtual society and constructed “PAW” based upon the policies by using CP system.

PAW (Personal Agent World) is a 3D personal agent-oriented virtual society with a social and environmental infrastructure where each user has her own personal agent. Figure 4.1 shows a screenshot of PAW^2 (the improved version of PAW). The personal agent is an embodiment agent and acts as a user’s communication partner and mediator in 3D MUSVE. Users can interact with the personal agent at any time and receive a constant service from the personal agent. PAW is publicly accessible on the Internet and all Internet users can access the world freely. The software is available from PAW’s home page or CD-ROM in some magazines. Users can access the manual in the home page or from the “help” menu in the CP browser.

In this chapter, we describe how we realize PAW and its initial evaluation.

Notice that PAW system has been improved after the initial evaluation was done. Its improved version is called “PAW^2.” In this chapter, we mainly describe PAW^2 for making readers easier to understand the system, because the PAW^2 system contains most features of the PAW system. The difference between the two systems is described as appropriate in the following chapters. Also see Matsuda and Miyake (2000) for the detail about the improvement of PAW^2 and its evaluations.

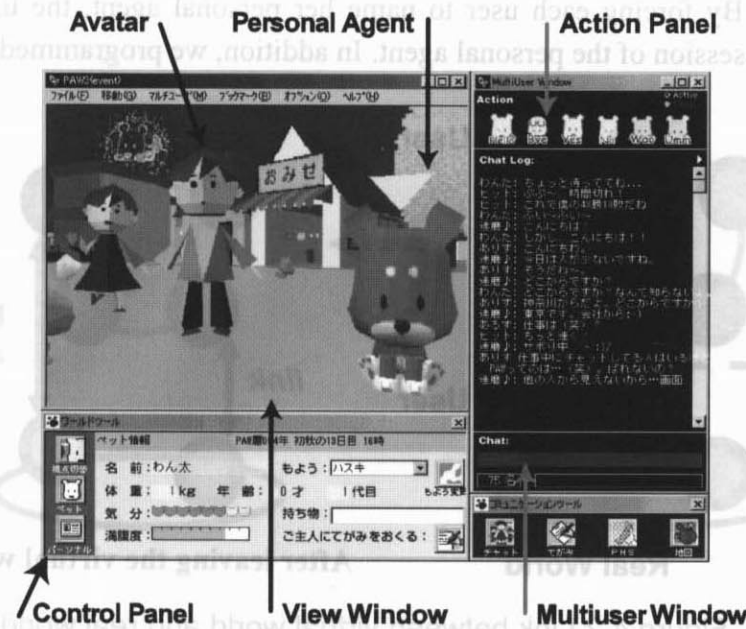


Figure 4.1 A screenshot of PAW^2

## 4.2. Design Policy

In order to make MUSVE possible to work socially and conduct social experiments, the environment needs to be populated by many people and allow them to organize social activities. For this purpose, we considered that several hundred simultaneous daily user access and several thousands accumulated user access are necessary. To achieve such high access rate, we have decided on design policies before developing our virtual society, i.e. PAW<sup>2</sup>, to support the following three points;

- (a) encourage people to stay in PAW<sup>2</sup> for a long time,
- (b) encourage people to visit PAW<sup>2</sup> repeatedly, and
- (c) encourage people to organize social activities in PAW<sup>2</sup>.

Based upon these points, the following four design policies are established:

- (1) Introduction of personal agent, (2) Introduction of social and environmental infrastructure, (3) Introduction of single-user game, and (4) Peaceful scene of world.

### (1) Introduction of personal agent

Most past and existing MUSVEs retained nothing about the user after she exits from the MUSVE (see the left side part of Figure 4.2). We thought this does not encourage the user to visit the MUSVE repeatedly. To solve the problem, in PAW<sup>2</sup>, we introduced a personal agent and assigned the personal agent to each user (Figure 4.3). By forcing each user to name her personal agent, the user can have feeling of possession of the personal agent. In addition, we programmed the personal

