An Integrated Help Desk Support for Customer Services over the World Wide Web - A Case Study

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Abstract

In a traditional help desk environment, service engineers typically provide a worldwide customer-base support through the use of long-distance telephone calls. Such a mode of support is inefficient, ineffective and generally results in high costs, long service cycles, and poor quality of service. The rapid growth of the World Wide Web technology, with its widespread acceptance and accessibility, have resulted in the emergence of Web-based help desk systems. Depending on the functionality provided by such systems, most of the associated disadvantages of the traditional help desk environment can be eliminated. This paper describes a Web-based integrated system, the WebHotLine system, that possesses Web-based retrieval, online multilingual translation capability for service records, rule-base reasoning for direct intelligent fault diagnosis by customers or service engineers, different modes of video conferencing for enhanced customer support and network security for secure data communications.

Keywords: Help desk, World Wide Web, machine translation, intelligent fault diagnosis, network security

1. Introduction

A multinational corporation in Singapore (hereafter known as MNCS) manufactures and supplies insertion and surface mount machines for use in the electronics industry. A hot-line service centre (or help desk) was set up by the Customer Support Department to service its worldwide customer-base and provide installation, inspection and maintenance support for its customers. Customer support is an important activity in all types of industries. The importance of such support facilities cannot be overemphasized. Many customers view customer support as one of the most important criteria when evaluating a product or a service. The level of customers’ satisfaction in this aspect will have a significant impact on whether new versions of the product or service will be supported by these same customers in future.

In the current setup, the service centre is responsible for receiving reports on faulty machines or inquiries from their customers via telephone calls. When a problem
is reported, a service engineer will suggest a series of checkpoints to the customers to implement or check as a means to rectify the reported problem. Such suggestions are based on past experience or extracted through a customer service database that contains previous service records that are identical or similar to the current one.

With these checkpoints, the customer will proceed to carry them out and later confirm with the service centre if the problem is resolved. If the problem persists after all the suggested checkpoints are exhausted, the centre will dispatch the service engineers to the customer's site (which may be located overseas) as soon as possible to carry out an on-site repair. During such trips, the service engineers will carry along with them past records of the customer's machine, related manuals (that can be bulky) and spare parts that may be required to carry out the repair. Such a process is inconvenient and often requires bringing more than it is necessary although at times, the service engineers may request the service centre in Singapore to send extra materials.

At the end of each service cycle, a customer service report is used to record the reported problem and proposed remedies or suggestions taken to rectify the problem. This recording is subjected to the service engineers' vocabulary. No standard format or vocabulary is used to record these service records. Information from such records are eventually returned to the service centre for recording and storage in the customer service database for future support purposes.

This traditional customer support process suffers from a number of disadvantages:

- The process is time-consuming and expensive. More often than not, service engineers are required to travel to a customer's site for an on-site service even for a small problem. As a result, the problem cannot be resolved efficiently and the machine down time can be significant. In addition, as the customers communicate with the help desk centre via telephone calls, they incur long distance telephone charges as most of them are located overseas.
- A certain number of service engineers are maintained in order to provide the service support. It needs to keep on training new service engineers, and at the same time, come up with new incentive scheme to keep experienced service engineers.
- The database of service records is only used by the service engineers. As these records contain past experience of service engineers on how to fix machine problems, customers may also use these information for fixing their machine faults. Therefore, such database can be made online for customers' access for a more efficient machine diagnosis.
- Expert advice to the problem is given either through the experience of the service engineers or the available past service information in the service database. No automatic provision of expert advice is available.

A number of research questions arise from this scenario. Given the amount of time and cost that is devoted by organizations to provide customer support, can computers and its related technologies be used to improve this important function of the organization? Which are the important existing knowledge and technology that are useful for the delivery of such a computerized system? To what extent can such knowledge and technology be harnessed and integrated together and provide a value-
added service that is superior to that of the telephone-based system? Can a proposed system be developed so that it can remain relevant and applicable for time to come?

