

# Continuous Connecting Voice Conferencing System

## - WorkWel Communicator provides support for physically challenged teleworkers working at home -

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### Introduction

The term “universal design” is often used nowadays. This conventional barrier-free concept has taken into consideration objects and settings from the perspective of physically challenged persons. Approximately three million people throughout the whole of Japan are physically challenged in one form or another, a figure which amounts to less than 3% of the total population of Japan.<sup>1), 2)</sup> The concept of universal designing is about creating designs that are easy for able-bodied people to use, and people who are physically challenged and this is the reason they receive universal acceptance.

With such a concept as a foundation and in order to provide support for physically challenged persons working at home, a designated special subsidiary of OKI, Oki WorkWel (OWW), received a subsidy from the National Institute of Information and Communications Technology (NICT) to develop a remote collaborative-type teleworking system, the details of which are introduced here.

### Purpose

A lot of physically challenged people around the world are able to perform at the same level or even outperform able-bodied individuals, if they are given an opportunity to gain employment to match their abilities. In order to make such opportunities available it is essential to provide an environment that matches the context of the

characteristics of physically challenged persons. The term “context” as used here is also referred to as the “Context of Use,” which is comprised of “User,” “Equipment,” “Task” and “Environment” (ISO 9241-11).<sup>3)</sup> A teleworking environment, intended for physically challenged persons performing professional work, is introduced in this paper.

### Background

Opportunities for physically challenged persons to work for businesses are increasing, with a number of modes of employment available. One such type of employment for physically challenged persons is working alongside able-bodied individuals in the same organization. Fuji Heavy Industries Ltd., is one such business in Japan. In this case, however, the employed physically challenged persons were limited to persons who were able to commute on their own, due to the rationalization of the work environment, and their disabilities had to be limited to the extent where they were able to work with other regular employees. Other case examples include the “Designated Special Subsidiary Program” used to establish corporate organizations comprised of a large number of physically challenged persons, with special consideration given to facilities and personnel management. Approximately 230 companies are currently registered under this category in Japan, including Oki WorkWel Co., Ltd., which is a designated special subsidiary of OKI, and Yokogawa

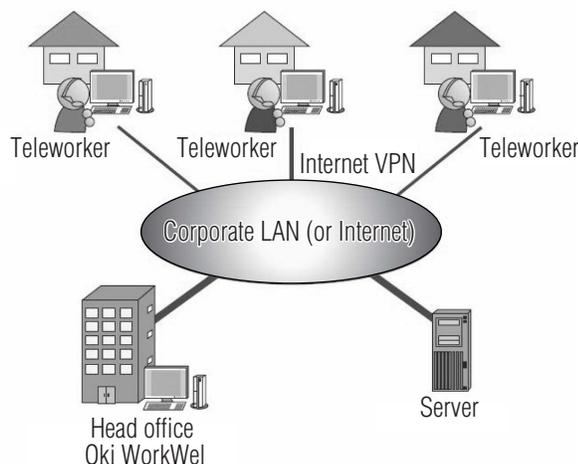


Fig. 1 Work environment

Foundry Corporation, a designated special subsidiary of Yokogawa Electric Corporation.

Severely disabled persons working at such designated special subsidiaries find it difficult to commute during rush hours, especially in the morning. For many, commuting is not an option. In order to resolve such issues the corporate organization at OWW is structured and administered using the "Small Office Home Office" (SOHO) method, utilizing groupware over broadband connections with the employees' homes (**Fig. 1**). Such persons with physical disabilities who work at home are called "OKI Networkers." Approximately 30 persons, primarily orthopedically impaired and severely disabled persons using wheelchairs, are currently retained at OWW.

Their work includes the production of web pages that involves the manipulation of computer languages and codes, such as HTML or Visual Basic Script and desktop publishing (DTP). Furthermore, they not only assemble content in HTML formats, but there are employees talented with drawing skills and so they prepare visual content and perform designing work.

The Web is an important position as a source of information for modern society. Visually impaired persons are less privileged in terms of obtaining information through such an avenue. These days some text and voice software offer sophisticated functions and easy operations, but it would be a mistake to assume that by merely making it possible for visually impaired persons to hear the text being read out does not enable them to understand the web without any problems. For example, descriptions are often provided as non-text information, such as diagrams or illustrations, or in the case of tables, reading out loud such information without any specification of order, would merely be a one dimensional enumeration of information in a series. This is what is meant by web accessibility and therefore these became essential elements for web production.