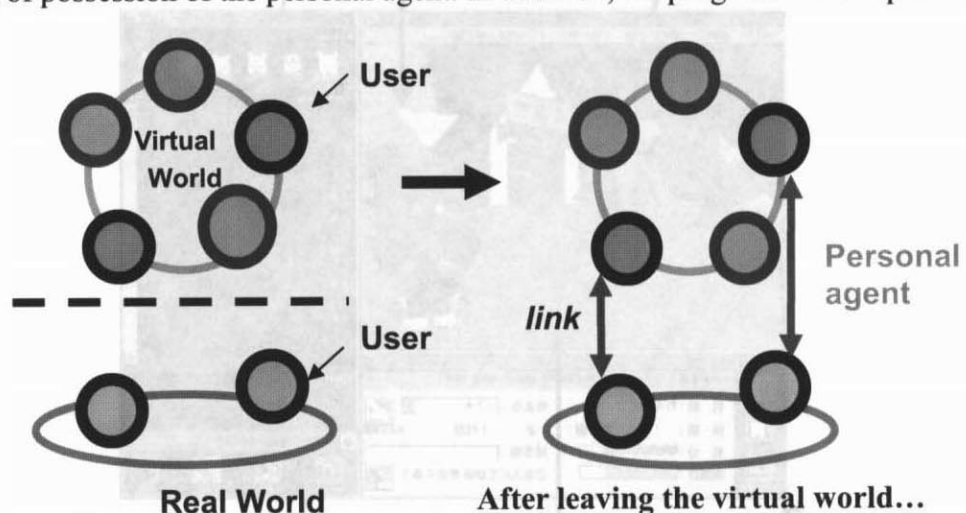


Figure 4.2 Link between virtual world and real world

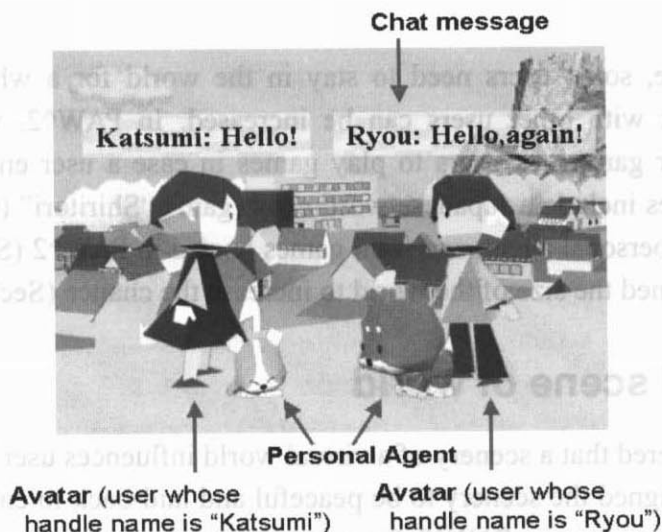


Figure 4.3 Basic interaction style in PAW^2

agent to have a life cycle and she<sup>1</sup> can grow up. Therefore, we can create a link between the PAW^2 world itself and the user (see the right side part of Figure 4.2) and this encourages the user to visit PAW^2 easily and repeatedly. In addition, a personal agent has several functions to enhance the link. We describe the personal agent in detail in Section 4.3. Since this virtual society is based upon a user's personal agent and specially designed social functions based upon the pair (i.e. agent and user), we call this system a "personal agent-oriented virtual society".

## (2) Introduction of social and environmental infrastructure

To construct a society (even it is a "virtual" world), only providing a MUSVE is not enough. Like the real world, a social and environmental infrastructure is necessary for enabling people to perform social interaction in the environment. In PAW^2, as a social infrastructure, we introduced an economic system (virtual shop, virtual money, and barter system), in-world communication systems, name card system and so on. As an environmental infrastructure, we introduced four distinct seasons (expressed for example in a change of scenery and ambient sound), day and night, a time measuring system, and more. We describe a social and environmental infrastructure in detail in Section 4.4.

