Promoting Universal Design of Automated Teller Machines (ATMs)

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Public services should be equally accessible to all users. Conversely, service users vary individually in terms of physical ability and experience in using the services. These individual differences have been a cause of a growing digital divide. The recent progress made in information technology has also provided more job and learning opportunities for those with disabilities, thus enhancing their social evolution. This trend can be seen in various countries that have established new guidelines for products and services and regulations concerning universal design. Before other companies, Fujitsu has always sought to implement universal design of its products and services in order to narrow the digital divide, while promoting improvements to machines and the development of new functions for automated machines used in banks, local government facilities, and hospitals. This paper describes Fujitsu's activities in promoting the universal design of automated machines, specifically Fujitsu's concept of universal design, methods of implementation, and the results of said activities. This paper also refers to new approaches being taken toward achieving the universal design of automated machines.

1. Introduction

Recently many public services are based on the assumption that service users themselves can operate the information equipment necessary to use the services. The information equipment (hereinafter referred to as "automated machines") should be accessible to anyone in order to render public services to all users equally. Therefore, automated machines should incorporate universal design so that every user can easily operate the equipment. As the progress made in information technology (IT) has assisted the social evolution of persons with disabilities, the scope of universal design has expanded into various fields ranging from individual products and commercial services to broadcasting, communications, buildings, urban design, education, medical services, and administrative services.

On December 24, 2002, the Japanese Cabinet endorsed the Basic Programme for Persons with Disabilities, which clearly states, in relation to information equipment and information services, that the government would "drive the establishment of Japan Industrial Standard (JIS) specifications to implement universal design in the fields of IT products and services" and "recommend the selection of products and services adopting universal design in the procurement of public resources."[1)] This trend is compelling industry organizations to establish guidelines for universal design and customers to demand improvements regarding universal design in products and services. Moreover, the universal design guidelines now being devised separately in Japan, the U.S., and Europe will probably be integrated into a global standard in the near future.

Fujitsu has lately been applying universal

design to various products and services, including personal computers, cellular phones, special-purpose systems, and Web services.

In Japan, the automated teller machines (ATMs) of banks have provided customers with a wide variety of services (in addition to the cash withdrawal function) and helped to automate bank counter work. Meanwhile, there is a growing demand for ATMs to be accessible to all users due to the variety and complexity of the services offered. Under the circumstances, ATMs in Japan have undergone many improvements in terms of barrier-free and universal design. Since not only the information equipment owned by individuals but also the equipment installed in public spaces are expected to be used much more frequently than ever before throughout the world, the case examples of enhancing the universal design of ATMs in Japan described in this paper will be helpful internationally.

This paper describes how Fujitsu has improved its automated machines (with a focus on universal design) in the course of product development, and refers to the concept of universal design, methods of implementation, implementation results, and future approaches to universal design.[2)]

2. Evolution of barrier-free ATM into universal design

ATMs were designed to automate various bank counter services, and have developed while increasing the services being offered. ATM users range widely from users familiar with machine operation to first-time users, the elderly, children, foreign residents, persons with sensory or physical disabilities, and those who are temporarily disabled due to injury. To transfer as many counter services as possible to ATMs, automated machines must ensure adequate usability for all these users.

To fulfill this requirement, Fujitsu incorporated various accessibility features into ATMs. The features incorporated were a bilingual function, a barrier-free screen with increased visibility of display characters for elderly persons, a handset with a numeric keypad for the visually impaired, an optional voice instruction (VI) function that allows users to operate the ATM using numeric keys according to voice instructions given through the handset, and additional mirrors to increase visibility inside the cash inlet/outlet port for wheelchair users and others with low eye levels.[note 1)] The branch bank offices located near blind schools or rehabilitation centers willingly introduced this type of ATM to improve machine accessibility for those with disabilities and replaced one of the machines in their ATM room with this type.

Figure 1 shows Fujitsu's steps to improve ATM accessibility. The improvements in accessibility on the FACT-A and earlier ATM models can be regarded as improvements in barrier-free design for the elderly and people with disabilities.

A barrier-free design can be defined as one that improves and adds functions in a standard system to enhance system accessibility and easy operation for specific users. Since the VI function and mirrors described above were added later to assembled machines, this had a major, adverse affect on the exterior appearance of the machine and necessitated the need to improve hospitality in the ATM room and further enhance machine accessibility.

