

**CLINICAL INFORMATION SYSTEMS:  
THE NEED FOR A MORE USER - FRIENDLY  
HUMAN – COMPUTER INTERFACE**

**J. C. Sarivougioukas,**

MSc CE, MSc EE, BSc,

Computer Engineer, Head of MIS department,

General Hospital of Athens “G. Gennimatas”,

Mesogeiwn 154, Holargos, GR-15659 Athens, Greece,

jcsari@hellasnet.gr

**A. Th. Vagelatos,**

PhD, BSc,

Computer Engineer, Project Management Bureau,

Computer Technology Institute,

Kolokotroni 3, GR-26221 Patras, Greece,

vagelat@cti.gr

## **ABSTRACT**

The introduction of a Clinical Information System (CIS) in a regional state hospital in Greece brought up a number of critical factors that affect the successful application of such systems. The major obstacle was identified to be the medical professional's refusal to use the system. As a way to overcome this obstacle the interest was focused on improving the system's Human Computer Interface (HCI). A number of technologies have been considered and examined such as Speech Recognition Systems, use of Palm Top Computers, and Bar Coding Systems. The productive use of the CIS was based on the usage of regular computer terminals (keyboard and mouse) proved that the clinical personnel do not accept the offered ergonomic solution. Without the application of improved HCI with state of the art technologies, the productive use of CIS seems rather difficult.

**Keywords:** Health Information System, Clinical Information System, Human Computer Interface.

## **INTRODUCTION**

The “G. Gennimatas” hospital is one of the largest regional state hospitals in Greece. The Ministry of Health and Welfare appointed the above mentioned hospital as the pilot one for the introduction of an Integrated Hospital Information System consisted of an Information System for Administration (IASH), a Clinical Hospital Information (CIS), and a Laboratory Information System (LIS).

During the productive use of the CIS it became apparent the medical professionals' refusal of using the system. The Hospital's MIS Department and the Computer Technology Institute, (C.T.I. is the technical consultant of the Greek Ministry of Health and Welfare regarding IT programs within Community Support Framework 1994-2000), examined along with the rest of the participants in the project various ways of improving the Human Computer Interface (HCI), since it was identified that the major factor to overcome, it was the users' resistance of accepting the use of the system.

In the rest of the paper it is presented a number of technologies for improving the Human Computer Interface of the introduced CIS. First, the IT infrastructure in the hospital is described. Then, the employment of state of the art technologies regarding the HCI that are under discussion for application are presented.

## **IT INFRASTRUCTURE IN “G. GENNIMATAS” HOSPITAL**

The software applications in “G. Gennimatas” hospital rely on a computer network consisted of fiber optics in order to connect the eight buildings, which constitute the Hospital's facilities. All the administrative positions are coupled through the network to

the main server where there are mounted three databases and the corresponding software applications.

The first of the installed databases serves the needs of the Information System for Administration of a Hospital, widely known as IASH. The Ministry of Health and Welfare assigned the development of the application to KHYKY a state organisation that provides computer services. The first application was installed in 1993 and concerned the Pharmacy's Department. Almost a year later, the Patient's Admissions Office and the External Patients' Appointment Office were launched. Next, the application of Billing Department was installed. In 1996 the software applications for the Warehouse and Supply Departments were used productively and a year later, the software application for the Dietary Department was installed. In 1998, the last software application was installed concerning the Accounting Department that is interconnected with all applications. The set of all applications was developed, tested, and integrated under the guidance of the Hospital's personnel that constitute the actual users of the developed system. Therefore, the mentioned system has a wide acceptance since the users had a critical role in the analysis and development of the system, to the benefit of the patients and the Hospital.

The second database was created in the fall of 1998 when a Clinical Information System was introduced in the hospital [10]. This system is in its roll out phase now and it has been introduced to almost half of the clinical departments. So far, there have been activated specific and discrete functions of the Clinical Information System, sending drug orders to Pharmacy, keeping records on patients' follow up, issuing discharge documents, etc.

The last database was installed in spring 1999 when started the works for the development of a Laboratory Information System (LIS) (the project is jointly funded by EU and Greece (within CSF 1994-2000)), as part of the Hospital's Integrated Information System. The LIS served and automated the procedures to book from the clinical departments the patients' laboratory examinations and receive the corresponding results in the electronic patients' record.

## **USERS' ACCEPTANCE OF THE CLINICAL INFORMATION SYSTEM**

Clinical Information Systems (CIS) contribute major benefits in the direct support of patient care, providing great advantages over the paper record in reporting, organising and locating clinical information. At the same time, CIS can assist physicians' decisions by providing protocols, reminders and alerts. Despite of that fact, CIS have not been successfully implemented in many cases. In these cases, the physicians act indifferently with respect to the CIS causing the failure of the productive use of the system. In some instances, the lack of physicians' acceptance led to the discontinuation of the implementation of the entire project [1].

