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INNOVATIVE HOSPITAL BED MANAGEMENT USING SPATIAL TECHNOLOGY

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Abstract

An efficient bed allocation management GIS based system tool, *eBeds*, is being developed within the hospital environment to meet the health industry's patient management protocols and to address community concerns. Inefficiencies and continuing difficulties in management of available and appropriate beds within hospitals have not been overcome and continue to be a source of practical, financial and management frustration.

The *eBeds* system is a practical, flexible and dynamic tool that aids planning and management of bed numbers, types and location for the allocation of in-patients. Using a geographical format, the data displayed is in a visual layout, in real-time, of the exact location of each bed within a room, ward or floor. It also has the capability to permit examination of a bed's attached patient records as existing hospital software applications can be efficiently and seamlessly integrated into *eBeds*. *eBeds* crystallizes the large number of current generally unsophisticated hospital methods used to gather, collate and display patient related information. It also complements the spatial industry expansion into other medical related areas, such as ageing population, community health and emergency services.

Introduction

One of the major problems within a hospital environment is dealing with the bottleneck of patient allocation and the availability of beds (Ward 2004). Through increased public scrutiny there is also a greater degree of accountability required from health care professionals with regard to facilities management and information administration. Our hospitals are running at peak capacity which almost guarantees queuing in the emergency department for available beds and other critical inpatient services (Richardson 2003). Bed availability is significant as a bed can be viewed as "one of the most fundamental inputs in the provision of acute health care" (Walsh 1998).

Queensland Health is currently managing major restructuring changes and resource difficulty within budget constraints. It also faces an increasingly higher level of demand from an ageing population, community health needs and emergency services. Substantial increases in the 2006 Federal Government Health budget acknowledge these resource shortages within the medical arena and the need for efficiencies.

Consequently, there is a critical need to develop a more efficient and suitable universal technique, compatible with existing data systems, to manage the bed allocation issues affecting hospital staff on a daily basis. There are a number of health care companies in Australia providing a variety of health administration systems to both public and private hospitals. These include such systems as iPAS, HBCIS, ibaPAS, OACIS, FastTrak, and AusPAS, which are all electronic based, some web enabled, but all lacking the visual display and spatial location advantages available from the ubiquitous GIS. Hence, the main focus of this study was to investigate how the application of GIS can benefit the health care industry and provide a simple universal graphical output system applicable and useful to all levels of medical careers in the hospital environment.

Development of a Bed Management System

In general, geospatial technology acquires, integrates, interprets, manages, analyses, maps, displays and distributes geographic, temporal and spatial information and knowledge to address the planning, decision-making, and operational needs of people and organizations. GIS technology is not normally associated with health care management, but it has the potential to solve the very complex and difficult issues of efficient bed allocation management that satisfy relevant health industry protocols. Hence, a significant part of the research involved:

- identifying specific and common management and administrative inefficiencies associated with bed allocation;
- persuading hospital authorities and staff that there were no confidentiality or privacy risk within the proposed project limitations;
- identifying the type of data and support that was available for the proposal; and
- convincing the hospital authorities and staff that there would be no interruption or interference with their normal work environment.

This project's application relied on hospital's having existing computer hardware and an existing bed information database, with related patient records, for integration into the eBed development software. "You get a much better government decisions [*management/administrative - authors*] if you can do your analysis in a more strategic way, which you can do if you have that spatial content to your data" (Nairn 2006).

The purpose of using the geographical format was to allow the data to be displayed in a visual real-time layout with the exact location and current and future occupancy rate of each hospital bed within a room, ward or floor. Attached patient records for any particular bed would be possible so that they could be examined by those with the appropriate authorisation. *eBeds* is also being designed to be expandable to encompass maintenance and other administrative information; be equally adaptable to both public and private hospital environments; be applicable in regional health care organisations; and will function equally well in specific internal units as mental health, obstetrics and emergency departments.

Allocating a patient to a vacant bed is one of the daily challenges faced by hospital staff. To date, the main focus into the development of *eBeds* has been on the application to provide a necessary and sufficient functionality required to support bed management. Upon consultation with a variety of medical and clinical staff throughout the public hospital environment, it was initially intended to establish whether the visual presentation would provide users with the ability to identify previously unknown relationships in the data that directly affected decisions about how and where patients are placed in the hospital, e.g. where to place patients appropriately in a ward and/or what available beds are suitable for patients' individual needs.