### Issues

Since it is the twenty first century the need for web accessibility has been an issue dealt with by the relevant accessibility laws, such as the Americans with Disabilities Act (ADA)<sup>4</sup> or JIS (Japanese Industrial Standards) Web Content Accessibility Guidelines (X 8341).<sup>5</sup> Without any experience or training in web page production it is not possible for someone to respond to such needs right away. It is from this background that physically challenged persons in wheelchairs at OWW are involved in activities to make web pages accessible even to people with various disabilities, such as visually impaired persons, through the design and production of web pages.

As mentioned above, experience and knowledge in a broad range of areas, including computer languages and codes, such as HTML, and the ability to prepare content or knowledge pertaining to web accessibility, are required for professional web designer work. Furthermore, knowledge in these areas is undergoing progress at a rapid pace, meaning that it is not sufficient to simply be a

professional thoroughly proficient in certain areas but the latest information must be learned and the person must become familiar with it at all times, otherwise they may be left behind.

With consideration for such a background, OWW developed a system that enables our Networkers to take part in collaborative efforts while working at home or to receive training to improve their IT skills from home. OWW first considered problems that physically challenged persons with acute disabilities encountered when they performed their duties as described thus far.

#### (1) Issue 1: Participation in collaborative efforts while working at home

Approximately 30 physically challenged persons (primarily orthopedically impaired persons) are currently employed by OWW to work at home, fulfilling their duties in business operations relating to web content development and the like. Orders received from clients are managed by a coordinator (full-time employee working in the head office), who allocates duties and issues work instructions to personnel working at home (**Fig. 2**). A leading figure of these persons working at home assumes the role of director and supervises a number of creators. As shown in the figure, the coordinator, director and creators need to communicate closely not only one on one, but also with multiple participants in order to fulfill their duties.

Currently such communications are conducted primarily by phone or through emails, but the issuing of an instruction in an interactive manner or simultaneously to multiple people or even a discussion between multiple participants can be quite difficult. Furthermore, telecommunication costs pile up, and spontaneous questions or timely discussions are also issues, as they are difficult to come by. If all members are at a work place, the progress status can be estimated through ordinary conversations or problems can be mutually shared and assistance can be offered as needed, and by learning from the way people nearby do their work (on the job training or OJT). Assessing situations or mutually learning from each other by sharing such opportunities is difficult for persons working at home, however.

#### (2) Issue 2: Receiving training in IT skills

OWW is currently offering courses for the IT Skill Training Business (a commissioned program with e-learning courses for training physically disabled persons) intended for physically challenged persons (orthopedically impaired persons) as a business commissioned by the Tokyo Foundation for Employment Services. It was difficult to organize for a lecturer and participants to meet and assemble at the same location for this project. Problems relating to the difficulties in asking and answering questions, and the lack of interaction between participants so they could learn from each other, were issues that surfaced. Although a bulletin board system for questions and answers was made available, it was still far from spontaneous or useful for interactive questions and answers, resulting in very infrequent communications between the lecturer and participants, and among the

participants. Furthermore, mutual learning can be expected by listening to other participants asking questions and by hearing the answers to such questions during an ordinary class room setting, however, this is difficult under these current conditions.

### Work flow of teleworkers

The conditions under which OWW teleworkers work at home, performing actual web productions and web accessibility verifications, are described (Fig. 2).

The work of the coordinator is currently being performed by an able-bodied person, who works at an office within the company. The role of a coordinator includes increasing the efficiency of the project management, assuring the quality of the finished products, interfacing the work with users and issuing instructions utilizing the specialized skills of the teleworkers.

#### (1) Phase for receiving orders from clients for web production work

A request for an estimate is first received from a client, the coordinator then prepares an estimate of costs and the development term. The order is received based on this estimate and accepted when an agreement is reached regarding the details of the work and the costs involved. The coordinator takes into consideration the abilities and physical capabilities of the teleworkers to be assigned tasks when preparing the specifications and work schedules.