## (3) Introduction of single-user game

If few people enter in a virtual world, it is hard to maintain a social system and the world becomes a ghost town due to a sparse population. To populate the

<sup>1</sup> Note: Both female and male personal agents exist in PAW^2, however for writing brevity we write simply "her" when referring to agents of either gender. Likewise for real users, the same writing style is used.

world with people, some users need to stay in the world for a while. Thus, the chance to interact with other users can be increased. In PAW<sup>2</sup>, we introduced several single-user games for users to play games in case a user enters the world alone. These games include a Japanese word-chain game “Shiritori” (Figure 4.4)<sup>1</sup>, a quiz game with a personal agent, and mini games hosted in PAW<sup>2</sup> (Section 4.5). In addition, we designed the size of the world to increase the chance (Section 4.6).

## (4) Peaceful scene of world

We considered that a scenery of a virtual world influences user’s behaviors in the world. We designed the scenery to be peaceful and laid-back to encourage users, especially women, to stay in PAW<sup>2</sup> for a longer time and promote a harmonious environment. In reality, we designed the scenery of PAW<sup>2</sup> based upon the scenery in Japan of halcyon days (1960s to the 1970s).

### 4.3. Personal Agent

We have defined the personal agent as an autonomous agent which personally supports a user while in a virtual world. Autonomous agents are computer application entities that are capable of independent action in open, dynamic, unpredictable environments. The agents are currently being applied in various domains, such as computer games and interactive cinema, information retrieval and filtering, user interface design, and electronic commerce (Maes et al., 1999). In PAW<sup>2</sup>, the personal agent is realized as a dog-shaped autonomous shared application controlled by program which ‘lives’ in the multi-user world. Therefore,



Figure 4.4 A word-chain game “Shiritori” with a personal agent

<sup>1</sup> A word game in Japan in which one player has to say a word starting with the last syllable of the word given by the previous player. If one player says the word ended with “N”, the player loses the game. In Figure 4.4, RINGO -> GORIRA -> RAION. In this example, the personal agent lost the game.

in addition to the user who owns the personal agent, other users can interact with the personal agent in the world.

A personal agent of PAW^2 is intended to be a guide, a playmate, a teacher, and a friend to users. The personal agent can utilize several information in a MUSVE to support user, e.g. the information of user herself (such as user's interests), that of user's context in the MUSVE (such as user's location), and that of the MUSVE itself. In addition, the personal agent acts as a mediator between her owners (Figure 4.5). For example, when a personal agent wears an interesting accessory, we can expect other users to ask the owner of the personal agent about the accessory, such as "How did you get the accessory?"

Bates (1997) and Maes (1995) have written on the importance of emotion in creating believable, entertaining agents. In addition to the basic support functionality of agent, PAW^2's personal agent also has both personality and transient mood (such as happiness) that can influence her behaviors.

### 4.3.1 Functional classification

Basic research on functional classification of agent is done in Nishida (1997). According to the classification, we can define our personal agent as follows. PAW^2's personal agent is an autonomous program which has the following composite functions:

- human interface by using anthropomorphic (human-like) entity,<sup>1</sup>
- autonomous program which performs tasks for the user, and
- autonomous program which has functions to negotiate with other agents and other users.



Figure 4.5 Interaction between owners

<sup>1</sup> In case of PAW^2, the entity is based on a "dog."



## 4.3.2 Appearance and behaviors

The previous research on agents is mainly focused on realizing an intelligent and anthropomorphic agent (Takeuchi and Naito, 1995; Nagao and Takeuchi, 1994). But in PAW<sup>2</sup>, we made the visual design of a personal agent friendly and cartoon-like to allow users to interact with her freely and easily. In addition, we did not try to add intelligent functions and made her behavior and interface rather infantile. Therefore, the owner of the personal agent does not need to have too much expectation of the agent, and can interact with her freely.

A personal agent has the appearance and behaviors shown in Figure 4.6. This design is based upon a famous cartoon character<sup>1</sup> in Japan and has a friendly appearance. The personal agent has more than one hundred behaviors such as smiling, eating something, being playful, and swinging its tail. These behaviors are triggered by the internal state of the personal agent and by interactions with owner. These actions help sustain users' interest in PAW<sup>2</sup> world. The personal agent also supports several types of voice of a dog, such as "bowwow."

A personal agent always walks around with her owner while the owner is in the PAW<sup>2</sup> world. When the owner is stationary, the personal agent is positioned in front and to the right side of the owner to provide services constantly. So the owner can receive the services, such as getting information about PAW<sup>2</sup> from the personal agent or playing single-user games with the agent at anytime and anywhere in PAW<sup>2</sup>.