With these questions in mind, a collaborative project between MNCS and the School of Applied Science, Nanyang Technological University, Singapore, has been initiated to study and propose a solution to the existing customer support function. The proposed solution takes the form of an integrated help desk environment over the World Wide Web. This Web-based integrated help desk environment provides four major functions including online retrieval, machine translation, intelligent fault diagnosis and video-conferencing. Together, it provides an integrated and ideal platform to transform the customer service support into an effective and efficient activity that meets users’ requirements and satisfaction.

2. **Online Help Desk Support**

Due to the inherent problems of traditional help desk support, some companies have started providing online customer service support. The earliest form of online help desk is supported through bulletin board systems (BBSs). BBSs enable remote customers or users to log on and tap into a knowledge database that is generally formatted in the form of Frequently Asked Questions (FAQs) that provide answers and solutions to the most common problems. Such systems relieve the need of experienced service engineers from answering telephone calls. It obviously provides fast responses that are available 24 hours a day. However, such FAQs are only capable of capturing past service information for tackling limited common occurring problems. Moreover, long distance telephone charges may still be incurred to access such systems. As BBSs are basically command-driven systems, they are not user-friendly and require some learning of corresponding commands prior to use.

With the advent of World Wide Web technology that can provide dynamic, interactive, hypermedia, platform independent, distributed and client/server services, such BBSs have become obsolete. The Web environment has obviously become a leading contender to provide online help desk support. Using this environment, customers can access the online knowledge database via any Web browsers such as Netscape’s Navigator [1] or Microsoft’s Internet Explorer [2]. If the problem cannot be resolved through the use of the online help desk functions, the customers can fill out a standard help request form to document their problems. This form can then be automatically routed to the experienced service engineers for further response.

Currently, a number of commercial help desk products for customer support, such as WebLink and WebSupport [3], are available. In addition to providing general Web support for accessing its knowledge database of problem solutions, these systems also support automatic problem diagnosis through artificial intelligence (AI) technology. The current trend of Web-based help desk environment for customer support is gaining acceptability and many MNCs such as Compaq and NEC [4] have adopted such an approach.
3. Integrated Help Desk Environment

Figure 1 shows the system architecture of the Web-based integrated help desk system, WetHotline, that is designed to support four main functions:

(a) **Web-based retrieval.** As the customer service (or knowledge) database contains past customer service records which serve as records of problems as well as provide knowledge into tackling similar problems, a Web-based retrieval tool is developed to allow remote customers access and retrieve service records from the database. Different ways of retrieval should be supported to make it flexible. For instance, the customers can retrieve all the checkpoints directly by selecting or defining the observed fault-conditions. These retrieved checkpoints can then be used to solve the problem. The Web-based retrieval function is achieved through the Retrieval Engine that interacts with the Customer Service Database.

(b) **Machine translation.** Currently, the Web-based help desk is mainly used to provide customer service support for MNCS’s Asian customers. However, as the service records are recorded and stored in English, they are retrieved and displayed in English only. This often poses problems for some of its Asian customers (such as Chinese and Japanese customers) who find difficulty in using the system. Therefore, in order to support these customers, and at the same time, tap into the expertise provided by the system, a provision of online translation of service records from English to other languages is necessary. Such a translation capability eliminates the need to create additional non-English service databases of identical content. At the same time, maintaining a central database of records offers significant advantages in terms of knowledge sharing, maintenance and extensibility. The online translation function is achieved through the Multilingual Translation module with the aid of the Translation Tables.
(c) **Intelligent fault diagnosis.** In traditional help desk service support, the identification of machine faults relies heavily on the service support engineers’ past experience or the information drawn from the service database. This method has a problem of training and maintaining a pool of expert service engineers. Thus, instead of relying on the knowledge of service engineers, an intelligent fault diagnosis tool that captures the expert knowledge of machine diagnosis to assist customers identify machine faults becomes extremely useful. This tool should be able to generate suggested remedial actions automatically or through user-interaction based on the observed fault-conditions. Such support is achieved through the use of the *Inference Engine* and its associated *Rule Base*.