The solution was to create an automated workflow process addressing the elements of patient discharge management and patient tracking. These elements are:

- Automating the 'white status board' now in common use
- Tracking the status of beds across all acute care wards
- Visually showing familiar views of beds in wards
- Providing helpful tools for analysis of efficiencies in bed management
- Creating a management report to be used by Admissions and Nursing Administration for early identification of problems in the patient discharge process
- Creating a management report of performance metrics to track the performance of the new bed management function. This will provide management with an assessment tool to further highlight additional areas for improvement of the process.

The Hospital Environment

The management of available and appropriate beds and their occupancy levels in hospitals is an integral part of the economical and ethical management of health care. Inefficiencies and continuing management difficulties within hospitals have not been overcome and continue to be a source of practical, financial and management frustration. "A hospital is a place where the staff have more complaints than the patients" (Shaw 1998). Existing hospitals systems rely on a large number of diverse methods to gather and collate patient and patient related information. The dissemination of this information does not enable the best informed and accurate decisions for planning and managing bed allocation, and hence providing the best economical, timely and beneficial patient care.

Hospitals also have a problem with losing beds, which further complicates bed allocation processes. One hospital dealt with during this research lost a significant number beds on one particular weekend. This resulted in some elective surgery being cancelled for that week and an increased bottleneck in placing patients into beds. The secondary consideration is the value of the bed as an asset. A "basic" bed generally found in the "non-specialised" wards costs approximately $8,000; a maternity bed can cost up to $30,000; and a special-needs bed (e.g. spinal bed or rehabilitation bed) can range up to $80,000.

Australia has approximately 750 public hospitals (Australian Institute of Health and Welfare 2003); while in Queensland there are 179 public hospitals, with four major ones located close to Brisbane City. The Brisbane hospitals were approached and two became willing participants in the development stage: the others expressed considerable interest in the concept.

In conjunction with the selected Brisbane hospitals, bed management has been defined as the management of all processes necessary to place a patient into an appropriate vacant bed (type, location, facilities, temporary or permanent status) or scheduled future other allocation. The processes taken into consideration are the admission of a patient, length of stay, type of specialist bed (if needed) and the pending discharge date (Commonwealth Department of Health and Aged Care 1999). Some patients may change beds during a hospital stay, depending on recovery rates or rehabilitation needs, or new medical procedure needs. Immediately including these reallocations data into the management system is also critical for optimal and rapid globally viewed bed management. Within the hospital, management and staff must find a balance between the demands for available beds placed on the organisation as a whole and the demands placed on them through the needs of continuum care of the patient and emergency or greater need demands.

The hospital system, in general, is renowned for being stretched to the limit in all areas of health care, including:

- staff shortages;
- greater demand in providing a higher standard of continuum of care;
- more access to better facilities and services; and
- a growing demand in providing sufficient hospital beds (Kirby et al. 2003).

To date, hospitals approach the bed allocation of patients and their requirements at a very basic appraisal level. Bed allocation decisions are either on a once daily basis or a reactive need-by-need basis, requiring the time and skill of a variety of fully informed staff members or managers to complete this task. However, a hospital environment has a varied and dynamic changing staff population attending patient throughout continuing 24-hour periods.

Major patient information systems in hospitals have similar applications aimed at assisting medical and administrative staff with patient administration. Investigations in the participating hospitals reveal that the software does not generally address the administration of bed management but provides an entry point of managing patient admission and discharge together with other applications e.g. recording of radiology, pharmaceutical, laboratory results.

The development of a GIS environment *eBeds* came from the need to have a more in-depth application that focuses solely on bed management and patient flow. Further development will include all patient data being imbedded into the beds information system; particular persons with selected authorization can then access patient and/or patient administration information irrespective of time or their location. This can be established for all related medical services needs.

Using other software to provide a solution, such as FORTRAN C++ and BASIC based applications were considered too high end and complex in this environment. For example, FORTRAN is a “general-purpose, procedural, imperative programming language that is especially suited to numeric computation and scientific computing”, (Wikipedia 2006). Using applications based on such software will not achieve the same graphic format as GIS and requires specialist expertise and the associated maintenance expenses.