The concept of universal design intends to incorporate improvements based on barrier-free designs into a product from the product planning stage to make the product accessible to as many users as possible.

Banks attempted to enhance the convenience

note 1) Japanese ATMs have a single cash inlet/outlet port, and users must reach into the horizontal hollow-shaped port to insert and retrieve cash. Therefore, persons of short stature and wheelchair users, whose eye levels are as high as the inlet/outlet port, could not easily look inside the port on many old ATM models.

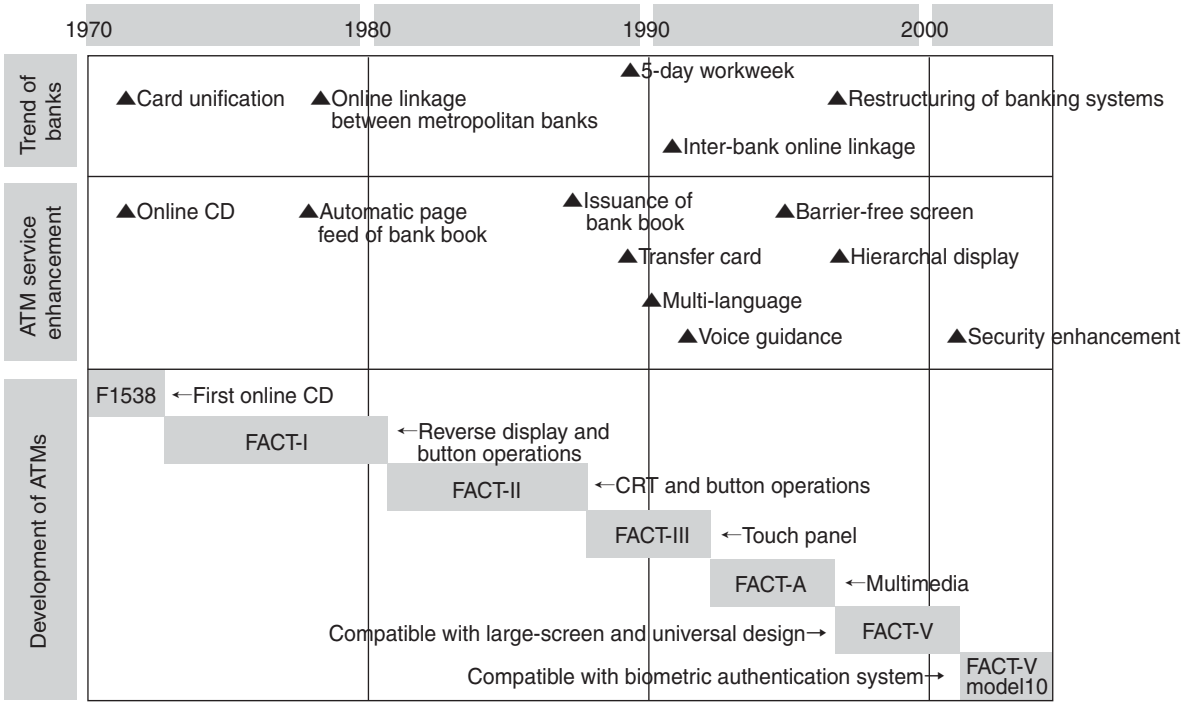


Figure 1
Fujitsu's steps to improve ATM accessibility.

of many users by transferring more counter services to automated machines and using the entire first floor of the banking facility as a fully unattended room with automated machines. This trend implied that the service-providing windows of each bank would shift from the counter to automated machines. Consequently, Fujitsu started developing the FACT-V as a smart ATM that can accommodate users and serve as a substitute for the bank teller who had responded flexibly and meticulously to the needs of individual customers at the counter.

Fujitsu introduced the concept of universal design in the development of FACT-V, and set the following objectives:

1) Equipping all ATMs with the functions to support disabled people as standard
2) Ensuring high accessibility for first-time users, the elderly, and those unfamiliar with machine operation
3) Incorporating the features described in 1) and 2) above into ATMs in natural forms to enhance hospitality in the ATM room for contributing to bank services

The following section describes the activities practiced to attain these objectives.

3. Development of FACT-V for universal design

We focused on two points when developing the standard functions to support disabled people. One point was to improve the accessibility features of conventional ATMs. The other point was to allow the support functions for disabled people to be used by a wider range of people than ever before. Improving the conventional accessibility features was intended for the visually impaired and wheelchair users, who actually use ATMs often.