(d) **Video-conferencing.** For certain difficult machine problems that cannot be resolved through the knowledge database or intelligent fault diagnosis, the customers need to seek help from the service centre directly. To cater for this functionality, a video-conferencing link over the Internet or Web can be established between the customer and service support engineers. Through video-conferencing, customers can discuss the problems and zoom into the faulty machine parts for assessment by the service engineers. This form of communication provides invaluable “sight and sound” response to allow service engineers carry out their advisory tasks. A *Low-Bit Rate Video Conferencing System* has been incorporated into WebHotLine to support such a service.

WebHotLine is developed on the Windows NT environment. The Netscape Enterprise Server 3.0 [5] is used as the Hypertext Transfer Protocol (HTTP) [6] server. The *Retrieval Engine* and *Multilingual Translation* modules are written in Visual C++ as Common Gateway Interface (CGI) [7] programs which are linked to the Web server. The Microsoft Access database management system is used for the *Customer Service Database*. The CGI programs communicate with the database system through Open Database Connectivity (ODBC) [8] to insert, delete or update information in the database. Hypertext Mark-up Language (HTML) [9] is used to create the user interface as Web pages to accept user queries.

Customers access the customer service database via any Web browsers such as Netscape's Navigator or Microsoft's Internet Explorer. The customer can interact with the system in many ways. One common method is to define fault-conditions in an HTML form. Through the retrieval engine, the system searches, retrieves and displays the corresponding checkpoints from the customer service database. If the problem can be resolved by using these checkpoints, the service cycle is complete. If not, the customer can document the problem by filling in an on-line help form for onward transmission to the service engineers. Alternatively, the customer can make use of the video-conferencing tool to communicate with the service engineers. If necessary, the service centre will then dispatch their service engineers for an on-site repair.

In addition, an automatic fault diagnosis engine has also been constructed based on a rule-based approach [10,11]. The purpose of the fault diagnosis engine is to provide an intelligent fault diagnosis to suggest possible remedial actions according to the fault-conditions of the problem reported.
4. **Web-Based Retrieval**

Web-based retrieval provides the facility to allow customers have direct access to past service records of machines that are stored in the customer service database. The customer would obviously be only able to access those records pertaining to their type of machines and not all the machines in the database. In addition, these service records pertain to all existing records that are previously accumulated for the same machine type from various customers. This enhances the amount of supported fault conditions and provides better chances for a reported fault to be resolved.

Upon successful user authentication, the customer will first select a particular machine type. This is followed by the selection of the reported fault as shown in Figure 2. Once a fault is selected by the user, a set of corresponding checkpoints are retrieved from the database and displayed as shown in Figure 3. These checkpoints are subsequently used by the customer in an attempt to resolve the problem.

**Fig 2.** List of fault conditions for selected machine type
5. Machine Translation

Machine translation techniques [12-17] have been successfully reported for English-to-Japanese and English-to-Chinese translation (among many others). Recently, machine translation systems for English-to-Japanese [18, 19, 20] have been developed for Internet or Web users. These systems translate the English information into the Japanese equivalent by maintaining the original layout of the Web page. By executing the translation program while receiving HTML documents, it gives users the impression of real-time on-the-fly translation. Thus, Japanese users can carry out net surfing as if the Web pages were all written in Japanese.

However, machine translation techniques are unsuitable for translating service records because of its technical nature and non-standard grammatical syntax of service records. Therefore, we propose another approach that uses translation tables (containing only limited entries of controlled vocabulary) for English-to-Japanese and English-to-Chinese translation of technical service records.

In this approach, language translation is achieved through the two processes of Technical Report Analysis and Online Translation [21] as shown in Figure 4. In Technical Report Analysis, a thorough preliminary and structured analysis of all the existing data in the database is first carried out to derive a set of new simplified common structures to adequately describe the contents of the service records. Based on these structures, translation tables for each unique word can be created.
During Online Translation, service records are first retrieved based on customer's input. The corresponding fault-conditions and checkpoints are parsed to the common structures identified earlier. Translation tables are then used to generate the specified language counterparts and displayed through a multi-lingual display software on the Web browser.