#### (2) Phase for distributing work to teleworkers

The coordinator divides the accepted work into modules and distributes it to the teleworkers, based on their abilities and work status. The health condition of these teleworkers is also considered at this time and a decision is made as to whether or not to distribute similar work to multiple workers for the purpose of risk management.

#### (3) Phase for design work by teleworkers

The teleworkers start working on the design of the work assigned by the coordinator. There are segments that cannot be designed based on the specifications provided by the coordinator alone, thus communications with the coordinator are ongoing at all times.

At the time the company was launched, on the job training (OJT) was also provided by the coordinator alone. Recently, however, there are an increasing number

of teleworkers with disabilities, who have accumulated experience in dealing with the work and have reached a stage where they are able to give instructions. The present status demonstrates that teams can form around such individuals as they become team leaders and they are also able to implement OJT one by one, realizing a situation that is desirable from the perspective of autonomy as well.

#### (4) Phase for interim verification of work performance

Once the work proceeds to a certain level and reaches a stage when the resulting deliverables start to take a form, an interim quality check on the work (alpha version) is conducted, primarily by the coordinators and team leaders to debug the work in progress. The teleworkers reflect the results of the verification when finalizing their work.

#### (5) Phase for final checking and delivery

Work is divided into modules and the team leader combines them to produce the whole deliverable work package. The coordinator verifies to ensure that the deliverable functions are according to the specifications defined at the onset of the work. Once the coordinator is satisfied, the work is delivered to the client.

### Maintaining environment and establishing WWC

Processing speeds, communication speeds and memory storage capacities are definitely improving in the field of Information and Communications Technology (ICT). Therefore, environments, such as remote offices, could not be realized in the 80s but can now be accomplished. Under the current situation, communication speeds are satisfied by taking advantage of the continuous connection services, which are reasonably priced, for up to 50 Mbit/s with ADSL and up to 100Mbit/s with optical communications. These broadband services are used for performing work that is coordinated through a linkup between the coordinator and individual teleworkers (Fig. 1). In terms of user interface (UI) aspects<sup>2)</sup>, however, this is still inadequate for providing psychological and cognitive support to teleworkers.

Furthermore, the "U-JAPAN" concept of the Ministry of Internal Affairs and Communications indicates that ubiquitous services will be in practical implementation by 2011 and it is believed that teleworking will be an

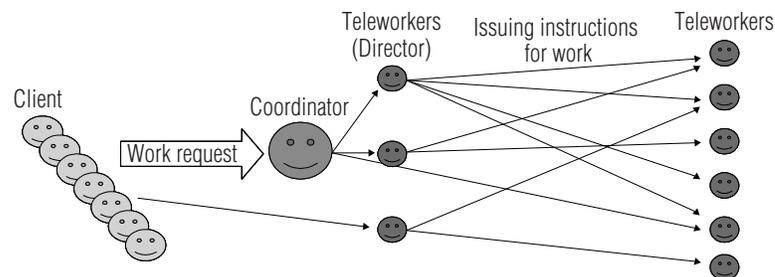


Fig. 2 Work flow

inevitable essentiality. Caution is required, however, since collaborative work can be impeded if participants start to feel isolated while performing their teleworking duties or when the task and load distribution does not work out well for proceeding with the work.

Groupware is a system comprised of software and a mechanism for supporting work conducted by a group, with an infrastructure and network for connections. It is also used to communicate and share information using network functions to increase work efficiency. The aspect to be noted is that the flow of information is not a one-way push-type of transmission, but interactive and bidirectional in nature. This makes it possible for teleworkers to distribute tasks and collaborate while working with colleagues in remote locations.

Teleworkers perform collaborative work by using this groupware and the coordinator manages the work and well being of teleworkers, and the progress status of work and quality control of the deliverables. The hiring of physically challenged persons requires more detailed management than the employment of able-bodied personnel, in terms of health management, as consideration is required for hospital visits and risks relating to work, such as timely deliveries. Furthermore, work is not constant and work loads tend to be a mixed bag of peak loads and idle periods. The idle periods are efficiently utilized in an environment that caters to proactive self improvements suitable to each person's individual progress, using training tools, such as new programming techniques, available in the groupware environment.