Development Of eBeds

The development of the *eBeds* system was visualized as firstly providing a practical and flexible tool that aids administrative and medical staff with the planning and management of bed numbers, types and location for the allocation to in-patients. Secondly, using a geographical format would allow bed data to be displayed in a visual layout, in real-time, in the exact location within a room, ward or floor; plus the added capability of intuitive access to attached patient records via the bed symbol. The design aimed to utilize the hospital’s software applications to efficiently and seamlessly integrate information into *eBeds* to provide for applications across a broad spectrum of medical services. The generic structure was developed to be adaptable to both public and private hospitals as well as regional health care organizations and such internal units as mental health, obstetrics and emergency departments. From this concept the requirements for the bed allocation system to deliver a satisfactory outcome were identified as having the ability to:

- Display current inpatient population by physical location in a room/ward.
- Query current in-patients by variables such as:

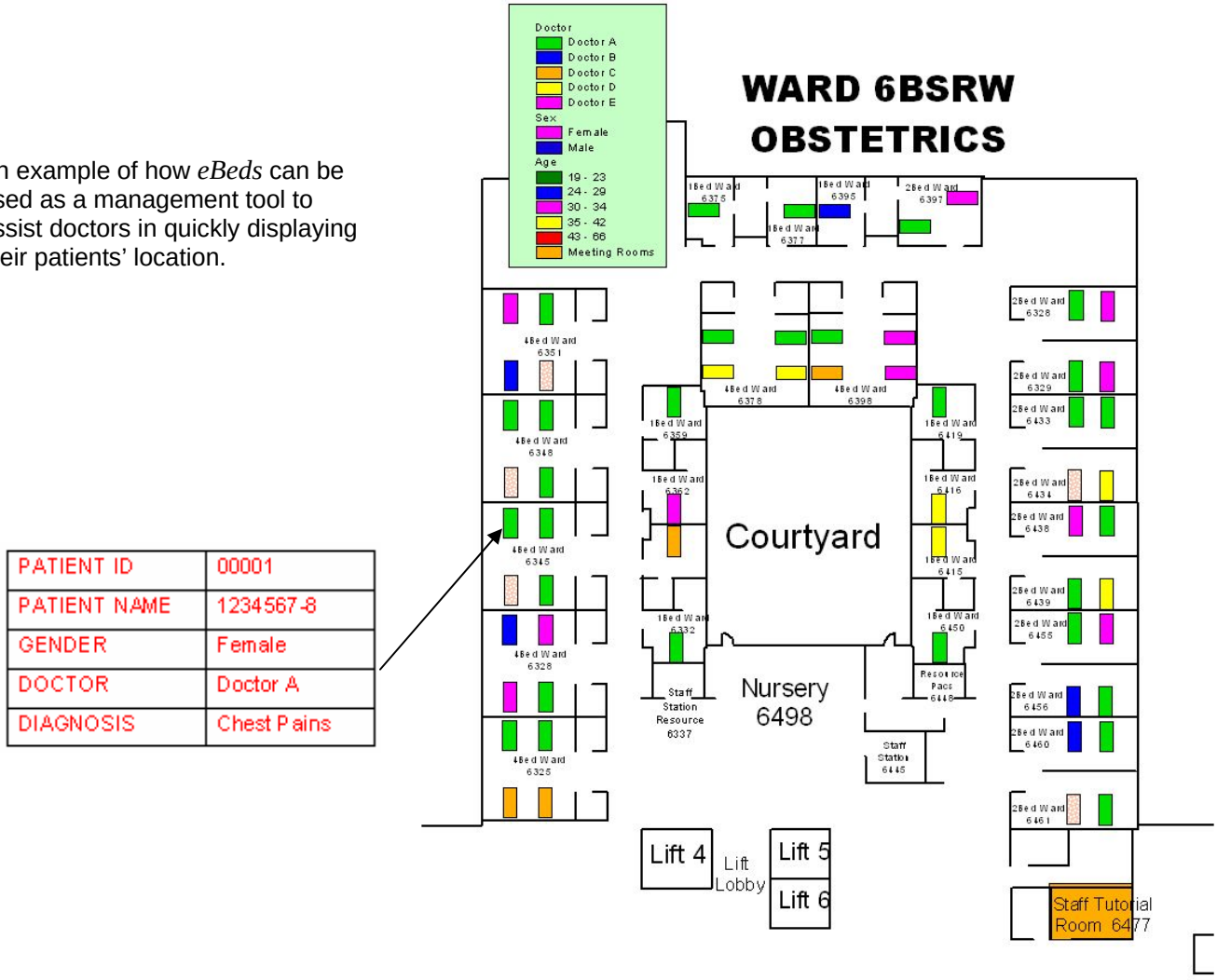
- Length of Stay (LOS)
- Expected discharge date
- Doctor
- Age
- Sex
- Medical and Nursing Acuity