The common structures derived are subsequently used by all service engineers to document future service records. In order to make this method effective, the vocabulary used in the service records is limited to reduce the size of the translation tables and to improve efficiency. As these common structures are derived from existing service records, they are not too restrictive and pose no problems for service engineers to use and follow in future. In addition, using this approach circumvents the need to carry out deep-level analysis of syntax and semantics between the English and other languages.

5.1 Technical Report Analysis

A service record contains both fault-conditions and checkpoints. Checkpoints are basically remedial actions to resolve the fault. As fault-conditions and checkpoints are both translated during the Online Translation process, all the existing fault-conditions and checkpoints are first analysed in order to understand their internal structures. As the two processes are very similar, we will focus on discussing the checkpoint analysis process to illustrate the underlying concepts of the analysis.

As mentioned previously, the purpose of checkpoint analysis is to identify a common structure for checkpoints from all existing checkpoints in the customer
service database. With this structure, translation tables can be generated. Before discussing the checkpoint analysis process in detail, some general features of existing checkpoints are observed and described as follows:

• Most checkpoints possess the structure of (VERB + OBJECT), where OBJECT may be nouns or noun-phrases. Examples include:

1. **ADJUST SERVO DRIVER -> (ADJUST + SERVO DRIVER)**
2. **CHECK MACHINE INITIAL SETTING -> (CHECK + MACHINE INITIAL SETTING)**
3. **CHECK THE BINARY LEVEL SETTING -> (CHECK + THE BINARY LEVEL SETTING)**
4. **RETEACH MARK DATA -> (RETEACH + MARK DATA)**
5. **CHANGE POWER SOURCE BOX -> (CHANGE + POWER SOURCE BOX)**

• Some checkpoints possess the structure of (VERB + OBJECT + CONDITION (ADVERB, NOUN or ADJECTIVE)) where CONDITION indicates the state of the OBJECT. Examples include:

1. **TURN POWER OFF ONCE -> (TURN + POWER + OFF ONCE)**
2. **CHECK WIRES FOR CONTINUITY -> (CHECK + WIRES + FOR CONTINUITY)**
3. **CONFIRM SENSOR. DIRTY OR DAMAGED -> (CONFIRM + SENSOR + DIRTY OR DAMAGED)**
4. **ATTEMPT RECOGNITION AGAIN -> (ATTEMPT + RECOGNITION + AGAIN)**

• A few checkpoints contain a sole verb structure (VERB). Examples include:

1. **EXIT**
2. **RESET**
3. **RETRY**

• Complex structures are present in some checkpoints. However, most of such checkpoints can be further separated into one or more individual checkpoints described earlier. Examples include:

1. **TURN OFF THE POWER SOURCE AND CHECK THE CYCLE TIMER, ANGLE SETTING AND WIRING**
2. **IN THE PRODUCT MANAGEMENT INFORMATION, THIS IS INCLUDED IN COMPONENT RECOGNITION ERROR**
3. **TURN OFF THE POWER AND CHECK IF THE RECOGNITION BOARD IS SET IN THE CONTROLLER CORRECTLY**
4. **FOR ORIGIN RETURN, IT MUST NOT TAKE MORE THAN 20 SECONDS**

• Some checkpoints contain reference information that is enclosed by brackets. Examples include:

1. **CONFIRM THE NC CARD (LAM 00205)**
2. **CHECK THE WIRING CONNECTION OF THE ENCODER (MOTOR -> DRIVER -> NC CARD)**
3. **CONFIRM THE NC CARD (783-203)**
4. **CONFIRM THE ROMS IN THE MAIN CPU CARD. (LAM 00001)**