**Table 1** is the result of a survey regarding the needs expected of a teleworking system by teleworkers working for OWW with severe disabilities. In terms of hardware, the survey covered aspects on broadband communication functions, whereas in terms of software the survey covered aspects on groupware functions. With regards to communications, the issues relating to cost and speed, and the degree of ease in connecting to portal sites, were prominent. Regarding the groupware functions, however, various needs were evident, such as

the ability to reference records from past work and an operating environment that is easy to use with realistic sensations in order to provide a feeling of working together is necessary in spite of the physical remoteness.

OWW designed a teleworking system called the WorkWel Communicator (WWC), which incorporates a screen that is to be displayed on the personal computers to be operated by teleworkers, and a graphic user interface (GUI), based on such situations and by observing how the teleworkers with severe disabilities carry on with their work (**Fig. 3**). Many systems intended for teleworking tend to operate on a system primarily comprised of a screen, such as with teleconferencing. In view of the work conducted by teleworkers, however, it became clear to us that a screen display is not considered very crucial to them, whereas voice is considered to be quite important. It was also determined that a screen display as a part of communications often became an obstacle in the performance of their work. Furthermore, OWW decided to make the continuous connection a fundamental condition of the system, in order to make accessible the things that are naturally available when sharing a space at a place of work, such as learning from conversations with other people or estimating a progress status, which are difficult to achieve with teleworking.

The individual features of WWC are described next.

### (1) Common and individual conference rooms

An observation of normal working conditions indicates that a work is done with everyone arranging their desks in rows and in other configurations when smaller groups gather for individual projects. One common conference room and six individual conference rooms are made available for WWC to simulate this condition on the system. Initially all teleworkers enter the common conference room to start the work. They then locate colleagues with whom they may have a work relationship and they are guided together to an appropriate individual conference room, where discussions pertaining to the project on hand are to take place. Once an individual

**Table 1 Needs of system for teleworkers**

		Yes	Sometimes	No
Increased broadband performance	Faster connections	12	5	3
	Interface for easier connections	8	7	5
	Easier connection to company office	11	8	1
	More economically priced services	15	5	
	Availability of IP phone for use at same time	10	7	3
	Others			
Increased groupware performance	Interface that is easy to use	11	8	1
	Coordinated linkups with auxiliary devices	2	9	9
	Feeling and environment that all members are together in same place	11	8	1
	Environment that makes it easier to give instructions	15	5	
	Synchronization not only with screen display but also with voice	10	8	2
	Wider and more detailed displays	10	9	1
	Substantiation of past performance records	17	3	
	Substantiation of training tools	13	7	
Others				

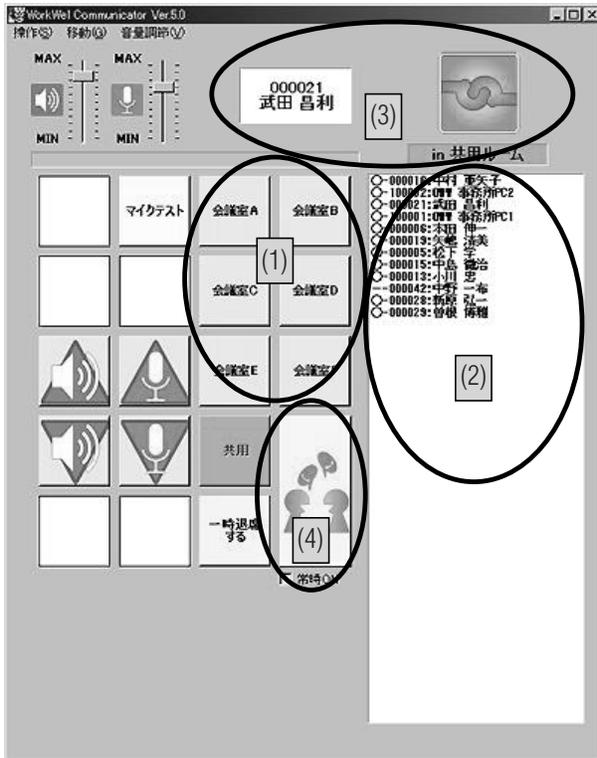


Fig. 3 WorkWel Communicator screen

process is finished, they go back to the common conference room [Fig. 3 (1)].

