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CDIO FOR DISTRIBUTED TEAMS: EXPERIENCES OF A JAPANESE AND AMERICAN TEAM

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ABSTRACT

The recent trend in globalization of business operations has increased the need for global teams in different aspects of a company's activities, including idea conception, product design and launch. These teams are faced with a variety of challenges, which need to be considered and resolved. This paper discusses the experience of distributed teams made up of participants from the Tokyo Metropolitan Institute of Technology and Stanford University in carrying out a design and development assignment. Ways of taking into account differences in culture, in time and experience were found out in the process of coming up with a new product. It was also found out that having at least one face-to-face meeting tended to improve teamwork and personal understanding. A major challenge was the finalization of the prototype using data and information from distributed sources. This was found to be more complex as new information continued to emerge in the last stages of the project. Most of these problems were overcome by setting deadlines for agreed milestones and the frequent use of electronic media. Even then, large documents circulated in time, were not always read by all of the team members. Timely use of telephone and video conferencing was found to be a very useful way of bringing everyone to the same page. It was found out that distributed design and development teams were more effective if they used modern information and communication technologies. The lessons learnt can be useful for distributed teams in other functional areas of a global enterprise.

1. INTRODUCTION

This paper discusses experiences based on a project carried out by a distributed team to design an in-vehicle interface for the purpose of assisting the driver to overcome fatigue and sleepiness while driving alone. Within this main objective, this team created a number of activities as follows:

- The design of an in-vehicle media capture system that can be used to relieve driver tedium, improve alertness and enable friendly interaction with the driver
- The construction of a functional prototype of the in-vehicle media capture system and make sure that it really works
- The testing of this system with the North American drivers to check its usability, suitability and popularity.
- The design, construction and testing of a voice-activated interface system that can enable Internet surfing, communication between the driver and the system and voice communication in using the in-vehicle media capture system

- Experimentation on the prediction of the condition/state of the driver using the voice that is captured when the driver is interacting with the voice-activated interface.
- Make recommendations to the sponsoring company on the way forward.

The Stanford University team, consisting of two United States citizens and one Canadian, concentrated on the first three activities and the Tokyo Metropolitan Institute of Technology (TMIT) team, consisting of two Japanese and one Zimbabwean, concentrated on the fourth, fifth and sixth activities. The team members provided input on all the activities through DocuShare, Internet, e-mails and teleconferencing (both video and audio teleconferencing). There were teaching teams in both countries assisting the team members.

The work involved a review of literature on the use of various technologies in coming up with a virtual passenger system, voice-activated interface and aspects on driver systems that exist already. The design for a voice-activated interface was then undertaken. An information browser system was constructed and tested. Experiments were done to try to use the voice profile in determining the state of the driver. Definite patterns were recognized for specific states. There is a possibility that this data can be used, when stored in memory, to give a rough condition of the driver. Finally some recommendations were given to the client company. Some concluding remarks on the way forward and suggestions the direction that work in future can take were made.

This study was prompted by the successful application of partly the teleconferencing in companies like NEC Japan. (NEC, 2001) The system uses the Internet, video-conferencing, telephone conferencing and real meetings. This model was used for the distributed team. The three participants from Stanford University visited Tokyo, Japan for three days and in return two members from the Japanese team were supposed to visit Stanford University. However because of VISA processing delays for the Zimbabwean member of the Japanese team only one member managed to visit.

2. ICT SYSTEMS USED BY THE DISTRIBUTED TEAM

Videoconferencing is essentially communication across long distances with video and audio contact that may also include graphics and data exchange. Digital video transmission systems typically consist of a camera, codec (coder-decoder), network access equipment, network, and audio system.