All these observations are useful since they form the basis of the heuristic concepts used for the checkpoint analysis process. Thus, given a set of checkpoints, the process will perform a sequence of steps as shown in Figure 5 to systematically reduce these checkpoints by processing and extracting relevant information at each stage of the process until no more checkpoints or the smallest set of checkpoints remains. In this way, the structure of the checkpoints can be identified from the heuristic concepts used.
In this work, a total of 4,851 checkpoints have been analysed. The analysis process is carried out as follows. Firstly, all repeated checkpoints are eliminated. Subsequently, the reference information, which can form part of the common structure, but need not be translated is identified and extracted. Next, non-alphabetical characters are removed since they do not need to be translated and can be displayed in its original form during translation. Removing them from existing checkpoints will not affect the analysis of record structure. As some checkpoints have complex structures which contain multiple checkpoints information connected using logical operators such as ”AND”, ”OR” or ”TO”, these checkpoints are identified and then separated into individual single checkpoints.

The next step is to identify conditions within checkpoints. The conditions will be used to form part of the common structure. Stop words and technical words in short form will be removed during analysis. However, in the display of the English text, the original form of fault conditions and checkpoints in the customer database is preserved so that stop words and technical short form words will be displayed in its original form. In the Japanese or Chinese translated text, stop words do not exist while
technical short form words are displayed in the original form. Finally, verb and verb phrases, and noun and noun phrases are identified which will form the core information in the common report structure.

From the 4,851 analysis, it was found that approximately 95% of the checkpoints posses the following common structure:

**VERB [PHRASE] [+ NOUN [PHRASE]] [+ CONDITION] [+ REFERENCE]**

With the common structure, a checkpoint translation table is created to store all the unique English words and their corresponding language (Japanese or Chinese) equivalent. However, about 5% of the existing checkpoints do not follow the common structure. This is mainly due to the fact that there is no standard format and vocabulary to record the service records. The remaining 5% checkpoints are required to be converted and re-written according to the common structure before they can be translated.

Similarly, the fault-condition analysis process has been carried out to analyse all existing fault-conditions. A total of 9,319 fault-conditions were analysed from the customer service database. As a result, a common structure for most of the fault-conditions (92%) has been derived as follows:

**SUBJECT [+ VERB [PHRASE]] + STATE (ADVERB, ADJECTIVE or NOUN)**

### 5.2 Online translation

Customers or service engineers interact with the system via client Web browsers. Prior to viewing the translated documents, multilingual display software such as TwinBridge [22] or WinMass [23] must first be installed and executed as a background process. Alternatively, the Web browser must be configured to have multilingual support directly through the addition of such language components. With the online multilingual option enabled, the retrieved fault-conditions and checkpoints will be parsed in the same way as the fault-condition analysis and checkpoint analysis processes into the common structures discussed previously. Based on the translation tables, the Japanese/Chinese equivalents of the fault-conditions and checkpoints are looked-up and sent to the client Web browser for display.

Figures 3, 6 and 7 shows a typical set of fault-condition and checkpoints in English and its equivalent in Japanese and Chinese respectively. It is apparent that the English text is maintained in the original form as stored in the database and that stop words in the text are eliminated while short form technical words or abbreviations are retained in the translated text.
6. Intelligent Fault diagnosis

Based on the common structures adopted for the machine translation process, rule-based programming has been applied to the data to derive rules for fault-conditions and checkpoints using the standard \textit{if} (fault-condition(s)) \textit{then} (checkpoint-action(s)) paradigm. In this system, CLIPS [24] was used as the tool for rule base management. As different fault-conditions may have the same checkpoints, such checkpoint rules were generated uniquely to avoid duplication. When a fault-condition is reported, the corresponding fault-condition rule and all related checkpoints rules will be applied for checking.
Figure 8 and 9 shows the fault diagnosis interface to guide the user to carry out the necessary remedial actions to rectify the reported fault. When a fault-condition is defined, the system will carry out the inference process and provide a remedial checkpoint as shown in Figure 8. A “How” option is available to provide more information to carry out the task. Upon activation, it will cause the system to load the corresponding help file (if it exists) as shown in Figure 9. At each stage of the consultation, the user confirms, at the completion of the current task, whether the fault is resolved. If it is successfully resolved, the diagnosis terminates. Otherwise, other
rules (tasks) are invoked through the same interface of Figure 8. When all the rules are exhausted (i.e. all the checkpoints have been checked) and the problem still persists, the system will request the customer to contact the Customer Support Centre for further assistance through electronic mail or video-conferencing.