Then, to ensure a high level of operability, we improved screen operations so that even first-time users and the elderly can easily operate the ATM.

We finally incorporated the concept of universal design into ATMs to actualize automated machines that are accessible to every bank

customer. This section describes these activities in due order.

3.1 Accessibility improvements for the visually impaired

As improvements for the visually impaired, use of the handset for the VI function was enhanced and service provided by the handset expanded.

1) Enhancement of handset usability

To find out about the needs of the visually impaired, questionnaires were sent out to working people who are blind or otherwise visually impaired. The questionnaire data indicated that the handset was valued very highly because users could privately operate the ATM with the handset without using personal identification numbers and operation instructions (known by third parties), and because users could check the deposit balance via button operation and voice information even if they could not read Braille.

To make further improvements, several model handsets of different shapes were made and blind persons were interviewed to solicit their opinions about the handsets. Their opinions clarified a critical factor regarding usability: whether the user could guess how to hold and operate the handset by simply touching it. Regarding this point, the conventional handset was more agreeable than the model handsets, but made the user uncomfortable because the back of the hand touched the user's cheek during button operation. It was confirmed that the model handset with a numeric keypad mounted at a lower position would not cause the hand to touch the cheek and let users easily guess how to operate it by simply touching it. Furthermore, user opinions made it clear that the mechanism needed further improvements in terms of returning the handset at the end of operation.

The handset designed based on these opinions was one that had a general shape with the numeric keypad positioned lower than before and a cord connected to a take-up reel on the receiver for easy replacement (**Figure 2**).

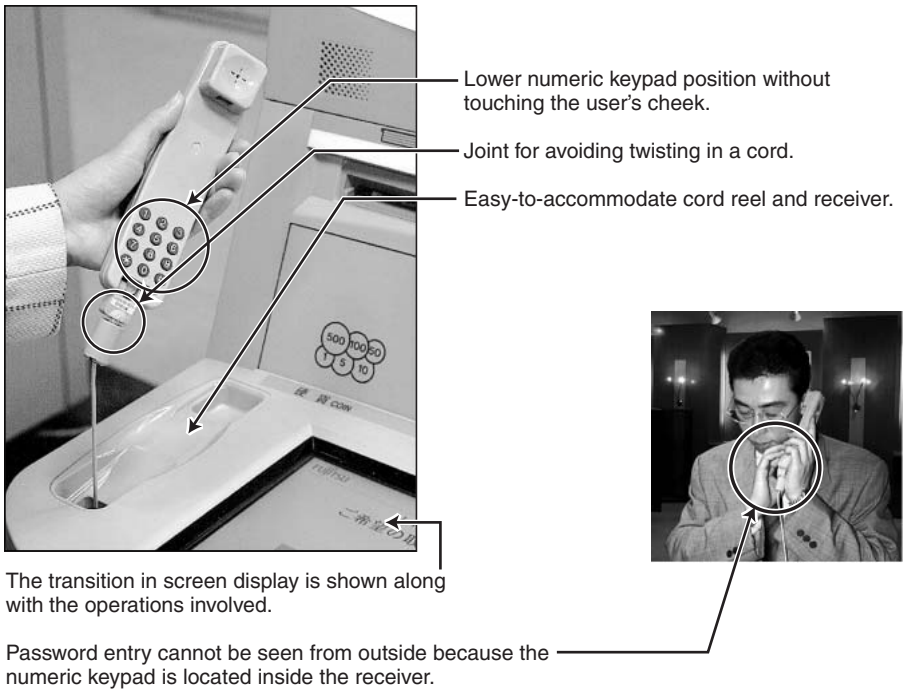


Figure 2
Improvement of handset.

2) Expansion of the range of services

To expand handset functionality, we incorporated the character input method used for cellular phones into the ATM earlier than other makers, and defined the sequence of key operation for cash transfer.[note 2)] Persons with visual disabilities evaluated the key operation, and confirmed that they could perform key operation without a large difference from those without visual disabilities.