The benefits expected in using these information and communication technology (ICT) tools in substituting live meetings are, cost savings like removing the need to pay travel business allowances, avoiding loss of working time and reduced hotel costs. Some studies indicate that teleconferencing systems, that is videoconferencing and audio conferencing equipment, have a payback period of less than one month. (Arnfalk, 2000). Tele- and videoconferences can replace conventional meetings and reduce travel. This is significantly so when travel by air is substituted. The traditional model for the link between overseas and local team members is as depicted in Figure 1

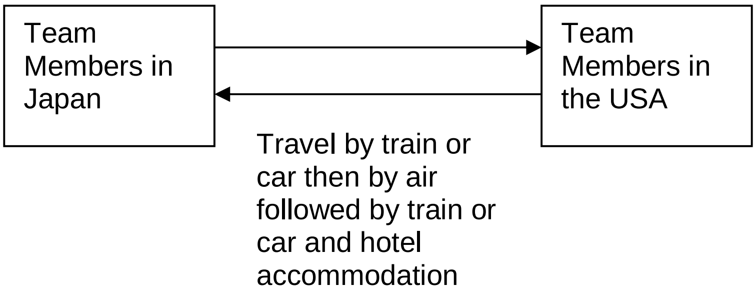

Figure 1: Traditional CDIO distributed team link

The system that was used for electronic communication using telephone conferencing and videoconferencing for distributed team communication is shown in figure 2. The equipment consists of servers and personal computers to enable Internet access and information exchange between the two locations. Two PCs and a server were needed at both locations.