## 4.3.3 Interaction with a personal agent

An owner can interact with her personal agent in several ways: via a mouse, a control panel, and natural language.

- With a mouse, the owner can directly stroke her personal agent like a real dog. The personal agent carries out a delight actions in reaction to that.

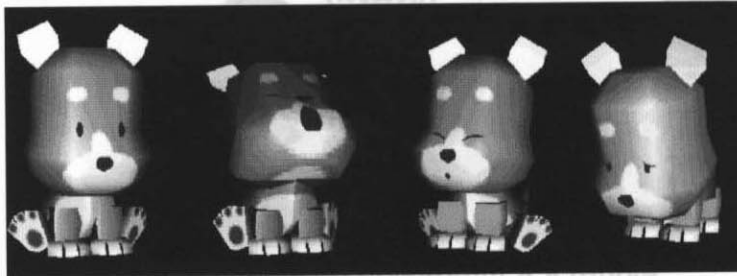


Figure 4.6 Appearance and behaviors of a personal agent

<sup>1</sup> "TAMA & FRIENDS": <http://www.scp.co.jp/characters/chara01.html> (in Japanese)

Also the owner hits her personal agent by clicking the agent to stop the bad behaviors.

- The control panel provides a PAW^2- specific GUI to interact with the PAW^2 system (see Figure 4.1). It also supports a user interface for a personal agent. For example, by selecting a food object from the belongings window with a mouse and clicking the “put” button in the control panel, the owner can put the object into the PAW^2 world and give it to her personal agent. Also the owner can get status information on the agent, such as hunger or emotion, by clicking the “status” button in the control panel.
- A personal agent has a natural language processing function extended on ELIZA (Weizenbaum, 1966). We extended ELIZA in a speech-oriented approach for a personal agent. We describe this architecture in Section 4.7.3. A personal agent can react to her owner’s (and other user’s) speech, instructions, and questions by using natural language. For example, the owner can ‘say’ (by typing a text message on the keyboard) “Let’s play a quiz game!” to start the game. Basically, a personal agent reacts to all text messages of her owner. In addition, we prepared various text patterns related to PAW^2 (e.g. items or events) to enable the personal agent to react to PAW^2-related chat message. Furthermore, we enriched the default text messages spoken out by a personal agent when the inputted text message does not match the predefined patterns.

In addition to the basic ELIZA functionality, the personal agent can speak out autonomously based upon the followings: her owner’s context in PAW^2 (e.g. location), her internal states, happenings (e.g. login/logout of her owner, encounters with other users or AOs, mail arrival), and PAW^2’s events. By using this function, the personal agent can greet, communicate her status, give information on PAW^2 world, and provide a cue to start chatting between owners or start playing games. For example, a personal agent can say “Please say ‘Let’s play a quiz game!’ to me” to the owner.

In terms of speech from a personal agent, she uses infantile expressions based upon her age. So, she speaks like a child. We considered that this feature also helps users not to have too much expectation of a personal agent, and can interact with her freely.

This natural language interface helps to simplify the user interface of PAW^2 system. For example, when a user asks “Teach me!” to a personal agent, the personal agent can inform about additional information about PAW^2 world or how to enjoy PAW^2 to the user. When a user wants to meet someone in PAW^2 world, the user can say “Fly me to!” to her personal agent. The personal agent locates someone in



PAW^2 randomly and relocates the user to that location<sup>1</sup>. In addition, we provided similar instructions available for the real dogs. For example, “Hand!” is the instruction to ask a personal agent to shake hands with her owner.

These interactions with a personal agent can affect her internal states such as growth and emotion. They also give a personality to the agent.

### 4.3.4 Being alive for 24 hours a day

A personal agent is implemented as an AO (see Section 3.3.3) and is controlled from the server side. So, as long as the AO is running on the server, the personal agent managed by the AO will continue to live in PAW^2 after her owner leaves PAW^2. At that time, the personal agent walks around the PAW^2 world freely, picks up something in the world, eats it, or gathers something that her owner likes. The agent will inform her owner about it next time she meets the owner. Sometimes, when a personal agent ate something wrong while her owner is not in PAW^2, she becomes sick. Additionally, a personal agent can receive food or medicine from other users and greet her owner’s friends. Being alive for 24 hours a day also can help to enhance the link between the user and the PAW^2 world to encourage the user to visit the world repeatedly.