Versatility of the handset could also be expanded to many users other than the visually impaired. To attain this objective, we incorporated the interphone system (usually installed in an ATM room) into the handset for reducing office construction costs, and enhanced usability by adding a user-friendly mode (described later) for issuing operation instructions to first-time users through the handset.

note 2) On Japanese cellular phones, several Japanese characters are assigned to each numeric button for the input of Japanese characters. This character assignment system is similar to that of American telephones on which three or four alphabetic characters are assigned to each number. To input a character on a Japanese cellular phone, the user presses the numeric button to which the character is assigned repeatedly until the character appears on the screen or is confirmed by sound fed back from the speaker system, and then presses the entry button. Since the exchange of e-mail using cellular phones has rapidly spread in Japan lately, this character input method is popular among Japanese people.

3.2 Accessibility improvements for wheelchair users

To evaluate machine usability for wheelchair users, we compared the FACT-V with conventional ATMs.

When wheelchair users operate an ATM, their eye levels are lower, their posture control is less stable, and the space for machine operation is narrower and lower compared with users who operate the ATM from a standing position. On the FACT-V, the display screen and inlet/outlet port for bills and coins were located nearer than those of conventional ATMs to make the operation area more compact (**Figure 3**). Moreover, the cash inlet/outlet port was enlarged for easy retrieval, and the mirror conventionally located outside the cash inlet/outlet port was relocated to inside the port. On the other side, the FACT-V eliminated the support handrail mounted on conventional ATMs. Most wheelchair users wanted to get closer to the machine for operation. Based on this preference, the FACT-V was designed to have a wide flat area around the display screen and a concave shape in front to allow wheelchairs

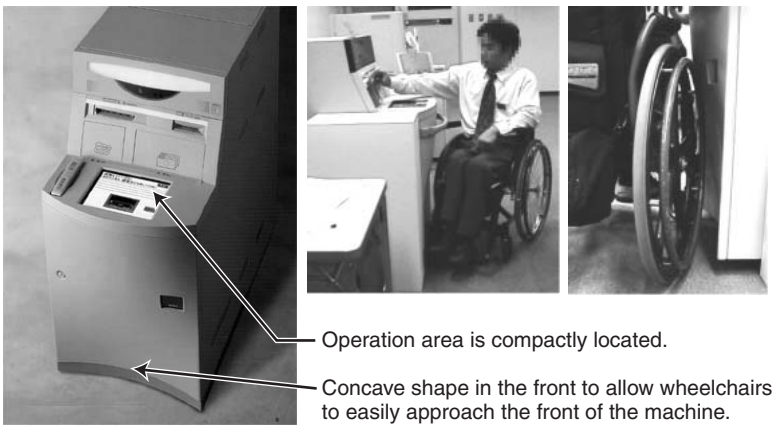


Figure 3
Improvement for wheelchair users.

to easily approach the front of the machine so that users can support their bodies at a position as close to the operation devices as possible. Thus, the FACT-V achieved higher accessibility than conventional ATMs.

3.3 Improvements for first-time users and the elderly

Questionnaires were also used to determine the needs of first-time users and the elderly. The questionnaire data suggested that first-time users and elderly people had difficulty in reading small characters and indications, and in understanding operation instructions on the display screen. It was also determined that users often made many operation errors because they felt pressured by others queuing for their turns and, consequently, happened to spend prolonged time on operation.

On the FACT-V, the following three points of improvement were made to ensure high accessibility:

1) Improved screen visibility
2) Definite and memorable operation instructions
3) Quick guidance for users puzzled about operation

As for improvement point 1), we increased the contrast between display elements, such as background, characters, and buttons, and enlarged the standard size of display characters. For screens that require the display of many items of information in a list (e.g., screen to confirm transfer destination), we incorporated a zoom mode to enlarge the display part containing the necessary information.

As for improvement point 2), we totally rearranged and consolidated the screen display area. Specifically, we divided the display area into definite sections, and placed the operating elements (e.g., guidance and buttons) and confirmation button in order along the movement of visual points from top to bottom on the screen (**Figure 4**). The operation method of proceeding to sequential screens by entering a single item of data on each screen was suitable for first-time users. However, this method did not allow first-