- Display patients by parameters (admit days > Possible LOS).
- Query the wards by bed status.
- Query and display, at any given time, the percentage of overall bed occupancy within any ward.
- Enter a discharge date or direct status changes into a reference file and immediately display the change of the bed status.
- Enable bed data to be summarised into a dynamic vacancy/type status that can be made available to emergency services to continually monitor and manage patient distribution.

The prototype (Figure 1) for one major Queensland public hospital was designed as a static demonstration for the hospital based on their precise specifications related to an extremely critical bed allocation situation. This prototype provided an understanding of how this concept could be applied to a hospital setting. The success has encouraged the development towards a full *eBeds* system to apply all the proposed variables of staff bed allocation management and planning. Expansion for incorporating other hardware and data systems such as Palm Pilots (PDA's) and equipment asset management has been allowed for. For example, doctors with individual PDA's that could be continually updated can have the latest information to hand and update the hospital's information data base through edits they make while attending a patient. This concept is not being introduced at this stage due to political and administrative uncertainties.

Figure 1 – Example of a hospital ward and bed related information

An example of how *eBeds* can be used as a management tool to assist doctors in quickly displaying their patients' location.



The current *eBeds* system development has a simple standard logon window (Figure 2) and easy access to the desired floor. The familiarity and simplicity of menu navigation has proven popular and easily understood.

Figure 2. eBed logon window.