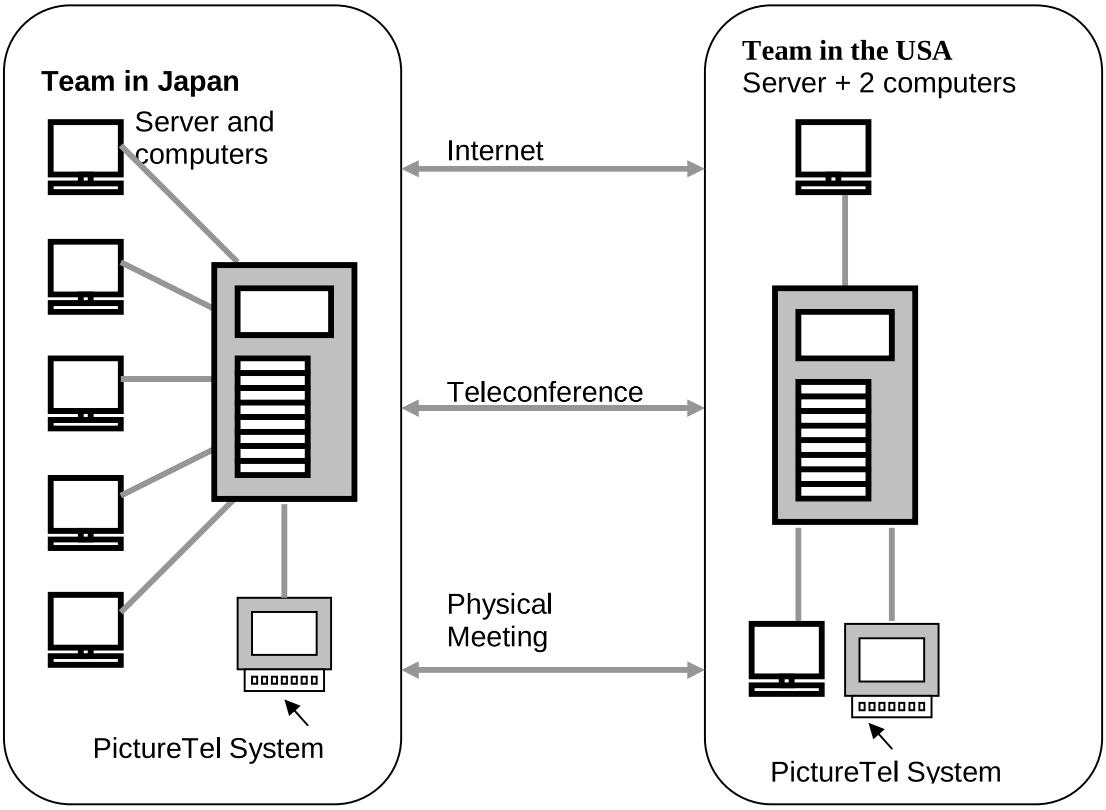

Figure 2: Configuration of the ICT system

Teleconferencing was scheduled bi-weekly. A couple of sessions were cancelled through e-mail communication when the need was not identified. Because of technical hitches videoconferencing was very rarely used. The system started working faultlessly after the project had been finalized. Technical problems that reduce effective communication need to be addressed decisively at the beginning of the project. Team members from both countries visited the client car company in Japan together and had fruitful face to face interaction during that time. The team spent 3 intensive days together planning the work and clarifying many communication problems. This was a very useful exercise, since it not only resolved some collaboration hitches, but enabled personal touch and communication among the team members. Observations, surveys, interviews, physical tests, questionnaires and condition detection experiments were done in the USA. Microsoft Messenger services were also used whenever two or more members of the team were online to enable data and information update. Brainstorming sessions were conducted during teleconferences and members were brought to the same page through these e-meetings.

3 THE INFORMATION BROWSER SYSTEM

The Japan team thought of the "Human Friendly Interactive Interface" as a passenger who helps in using the systems inside the car. Attention was paid to two points that is the need to concentrate the driver's eyesight to road and the need to keep the driver's hands on the driving wheels all the time. It was decided that the system's interface should use voice using voice recognition software, personal computers (PCs) and a simple menu structure. The system consisted of two PCs, LINUX software and ViaVoice 9 (voice/speech/text recognition software). One PC is located inside the car and the other was used as an external server. The reason for using an external server was to keep the system inside the car very simple. This way a simple and basic car computer can be used. In order to enable communication inside the car system and with the external server, HTML(Hyper Text Markup Language) was used. This was because HTML, can provide the menu easily and all equipment's menu for the same structure can be accessed easily. The in-car system program performed the next tasks: Getting the users' voice input; getting information from the external server system and; providing output information. This system was developed with Linux, IBM ViaVoice 9 SDK (System Developers' kit), a microphone and a speaker. The system stays on standby and is prompted by a voice message, to which it responds appropriately. It was tested with the following commands:

Click	Chooses the menu item (click the link)
Back	Moves back to the previous menu item
Forward	Moves forward to the next menu item

The following commands were prepared to directly change the menu or category

Music	System selects the music in the menu and starts playing
News	System selects the news item in the menu and starts playing

A possibility was given to select news category such as a "Sports", "Economics", "Politics" and many more, all of which could be voice prompted. Some text to speech experiments were conducted. However the system read the text monotonously and with some difficulty. A link was connected to the external server to improve information sources. The external servers system was developed using Linux enabling it to communicate with the in-car system transferring information from the Internet.

This system worked reasonably well in Japan. However, when the design was transferred for use in the USA, the software could not easily pick spoken commands and offered less functionality. Transfer of software, programs and system configuration did not help. Some of the software was sent by Federal Express to meet the project deadline. However the trouble shooting skills available in the Japan Team were not there on the other side. The Japanese software expert and trouble shooter got the USA too late. As a result, a hand operated display had to be used in designing a media capture and playback system.

4. Driver’s Condition Detecting System

The “*Driver’s condition detecting system*” was designed as an attempt to detect a driver’s condition using the driver’s voice commands. Periodically the system prompts the driver into giving commands, which are captured by the “*Information browse system*” discussed in the previous section. The condition detecting system simultaneously records the voice data in ‘”wave form [*.wav]”. It compares the voice data with the classified data patterns in the voice data memory system and judges whether the driver’s condition is suitable for driving.

In order to investigate the driver’s possible wave form for different conditions, experiments were carried out for various predetermined emotional conditions. The word that was used for voice recognition capture was “SPORTS.” The assumed mental conditions were ”composed”, ”happy”, ”angry”, “sad”, “irritated”, “depressed” and “tired” In order to improve voice-capture accuracy each person practiced 3 or 4 times until the voice was recognized. The recording of “composed voice data” was done after a signal was given. The subject simulated the various conditions. Sufficient time was given and more practice done to enable the subject to pronounce the word expressing different emotional sentiments. It was not easy to get the subjects to adjust to different mental conditions. However in the end different waveforms were noticed for different states. Here again the experiment was conducted in Japan and different waveforms would be expected for different people and for Americans.