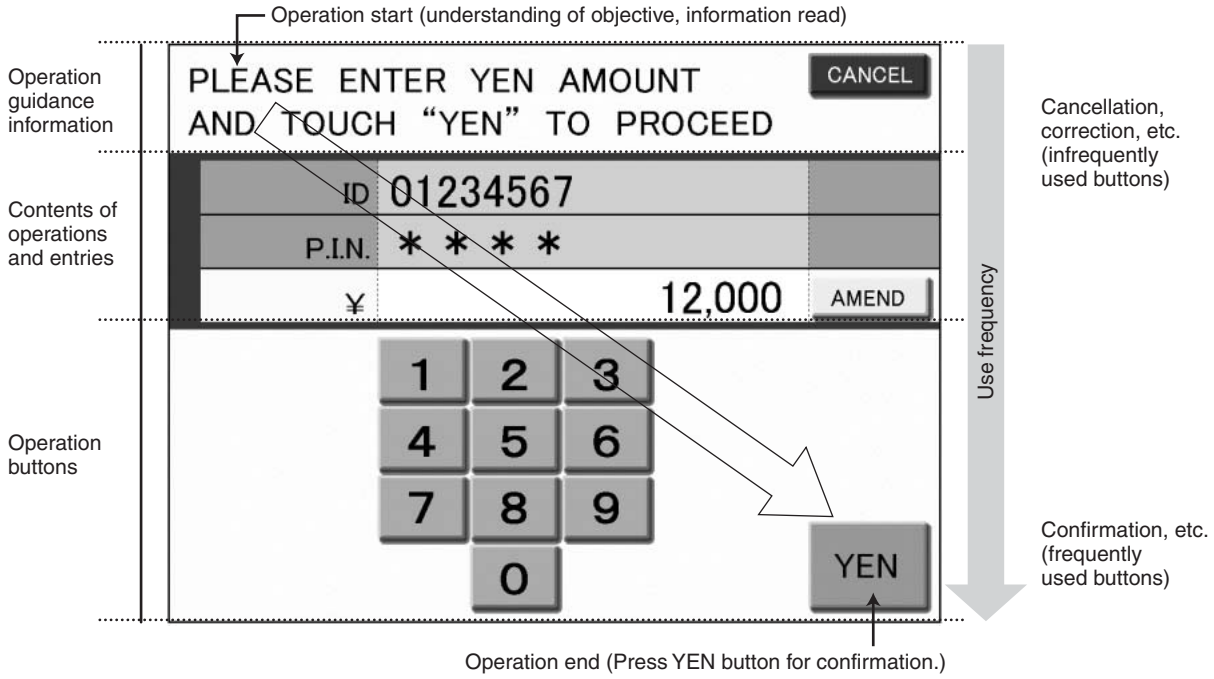


Figure 4
Improvement of graphical user interfaces.

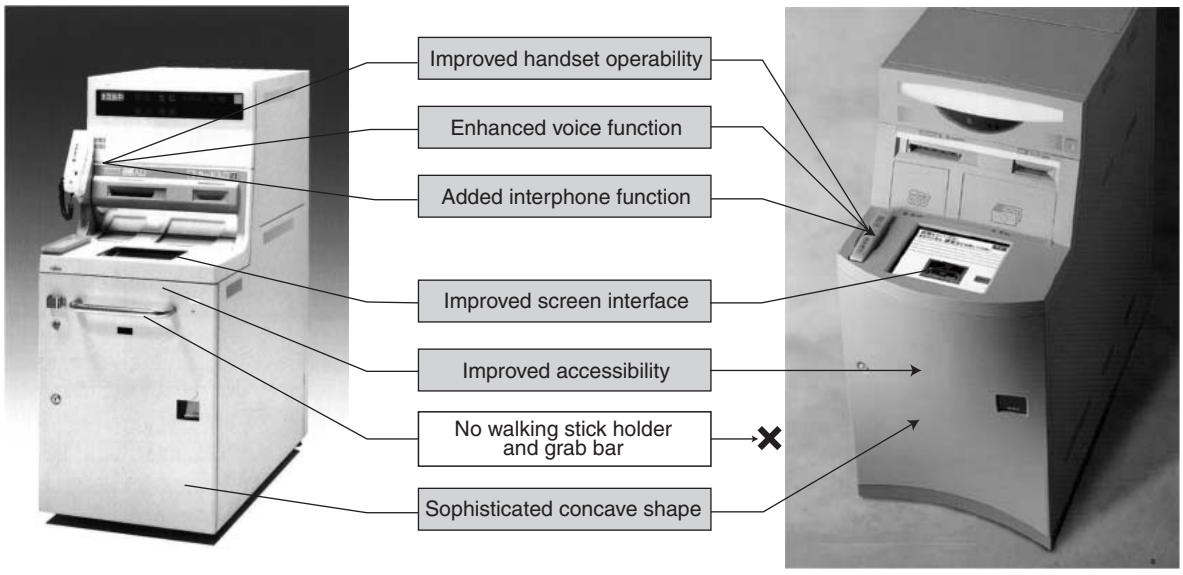
time users to simply understand the overall picture of the operation process and was redundant to users familiar with ATM operation. Accordingly, especially for complex operation processes requiring many items of entry (e.g., operation for cash transfer), we designed the screens to display multiple entry factors together so that the overall processes can be understood systematically.