### (2) Presence display

In actual operations, one cannot always expect the person of interest to be in the common conference room as that person may be participating in a discussion at an individual conference room. A display by the presence feature is made available for such situations, to indicate where the person of interest is located [Fig. 3 (2)].

### (3) Current position display

When a teleworker intensely concentrates on the work being performed in a virtual world like WWC, the person can sometimes forget which room it is that the teleworker is currently working in. For this reason, a feature is made available to display where the person is currently located and a display that shows whether or not the personal computer being used is connected to the system [Fig. 3 (3)].

### (4) Mute feature

Since the work is being performed at the teleworker's homes and not at an office, aspects of daily life at home can potentially seep into the conference room of the WWC, which could lead to privacy problems. For this reason, a mute feature that can turn down the microphone volume with a single button, is made available [Fig. 3 (4)]. Furthermore, since a person can forget to turn the microphone off at times, an Auto Mute feature, which automatically turns off the microphone



Photo 1 Scene of teleworkers using WWC

after a certain period of time, is also incorporated.

### (5) Others

Teleworkers with severe disabilities, who are primary users of WWC, are often unable to manipulate a keyboard or a mouse of a personal computer and able-bodied individuals. Operating keys are created for a personal computer via a Universal Serial Bus (USB) on the GUI of the WWC, so that it can be operated in the same way as a keyboard and the like. Since physical keys are available it is not necessary to position the cursor on the screen, as a person would do when using a mouse.

The scene of a teleworker with severe disabilities at work using the system, is shown in **Photo 1**. This teleworker is performing entries on the personal computer using a long stick, about the length of a chopstick, since the teleworker is unable to smoothly move his fingers.

## Evaluation

This project of NICT is a three-year program, which started in FY2006. A system prototype was created in the first fiscal year and last year the system was used while connected at all times, since the work for the development of the programs took place at OWW. Furthermore, the system was also lent to external organizations to be evaluated.

Since the WWC is based on voice conferencing the initial problems that surfaced related to voice quality. For this reason Com@WILL<sup>\*)</sup>, <sup>6)</sup> with, "e-Sound<sup>®</sup><sup>\*)</sup>," the incorporated voice technology of OKI, was adopted to obtain a communication voice quality closer to that of a natural voice.

Other than the severely disabled persons, one employee hired by OWW has visual impairment and the other is unable to vocalize speech. The visually impaired employee uses a text to voice conversion software to verify whether or not produced web pages satisfy the

<sup>\*)</sup> e-Sound and Com@WILL are registered trademarks of Oki Electric Industry Co., Ltd.

criteria of web accessibility<sup>5)</sup> one by one.

The employee who is unable to vocalize speech, on the other hand, could not speak up using the WWC and was unable to communicate with the right timing. For this reason voice files with a minimum required vocabulary, such as “Yes” or “No,” were created so that the voice synthesis feature of a personal computer could be used to enable the person to participate in the proceedings of meetings.

Furthermore, validation experiments were also conducted by four external organizations, to which an environment was provided. A survey was conducted on the experiment participants who used the system. Opinions obtained included “convenient since one can participate in meetings from home,” “coordinating schedules to create time to spend together is very difficult, since each member has different work schedules,” “more improvements are needed for the sound quality.” It was determined that communication environments, the way work was conducted and the effectiveness of the system varied, depending on the organization using the system.

### Conclusion

This paper introduced the WWC system, which was developed to provide support for physically challenged persons to work autonomously at home by teleworking. OWW believes that it is a meaningful project and one that allows us to fulfill corporate social responsibility (CSR) as a business, to promote employment and offer support for physically challenged persons, who have skills and capabilities, and are able to fully function as professionals, given the right environment.

A lack in team meetings because members are working at home or senior personnel not having an opportunity to implement OJT to teach work to junior personnel in any effective manner or a feeling of loneliness, can all be cited as problems facing physically challenged persons in their efforts to fulfill their work duties. WWC was intended to be a multiple site voice system offering realistic sensations, while easy to use for physically challenged persons, in order to solve such issues. Efforts were made particularly to realize a user interface that is easy for physically challenged persons to use, with a stress free and clear voice quality delivered without delay, in a most reasonably priced system, with communication costs included.

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