The voice data was analyzed using MATLAB. This software was used to classify the data into normal speaking data and other data for simulated conditions using the former for comparison and analysis. In addition, the maximum amplitude of the voice data [max_wave], the average of voice volume [Ave.] and the deviation of voice volume[Dev.], were investigated. Similar results were obtained from the eight subjects. Results from one of the subjects are classified as follows: ”composed” --- Loud and clear voice. (Basic data); “happy”---- Speaking a little bit faster. (Compared with Basic data); “angry”---- Speaking at the same volume. The average value of the size of voice signature was larger. (Compared with Basic data); “irritated”--- It was guessed that the intonation of the voice is lost; “depressed”, ”sad”, ”tired”--- The voice signature became small on the whole, in all three states. So, distinguishing the three mental conditions was found to be difficult. Figure 3 shows one of the subjects’ voice data.

From these results, a driver’s condition detecting system using voice was proposed. On its basis, the media capture systems would be activated appropriately, to address the condition of the driver. A warning system was proposed, that can send information to another person who can then phone the driver and engage them with a view to convince them to take a rest. It was found to be very difficult to finely define the condition of the driver on the basis of voice alone. The driver’s mental condition can be detectable by also measuring the change of blood pressure and heartbeat. The next table expresses the changes of mental condition that are expected due to changes in blood pressure and heart beat.

Table1: Relation between body information and Condition

	Increase	Normal	Decrease
Blood pressure	**Worried and Surprised**	**Relaxed and Angry**	**Blunt judgment**
Heartbeat	**Strained and Tired**	**Stable**	**Sleepy**

It was concluded that a driver’s mental condition detecting system can be more accurate if it uses the correlation of the results of the body information system and the results of the voice information system. However the system developed in the end was a media capture and playback system that required minimal distraction since it had a limited menu.