As for improvement point 3), we developed a user-friendly mode. In user-friendly mode, the FACT-V monitors the time required for transition from one screen to another. If the FACT-V repeatedly detects a transition time longer than others, it automatically determines that the user is puzzled about operation, displays an operation guidance on the screen, and gives operation instructions by voice. Furthermore, if the user picks up the handset under this condition, the FACT-V will give the user detailed explanations of the meanings of displayed buttons and other items for help in operation.

3.4 Incorporation of improvements into ATM in natural forms

Universal design is intended to make machines and services suitable for as many people as possible. An important criterion for evaluating a design is whether the designed machine or service encourages not only persons with disabilities to use it, but also whether it is advantageous for its designer to use it. When designing the FACT-V, we first decided to design the front panel as a surface with a large curvature in a simple form to encourage customer use in order to enhance hospitality in the new ATM room of a bank. We reflected the concept of universal design in the FACT-V from its initial stage of development, and thus could incorporate various improvements into the FACT-V in natural forms (**Figure 5**).

As stated above, ATMs equipped with accessibility functions as standard realize an ATM room in which anyone can use any ATM without the need for selecting usable ones. Branch bank offices in Japan have installed multiple ATMs to relieve congestion, and each office has usually had



(a) FACT-A (conventional type)

(b) FACT-V

Figure 5
Improvement points of FACT-V.

only one barrier-free ATM. As a result of our development of the FACT-V, which offers accessibility functions as standard, some banks have begun replacing all ATMs in their ATM rooms with the FACT-V (or ATMs with the VI function) to improve service accessibility and distinguish themselves from other banks.

When Fujitsu disclosed the specifications of its new handset, other makers incorporated similar handsets in their ATMs. Thus, we were also able to contribute to society.

4. Verification by users and feedback

Activities to promote universal design are expanding to various domains of society. The application of barrier-free designs to transport and store facilities, and improvements to the driving-assistive devices of automobiles have enhanced the social evolution of wheelchair users and others with severe disabilities.

This section gives a case example of promoting the universal design of automated machines. In this example, users verified the FACT-V, with the verification results being fed back for the development of an automatic doctor charge settlement system ("amabile"), which is an automated machine used in hospitals (**Figure 6**).

Before developing amabile, we verified the disability levels of wheelchair users and their capabilities of machine operation with the FACT-V in cooperation with a research institution to clarify the problems in making the automated machine accessible to as many disabled people as possible.

The verification results showed that even disabled persons who could only raise their arms up to shoulder level and had a motor function or sensory disability in their fingers (i.e., those unable to pick things up and press buttons with a finger or the back of their hand, those who cannot sense by touching) would likely be able to operate machines that they could not otherwise use when operating devices of appropriate sizes placed in appropriate positions on the machines.

We made active use of these verification results in developing amabile to ensure and enhance machine accessibility for wheelchair users and those with temporarily injured hands or arms.

For security protection when entering personal identification numbers, for example, the numeric keys on the conventional model were located adjacent to the screen, thus preventing viewing by other people. This design failed to allow a person with disabled fingers (e.g., bandaged fingers) enough room to press keys with the back of their hand. To avoid this problem, we relocated the numeric keypad to a lower position near the center of the machine and enlarged the space around the keys for improving the ease of key operation. In addition, the conventional model was not accessible to persons with disabled fingers because it had separate ports for coin

Figure 6
Hospital station "amabile".

entry and reception. We integrated the ports into a coin inlet/outlet port of enlarged size to enable disabled users to drop in coins one at a time and easily scoop out coins from the port .