### 4.3.5 Function to send Internet mail

A personal agent can send Internet mail (e-mail) to her owner. A user registers her own e-mail address to the personal agent when she accesses PAW^2 for the first time. We can utilize this function to inform information to the owner and also enhance the link between the personal agent and her owner (Figure 4.7).

A personal agent sends e-mail to her owner if the personal agent has new information about PAW^2, becomes lonely (i.e. her owner does not visit PAW^2 for a long time), becomes hungry, becomes sick, and so on. This function is also used to send information about notification of events provided by PAW^2 (see Section 4.5).

For example, when a personal agent becomes hungry, she sends “I’m hungry” mail to her owner. In a similar way, when a personal agent becomes sick, she sends “Help me!” mail to her owner to help her. If another user helps the personal agent in advance, both the user and her owner receive an e-mail from the personal agent concurrently. In this case, the personal agent sends “Thank you!”

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<sup>1</sup> To avoid anti-social user behavior such as stalking, a user cannot move directly to another user's position by using the command “Fly me to <user name>!” It is important to design a socially-acceptable user interface for a virtual society. See also Section 4.7.8.

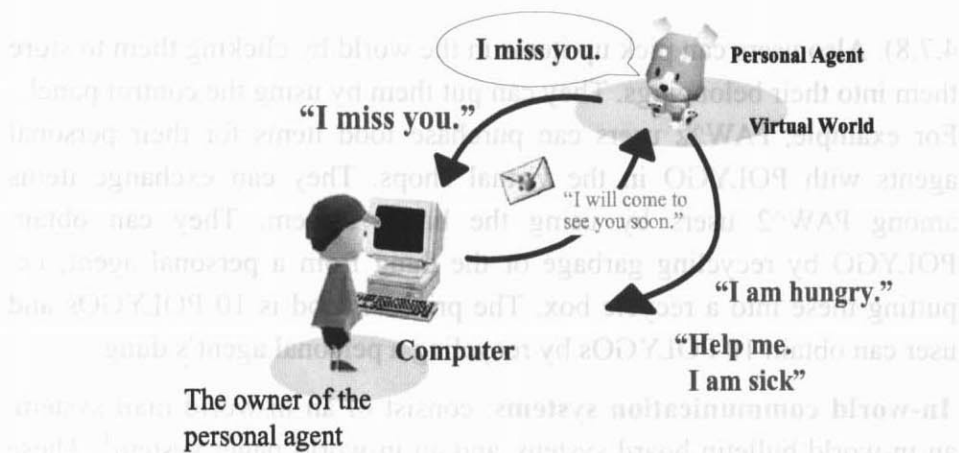


Figure 4.7 Function to send Internet mails

mail to the user who helped her and "She helped me. Please say thank you to her!" mail to the owner. This can provide a cue to owner and the helper to communicate with each other.

## 4.4. Social and Environmental Infrastructure

PAW^2's basic infrastructure for a virtual society can be categorized into two types: social and environmental infrastructure. The social infrastructure is a software system for realizing and supporting various social systems in a virtual society. The environmental infrastructure is a software system for realizing and controlling scenery in a virtual world and its sense of time.

### 4.4.1 Social infrastructure

PAW^2 provides software components for supporting the social infrastructure to enable people to perform social interactions. These consist of an economic system, in-world communication systems, a name card system, a text chat system, and a handle name system.

- **Economic system:** consists of virtual shops for selling virtual goods (items) in the virtual world, virtual money called "POLYGO", and a barter system. An item is a fundamental component in this system which users can possess. For example, The PAW^2 system provides food for personal agents, accessories, and name cards as items. POLYGO is the monetary unit in PAW^2. The barter system basically allows users to barter items by hand (avatar's hand) in the PAW^2 world (see Section

4.7.8). Also users can pick up items in the world by clicking them to store them into their belongings. They can put them by using the control panel. For example, PAW^2 users can purchase food items for their personal agents with POLYGO in the virtual shops. They can exchange items among PAW^2 users by using the barter system. They can obtain POLYGO by recycling garbage or the dung from a personal agent, i.e. putting these into a recycle box. The price of food is 10 POLYGOs and user can obtain 10 POLYGOs by recycling a personal agent's dung.