7. Video-conferencing

A stand-alone low-bit rate real-time Internet video-conferencing tool [25, 26] has been developed and integrated as part of the help desk system. The provision of various operating modes of sight and sound has greatly enhanced the whole customer support process. This tool was originally developed to study the feasibility of utilising various techniques to enhance the Quality of Service (QoS) of real-time audio and video communication between two users using Internet as the transmission medium to exchange real-time data. It uses the techniques of data compression, data buffering, dynamic rate control, data packet lost replacement, silence deletion, and virtual video play-out mechanism to provide a cost-effective and acceptable means of real-time communication.

![Video conferencing tool interface](image)

**Fig 10. Video conferencing tool interface**

In the context of help desk applications, the video conferencing tool can be used in different operating modes by defining the audio and video priority under different conditions as shown in Figure 10:
High video and audio priority. With the presence of adequate bandwidth, some of the mechanism designed for the occasional unreliable Internet network such as dynamic rate control, dynamic video frames reconstruction and virtual video playback becomes unnecessary and can therefore be de-activated. However, audio and video compression is still used to enable effective management of data packets by the underlying network layer. This is the ‘normal’ video conferencing mode for customers and service engineers to communicate.

High video and low audio priority. When good quality video is desired, lower quality audio quality compression can be used or even terminated to allow for better video transmission. This is useful for sending a sequence of video frames to the service engineers for their evaluation. Such a mode of operation has been used to remotely monitor and observe the action of faulty machines at the customer’s site.

In the case where a static but larger and higher-resolution image is desired, the video conferencing mode can be switched to the Picture Phone mode and allow the exchange of snapshots and images from the video-capturing device. Thus, only an enhanced single frame (of user-defined size) is captured and transmitted as shown in Figure 11. Such a facility will allow images of critical components to be zoomed in and out during the diagnostic process. In this instance, the reliable Internet protocol, Transmission Control Protocol (TCP), can be used for data transmission to guarantee the safe arrival of the image at the service engineer’s site since any time delay in obtaining the image will not incur any inaccuracy to the communication process.
Low video and high audio priority. In this mode, emphasis is placed on the audio communication aspect so that a virtual video play-out is used to provide a better communication session. Since audio takes a higher priority, dynamic video frames reconstruction is employed to allow for low video transmission rate with minimal jerky play-out. This is done by reconstructing (through image interpolation) a series of frames within previously received video frames and repeating the play-out sequence. Virtual video play-out is used to simulate video presence when no video frames are transmitted. Such a facility is useful for service engineers to concentrate and listen to a sequence of sounds that is generated by a faulty machine at the customer’s site. If necessary, this sequence of sound can be recorded beforehand and transmitted via TCP. A sound wave analyzer can be used, as shown in Figure 12, to observe the wave pattern of the transmitted signals. This allows important information, such as threshold sound values and cycle times to be determined easily at the service engineer’s end.

The provision of these various operating modes in contrast to traditional video-conferencing stems from the realisation that during a service cycle, the important audio and visual aspect is to listen and view a faulty machine’s condition or an enhanced image of some machine component as opposed to the users’ faces.

8. Security issues

Issues with user and data security are an important consideration in the design and delivery of the help desk system since important and critical data is being transferred across the insecure Internet network that is prone to data tapping, data interception and user impersonation.