In the case of "G. Gennimatas" Hospital, we experienced analogous behaviour. The clinical departments are usually understaffed and the clinical personnel is most of the times occupied with its regular duties and it is proved that it is rather difficult to obliged them to use computer terminals too. The Hospital's Administration offered as outsourcing a number of data-entry operators to assist the physicians and the rest of the personnel to enter medical data into the system. To a certain degree, the flow of work in

the clinical departments is changed due to the introduction of the CIS, altering traditional medical procedures followed for many years, making it, especially for the older physicians, more difficult to accept the use of the system.

The contemporary data-entry practice includes the use of the keyboard and the mouse device, which require an operator to spend some time seating in front of a terminal. The nature of the physicians' work does not allow the extensive use of a terminal since the medical doctors are required to be present at various locations within the clinic offering their services. The traditional terminals do not provide such a user friendly environment for the physicians due to the time consuming process of typing, most of the medical professionals do not have enough time for typing practice, and the typing process is getting tedious for the older ones. It is obvious the need for use of practical and more friendly ways of interaction between the medical personnel and the CIS.

## **UTILISATION OF MORE USER – FRIENDLY INTERFACES**

One of the most notable trends in computing in our days is the increase in the variety of computational devices with which users interact. In addition to workstations and desktop personal computers, the users are facing (to mention only a few) laptops, PDAs, liveboards, microphones, etc. In the near future, Internet communication will be universally available, and the new Internet appliances may allow interactions through the user's television and local cable connection. In the more distant future, wearable devices may become more widely available [8].

On the other hand there is substantial empirical evidence that employing such HCI techniques and tools can dramatically decrease the costs and increase the productivity. Report shows that the decrease task time reduces user disruption, reduced burden on support staff and elimination of training [8].

Effective tools and user interfaces to complex applications like clinical information systems are indispensable. Having that in mind and at the same time having experience the negative attitude of the medical staff that uses the CIS, the use of improved HCI devices came under consideration. More specifically the following technologies are considered: speech recognition systems, utilisation of palmtop computers and the use of bar coding systems.

### **Speech Recognition Systems**

Speech recognition technology is developing rapidly and is being continuously applied to new markets. Especially in recent years, speech recognition systems have seen such marked improvements in accuracy rates, specialised vocabulary development and CPU processing speed that it has become a factor in improving productivity in many vertical markets. One of the major such markets is Health Information Systems (according to market analysts, the medical dictation market is the largest vertical market in the speech technology industry [6]). Many physicians have discovered that speech recognition can be a reliable and quick means to get from spoken word to written output [9]. A number of reasons have been cited to explain why the medical field is so strongly involved with speech recognition. Medical care is increasingly being driven by costs, and medical transcription is a big budget item for major hospitals and individual physicians. The health care industry faces a need to keep the costs of transcription as low as possible,

while continuing to provide reports with both accuracy and speed. Health care professionals have a need for accurate reports and highly specialised vocabularies. These are all factors that point to the value of speech recognition, and they help explain the rapid rate of adoption of this technology in the medical field.

With such a system, the physician can save time by inputting data in the patients' records and the associated diagnostic reports with voice to text applications, having the system automatically transpose the audio to text.

In the "G. Gennimatas" hospitals, such a system will definitely improve the users' attitude against the clinical system. Especially for reporting purposes, speech recognition systems seem to be the most appropriate solution. The medical reports must be entered into the system in the shortest possible time after the diagnosis, and even better, during the patient's examination. As an example, consider the radiology department where in certain sections (e.g. Ultra Sound, MRI) the personnel is processing and carrying diagnosis procedures on images.

## **Palmtop Computers**

Many people work in non-traditional office environments anymore. Such environments usually have a series of temporary workplaces, as in the case of the travelling sales representative. The nature of the job of certain professions require the employee to move from place to place or from room to room as it usually happens usually with the industrial workers or health care professionals.

In the last three years, a number of portable information appliances, from Handheld PCs to Pocket PCs, have become available to assist this mobile work force. These devices not only assist in managing appointments and contacts, but also provide a tool for replacing paper-based business processes with forms-based applications. The increased efficiency and accuracy of capturing data quickly into a computing device can result in a higher degree in the employee's productivity, faster business reporting for decision making procedures, and reduced operating costs [11].