- **In-world communication systems:** consist of an in-world mail system, an in-world bulletin board system, and an in-world pager system<sup>1</sup>. These systems are available only in PAW^2. Therefore, users need to enter PAW^2 to use them. They can use these communication systems with their handle name to help them to communicate with each other easily.
  - **In-world mail system:** is an e-mail system within PAW^2 and provides similar functionality of existing electronic mail system in PC environment. Just like sending e-mail by using a mailer in PC, a user can send an in-world mail by writing its header and body, and pushing the “send” button. The in-world mailer can be accessed through PAW^2's control panel.
  - **In-world pager system:** is a messaging system to allow users to exchange short messages (within 30 characters) in real time between users outside each other's aura just like a conversation in the real world (Tsuji et al., 1999). When message recipient is outside the sender's aura, real time chat is not possible in CP system (Section 3.6.2). This operation is by design, in order to allow users the ability to opt in or out of conversation at will depending upon proximity to other users (see text chat system below). In the out-of-aura case, the pager system allows users to exchange short messages by inputting the text and pushing carriage-return or the “send” button.
  - **In-world bulletin board system:** is a bulletin board system (BBS) represented in 3D shape in PAW^2 world and provides similar functionality of existing bulletin board systems in Web pages. Any user can read and contribute the bulletin board content by clicking the 3D shape (Matsuda and Miyake, 2000). Three BBSs are available.

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<sup>1</sup> The in-world bulletin board system and in-world paper system have been added in PAW^2, not in PAW (Matsuda and Miyake, 2000; Tsuji et al., 1999). See also Matsuda and Miyake (2000) and Tsuji and others (1999) about evaluations of these systems.

- **Name card system:** provides another way to retrieve additional user information except for her handle name. A name card includes the name of the user's personal agent, the date when the user accessed PAW<sup>2</sup>, and personal messages. The barter system allows a user to pass her name card to other users. She can store other users' name card into her belongings. In addition, the name card system provides several additional functions. For example, the "Meet" function allows users to locate the selected user from the name card and relocate them to the location to meet the selected user. The "Write mail" function allows users to write in-world mail by pushing the "Write mail" button on a receiver's name card.
- **Text chat system:** is a basic communication system among users. When a user types a chat message in the multi-user window (Figure 4.1), the message is displayed with her handle name in form of "handle name: message" (see Figure 4.3) in both the multi-user window and a text balloon floating above her avatar's head. It is visible among users in her aura. HTML tags are also available in the chat message, such as <FONT> tag and <BR> tag. The former is used to change the color of a personal agent's chat messages to distinguish these from user's chat messages and show the personal agent's emotion. The latter is used for formatting text for a specific purpose, such as providing a multiple-choice quiz<sup>1</sup> from a personal agent.
- **Handle name system:** provides a mechanism to identify each user and change her handle name. The handle name is displayed in chat message, scouter<sup>2</sup>, and name card passed to other users. Users can change their handle names by using control panel. The modified handle names are updated in real time and displayed in chat message and so on.
- **Changing avatar color system<sup>3</sup>:** allows users to customize their avatar color. PAW<sup>2</sup> provides a dedicated room in the world for this activity. In the room, users can change the color of body segments of their avatar by using a dialog box.

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<sup>1</sup> For example, the following is a sample multiple-choice quiz provided by a personal agent:  
 "When was the New World (United States) discovered?"

(1) 1492  
 (2) 1192  
 (3) 1919

<sup>2</sup> A user interface system to display related text information over a 3D object when a user positions the mouse cursor over an object. In case of an avatar, the name of his/her user is displayed. See also Appendix A.

<sup>3</sup> This system has been added in PAW<sup>2</sup>, not in PAW (Matsuda and Miyake, 2000). See also Matsuda and Miyake (2000) about an evaluation of the system.