In this work, security is achieved through password authentication, data encryption and verification. Password authentication involves the setting up of user
accounts and passwords in the Web server for user authentication prior to being able to access the facilities of the help desk system. Such a mode of protection is still subjected to interception or tapping by hackers as the user and password information is being transmitted from the user to the Web server. Thus, data encryption, which is defined as the transformation of data into a form unreadable or indecipherable by anyone without a secret decryption key, has been utilised in this work to further protect the password authentication data. Current encryption efforts are focused toward allowing secure communication to take place over insecure networks, such as the Internet. Substantial efforts have been focused on creating digital signatures for authentication due to commercial reasons. Encryption basically ensures data confidentially while authentication ensure data integrity.

Two kinds of encryption can be used. Symmetric encryption uses the same secret key to encrypt and decrypt a message, while asymmetric encryption (or public key encryption) use one key (the public key) to encrypt a message and a different key (the private key) to decrypt it, or vice versa, as shown in Figure 13. In this work, ActiveX and CGI programs have been used to fulfill the encryption and decryption process.

An ActiveX program in the Web client side will require the customer to key in the account and password that are then encrypted using a public key and transported back to the Web server for verification. The CGI program in the Web server will decrypt and verify the user prior to permitting access to the various help desk functions. As both the ActiveX and CGI programs are written in Visual C++ and compiled into binary code, identifying the encryption method used becomes more difficult. Furthermore, as the public key is compiled into program binary code in ActiveX, it becomes very easy to change a public and private key pair regularly and transparently on the Web server side. All that is required is the recompilation of the client program with a new public key that goes unnoticed from the user’s point of view. Similarly, all data that is transmitted across the network between customer and Web server or service engineers are protected in the same manner.

Fig 13. Encrypted communication across the help desk system
9. Conclusion

This paper has presented a traditional help-desk environment, shown how its limitations can be eliminated and its support enhanced through the introduction of an integrated Web-based help desk system that comprise the four main functions of Web-based retrieval, online multilingual translation, intelligent fault-diagnosis and video conferencing.

In order to ensure that the proposed system remains relevant and useful in the long term, the system architecture has been derived following a careful evaluation of the pertinent functionality of help desk systems and existing computing technologies. Even if someone applies the same set of technologies used in the proposed system, it may not necessarily lead to the same results since the integration of technologies and a unified framework is an important design consideration and delivery of the system.

It is envisaged that the proposed system architecture will form a useful help desk framework that can be extended in future in view of emerging research in areas of human computer interaction, artificial intelligence, natural language processing and computer communications. The use of such a “plug and play” paradigm in the system design will ensure that such emerging researches can be integrated into the existing framework to further enhance the quality and service level of such a system.

In its present form, the system yields a number of distinct advantages over its traditional counterpart:

- Better and faster response time to customers’ problems;
- Video-conferencing/picture-phone modes of operations enhance the support and chances of solving the reported problem by service engineers who are able to use both visual and audio mode of communication and information exchange;
- Substantial cost savings in eliminating the charges of expensive overseas telephone calls, reduction in machine down time, and reduction in the number of site-visits by service engineers to an ‘unless-absolutely-necessary’ basis;
- World-wide accessibility to the Web from any computing platform and at all hours for customer support;
- Minimises valuable service engineers’ time from handling time-consuming telephone calls for routine problems, thereby reducing the number of full time service engineers on standby;
- Serves as a depository of knowledge that can be structured, shared and used as a support and advisory tool for customers and an educational tool to train new service engineers;
- Serves a multilingual base of worldwide customers who feel more at ease at accessing a native-language interface and advisory system.

The lessons learnt in carrying out this two-year research project and presenting the case study are threefold. First is the need to understand the whole process of the existing service thoroughly even before any work on the proposed solution takes place. Second is a need for a detailed survey and understanding of what is possible, what has been achieved, and to what extent have these facets of knowledge and technology work in such an environment. It is only through such a vigorous study and evaluation can an integrated and extensible framework be proposed, designed and
implemented. Finally, it should become apparent that there is an important need to constantly keep track of emerging state-of-the-art research and technologies so that they could be harnessed to yield synergistic effects (through careful planning and integration) and add value to existing computing systems and services.

References