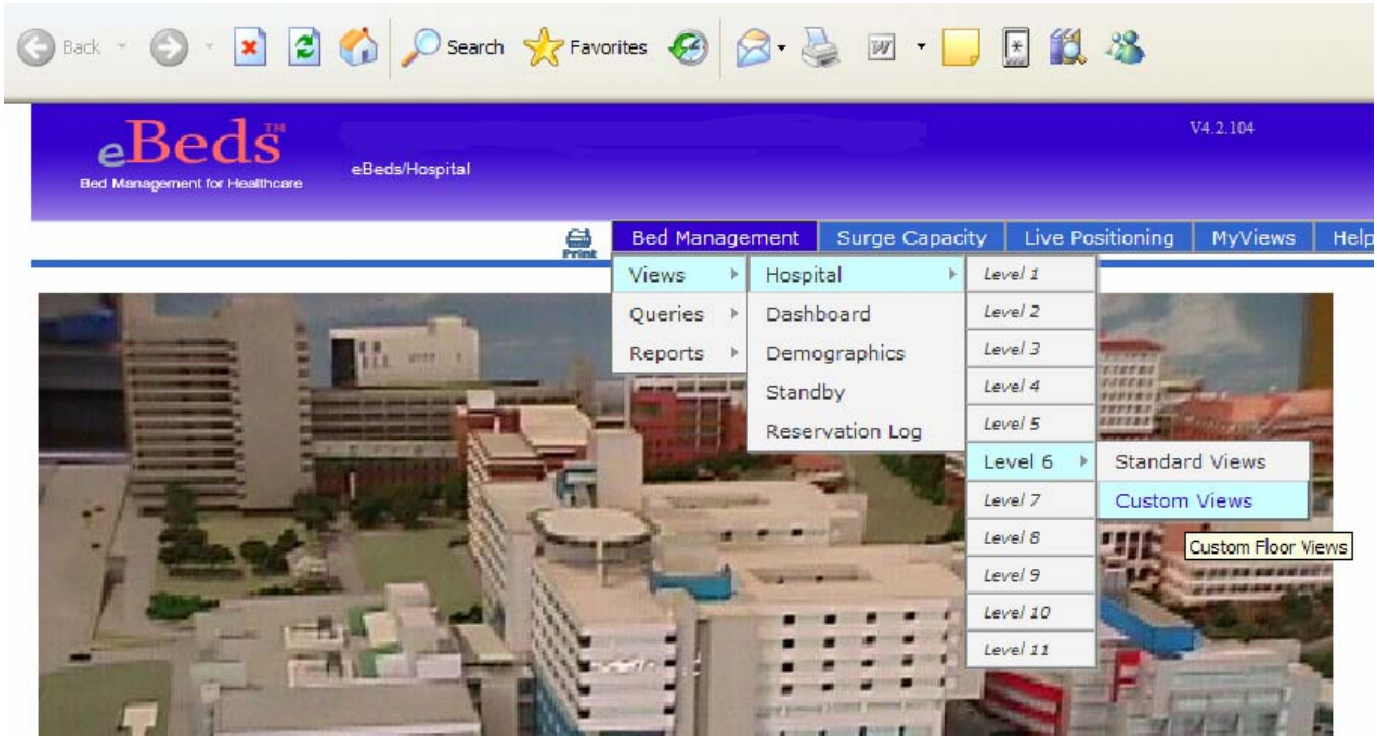
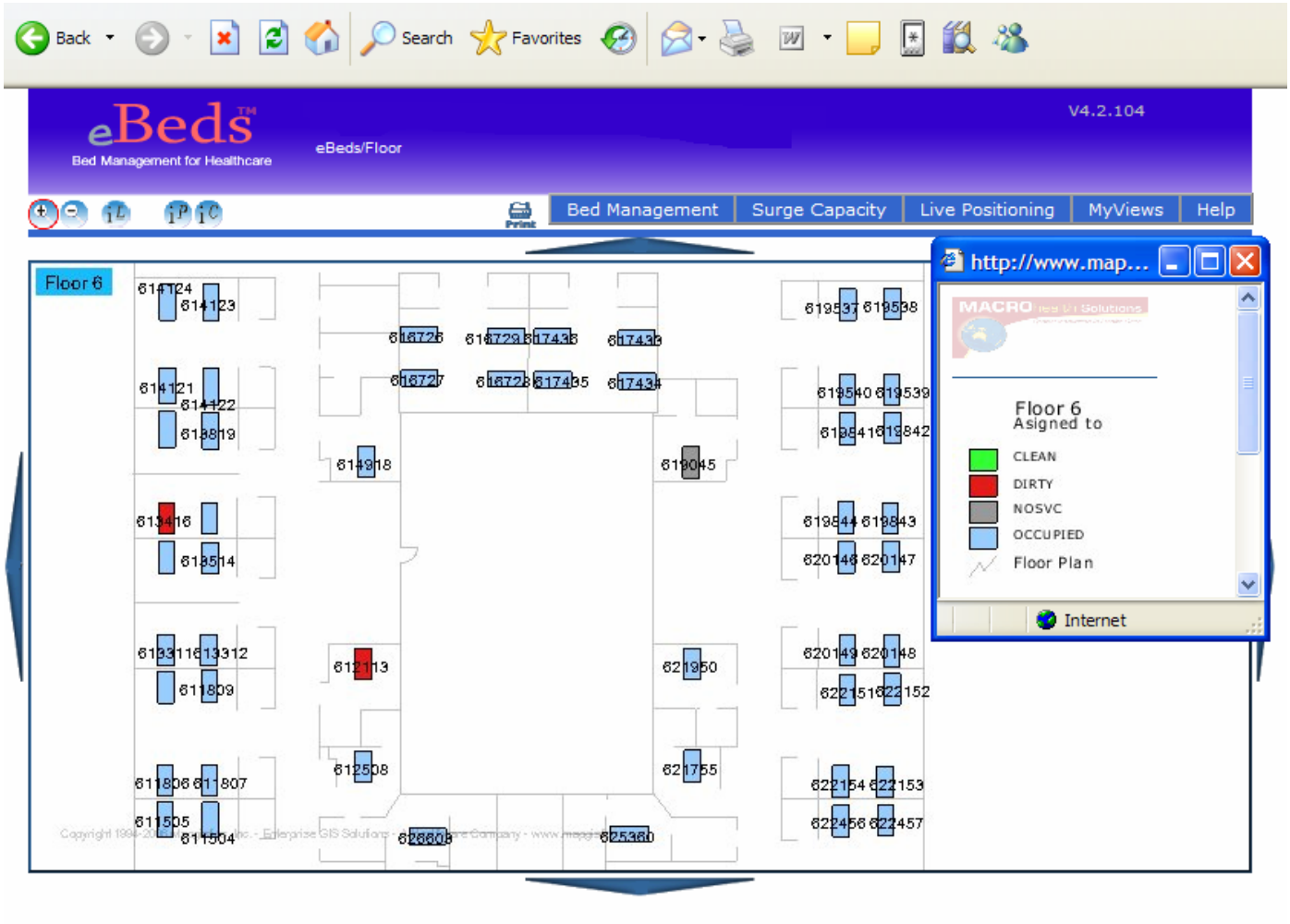


Figure 3 displays the occupied beds and those closed for house keeping. Bed condition and patient information can be maintained by staff within each ward or floor to facilitate real time data availability for the entire hospital management team. A graphical display is found to be easier to interpret and update than descriptive records.