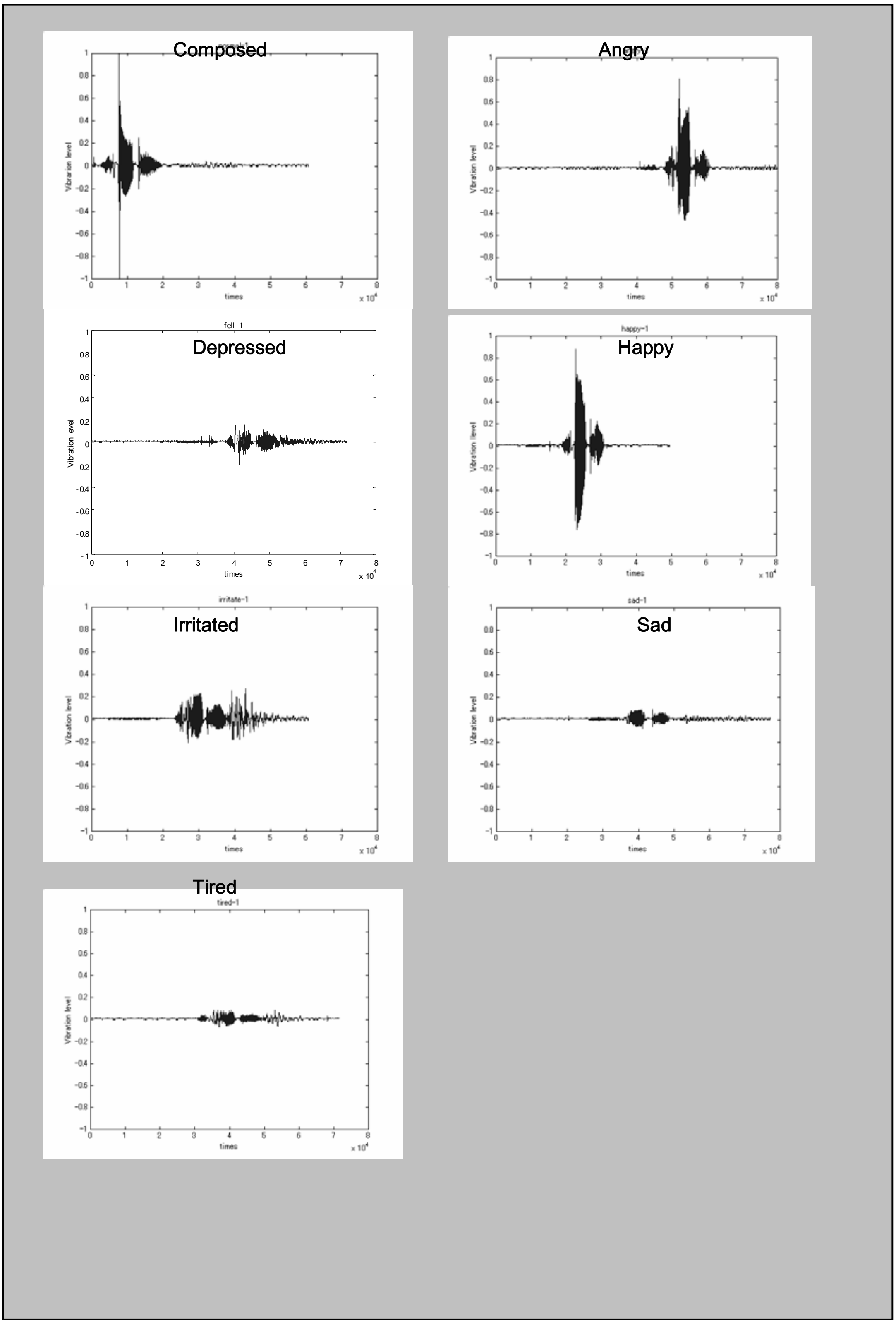

Figure 3: Voice Data for one Male Subject

5. LESSONS LEARNT

The use of distributed teams in conceiving, designing, implementing and operating poses more challenges. Doing so using a local team is challenging enough hence these experiences will be found useful for engineers that want to take that route. Distributed teams have become a daily reality due to globalization. The lessons learnt are as follows:

- The weekly meeting with teaching teams from both universities and countries changed the direction of the project many times. Two other parties came into play and this prolonged decision making and taking
- The success of such a project requires good cultural understanding. Language was a barrier for one of the team members, reducing full participation. Team methods, skills and thought processes were different also. It took some time to reach a working relationship. This problem can be minimized by arranging for face to face meeting during the early stages of the project
- Excessive data was created or compiled in electronic form. Initially most of the team members did not bother to read it. However when the person posting the data summarized it, the response rate improved. The effort of summarizing data is worth it, because it conveys critical information that would otherwise be ignored
- When planning such projects, include the details. Time saving changes, which are done in the USA and not in Japan cost the group two scheduled meetings. Critical date like those when there are changes to winter time or summer time need to be noted. Also the time and day differences posed further challenges. For example Thursday 8pm at the University of Stanford was Friday 12 noon at the Tokyo Metropolitan Institute of Technology in Japan. The final project finalization and presentation was compromised because the second team member could not travel as the VISA application to enter the USA took a long time to be processed. Also the team member that traveled from Japan to the USA went there too late to make an impact on the final product. Better planning could have avoided this problem.
- All communication technical hitches like videoconferencing and having in place reliable Internet should be put in place at the inception of the project
- It is important at the onset to select and agree on tools, equipment and specifications to be used, taking care to avoid choosing too many of them. At one time the teams were working in completely different directions because they could not agree on the way forward. There is a need for an authoritative body that enforces the final direction of the project
- The team members should work on a tight deadline and there must be a time beyond which new ideas and design changes are no longer accepted. In this case new ideas kept on coming until the last stages of the new product development. This negatively affected the quality of the final product
- Methods should be put in place to enable effective transfer of designs, programmes and data/information needed for the final product development.

6. THOUGHTS FOR THE FUTURE

In conclusion, it is clear that distributed teams will become a more frequent feature in future. The question is no longer whether or not to have such systems, but how to make such teams more effective in CDIO projects. The following are recommended:

- There is need for more work and research on how to make distributed teams more effective

- Information and Communication Technology will play a very significant role in future, hence there is a need for organizations to constantly update and upgrade their systems so that they can facilitate more effective information exchange among the project partners local or distributed. They also reduce the number of expensive live meetings, which involve a lot of travel and environmental pollution

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