Wheelchair users made the following comments:

"(I can drive to a bank by myself, but) I cannot enter the bank office in a wheelchair because of the stairs. I usually park in the bank's parking lot, call a teller from my cellular phone, and ask the teller to withdraw my money using my bank book and signet, or make entries in my bank book."

Another stated, "I went to the ATM room in a department store to withdraw my money, but could not reach the ATM because the service counter on both sides hindered my wheelchair from approaching the ATM. I finally gave up."

Yet another said, "When I entered an ATM station installed in the outdoor parking lot of a local supermarket, it was too narrow inside, and I was blocked in. What was worse, I became stuck there."

These user comments made it clear that we should also reduce the problems concerning the installation environments of automated machines.

As part of its efforts to enhance the accessible environments of automated machines, Fujitsu has prepared an installation manual to help customers install automated machines in consideration of wheelchair users from the standpoint of universal design.

5. Future approaches to universal design of ATMs

This section describes the aspects of future ATMs that can be adjusted to accommodate different users for further promoting universal design.

Those accustomed to using ATMs often consider the user-friendly mode described above to be redundant. Conversely, beginning users consider it easy to use the user-friendly function from the start of ATM operation.

To provide usability that can be adjusted to accommodate individual users, future ATMs should have two new functions as described below.

5.1 User identification

The function to manage user information on intended usage by using an IC card and verifying identification through biometric authentication can be used to determine what kind of accessibility the user needs in advance. This function assists a user in ATM operation by adjusting the machine height, operation panel angle, screen display content, and display styles according to information on intended ATM usage (e.g., need for voice guidance for operation) previously stored on an IC card. In preparation for when a user cannot be identified as the person who registered the user information with the IC card alone, authentication based on biometric information (fingerprints or palmar veins) will likely be used to verify user identification. In particular, the biometric authentication system using palmar veins will accommodate application to public facilities, including ATMs because the system can collect information in a fully non-contact manner (**Figure 7**).

The implementation of personal identification and machine adjustment to the user's intended usage requires the advanced management of

Figure 7
ATM with palm vein recognition equipment.

personal information. It will be fundamental to incorporate a high level of security technology to avoid disadvantages to the user and prevent crimes resulting from the illegal use of personal information in return for convenience. The system combining IC cards and biological authentication does not exchange personal information on a network, but can identify individual users to provide them with appropriate services through only information processing inside the machine. Therefore, such a system will allow us to ensure high security for user identification and also recommend various system solutions.

5.2 Linkage with user mobile devices

Persons with severe disabilities often use special devices for physical assistance. Based on the recent progress made in information equipment, it is likely that not only special assistive devices but also information equipment (e.g., cellular phones) will be available to assist users in ATM operation to deposit and withdraw money.

Under these circumstances, it is important to link ATMs to information equipment and the special assistive devices of individual users, as well as incorporating all necessary assist functions.

To cite a case, even a wheelchair user who cannot reach the ATM operation buttons will be able to perform necessary information entry from a wheelchair when information entered on a cellular phone can be transferred to the ATM. (Needless to say, such a future ATM will have a media port for IC cards at a location allowing users to insert IC cards from a seated position.)

Incorporating these new functions into ATMs counts for much. Furthermore, it is essential for the ATM makers and ATM-installing organizations to understand the users who will operate the ATMs. To share the concept of universal design with ATM-installing organizations, Fujitsu offers documents with which such organizations can fully understand our position on universal design.

6. Conclusion

Universal design will become increasingly important in the design of automated machines. This paper described Fujitsu's activities regarding universal design, some detailed approaches to the future universal design of ATMs in relation to the objectives of developing the FACT-V automated machine, and meeting these objectives.

Fujitsu has been applying daily activities for universal design to the development of products destined for both the Japanese market and other markets. The ATMs developed in line with the concept of universal design can be used for a wide range of information services (in addition to simple cash deposits and withdrawals), and installed in not only banks but also various public facilities (e.g., government and other public offices, hospitals, transportation facilities) for upgrading and expanding their services. Fujitsu has no doubt that its ATMs contribute to public services in this way.

Fujitsu is also confident that it can provide customers with solutions for information systems, in addition to products, that are accessible to many people through evaluation and analysis of installation environments and user interfaces.

Fujitsu intends to move ahead in its development of products and services based on the concept of universal design, and will continue to offer highly effective products and services that contribute to enhancing our corporate image and exercising our corporate social responsibility.

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