Certain vertical markets are already experiencing the distinct and efficient characteristics from the use of mobile devices [3]. One such vertical market is healthcare. Quick access to current patient information, writing or renewing drug prescriptions, capturing dictation, inventory management and patient monitoring are among the ways mobile devices can improve efficiency in the health-care sector.

Within this context, the utilisation of such devices for "G. Gennimatas" hospital is under consideration. The considered objective is to help physicians in the use of the clinical system during the morning's visit to the wards. At that time, and due to the nature of the procedure, it is impossible to utilise some kind of a traditional PCs. On the contrary, a palmtop computer seems to be an adequate, if not perfect, solution. Hence, physicians will be able to use such devices under any circumstances, at every place, within the hospital, thus making it easier for them to complete the kind of procedures that they are responsible for.

## **Bar Code Systems**

Modern bar code began in 1948 [11]. Bernanrd Silver, a graduate student at Drexel Institute of Technology in Philadelphia, overheard the president of a local food chain asking one of the deans to undertake research to develop a system to automatically read product information during checkout. Silver told his friend Norman Woodland about the food chain president's request. Woodland was a teacher at Drexel. On October 20,

1949, Woodland and Silver filed a patent application titled "Classifying Apparatus and Method". Nevertheless bar code was not commercialised until 1966, when the U.S. National Association of Food Chains (NAFC) put out a call to equipment manufacturers for systems that would speed up the check out process. In 1967 RCA installed one of the first scanning systems at a store at Cincinnati, Ohio, USA. The adoption of the Universal Product Code (UPC), on April 3, 1973, transformed bar codes from a technological curiosity into a business reality. Before the UPC, various systems had begun to come into use around the world in stores, libraries, factories and the like, each with its own proprietary code. Afterwards any bar code on any product could be read and understood in every suitably equipped store all over the world.

As far as health care is concerned, bar codes started to be used in the early years of hospitals' computerisation. Especially the pharmacy information systems as well as the laboratory information systems, were among the first to explore bare code capabilities.

At the "G. Gennimatas" hospital, the use of bar code technology is going to improve the procedures of sending the patients' specimens to the corresponding laboratories for the exercise of examinations. The issuance of bar coding labels from the CIS and stamping the package of the patients' samples, first, it is going to accelerate the material handing procedures for the clinic, and then, it will make easier the handling and identification of the arrived samples at the laboratory.

## **CONCLUSIONS**

The application of a CIS in a regional state hospital in Greece, has proved the medical professionals' refusal to use the system. The regular computer terminals do not offer reasonable friendliness to the medical users since they rely on the usual schema of the keyboard - mouse combination which it seems to be unacceptable for applications in the clinics' environment. The uses of advanced HCI technologies accelerate the performance of everyday operations that are tedious with the usual computer terminals. In addition, the application of such technologies simulates more efficiently the carried out procedures and the users approach the system easier.

## **REFERENCES**

- [1] Anderson J. Clearing the way for physicians use of Clinical Information Systems. Comm. ACM, 40, 8, 1997, pp. 83-90.
- [2] van Bommel J, Musen M, editors. Handbook of Medical Informatics. Springer; 1997.
- [3] Enterprise case studies. Microsoft corp. [www.microsoft.com/mobile/enterprises](http://www.microsoft.com/mobile/enterprises).
- [4] Davidson P, editor. Healthcare Information Systems. Auerbach; 1999.
- [5] Iakovidis I. From Electronic Medical Record to Personal Health Records: Present situation and trends in European Union in the area of Electronic Healthcare Records. Proc. of MEDINFO 98, Seoul, Korea.
- [6] Moyers G. Doctor, Doctor: Speech companies jump headlong into the medical

market with major acquisitions. *Speech Technology Magazine*, September/October 2000.

[7] Myers B, Hudson S, Pausch R. Past, present and future of User Interface Software Tools. *ACM Trans. on Computer-Human Interaction*, V. 7, 1, 2000, pp. 3-28.

[8] Myers B, Hollan J, Cruz. I. Strategic Directions in Human Computer Interaction. *ACM Computing Surveys*, V. 28, 4, 1996.

[9] Osborne M. Doctor's Orders. *Speech Technology Magazine*, September/October 2000.

[10] Sarivougioukas J, Vagelatos A. Introduction of a Clinical Information System in a Regional General State Hospital of Athens, Greece. *Proc. of MIE2000*, Hanover, Germany.

[11] Seideman T. Bar Code Systems. *Invention & Technology*, vol. 8, no.3, 1998.

[12] Why pocket PC? White paper. Microsoft corp. [www.microsoft.com/mobile](http://www.microsoft.com/mobile).