Figure 3. Visual display of occupied and closed for house keeping beds information.



Further windows provide specific ubiquitous details or hidden information only available to specific authorized persons. Examples of general management information that is automatically updated easily and rapidly interpreted, ideal for informed and rapid decision making, are depicted in Figures 4, 5 and 6, viz.

- Real-time bed occupancy of any ward throughout the hospital (Figure 4).
- Bed standby and reservation display (Figure 5).
- Discharge details and a summary of expected discharge time (impending bed availability).
- Surge capacity overlaid on a map for emergency services patient distribution and routing management (Figure 6).

Figure 4. Real-time bed occupancy of any ward throughout the hospital.

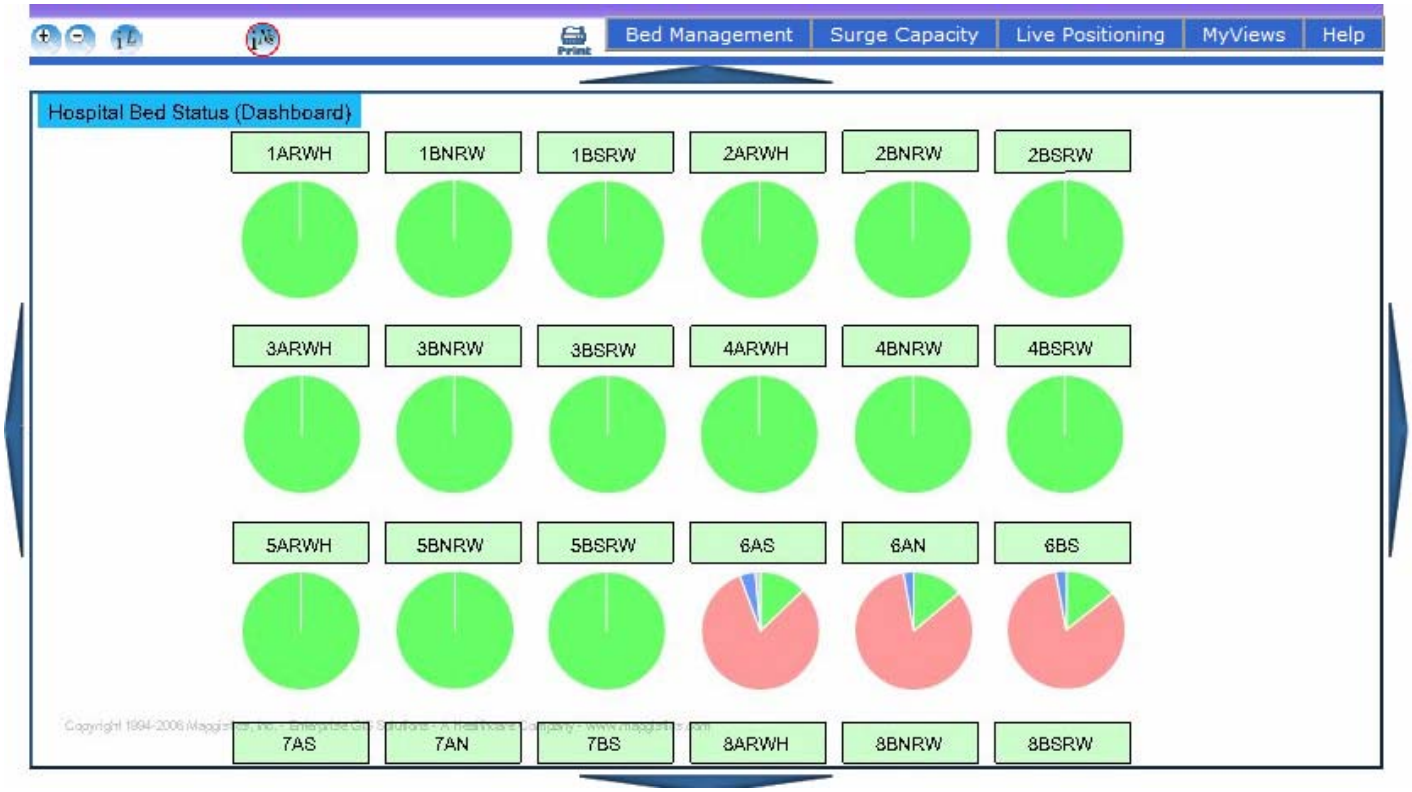


Figure 5. Bed Standby and reservations display.

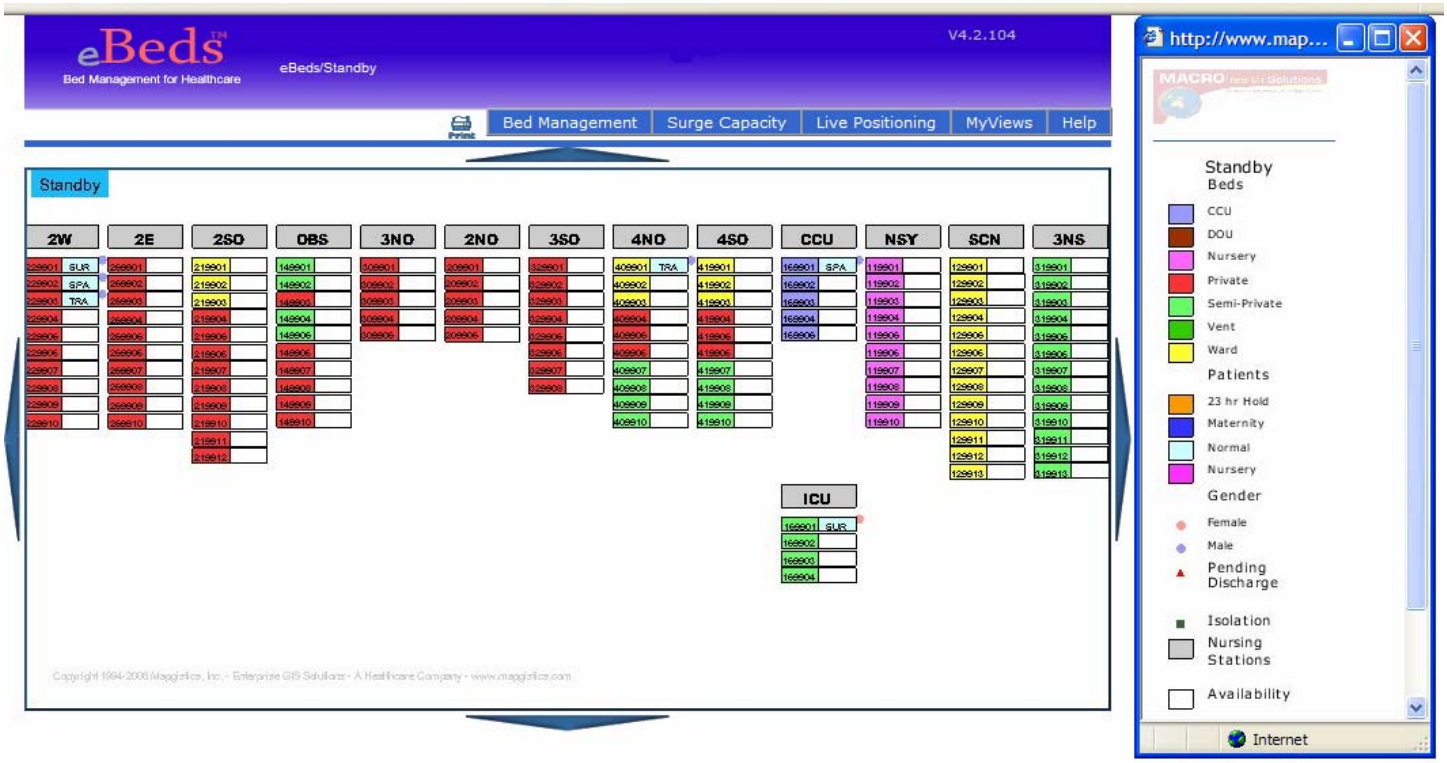
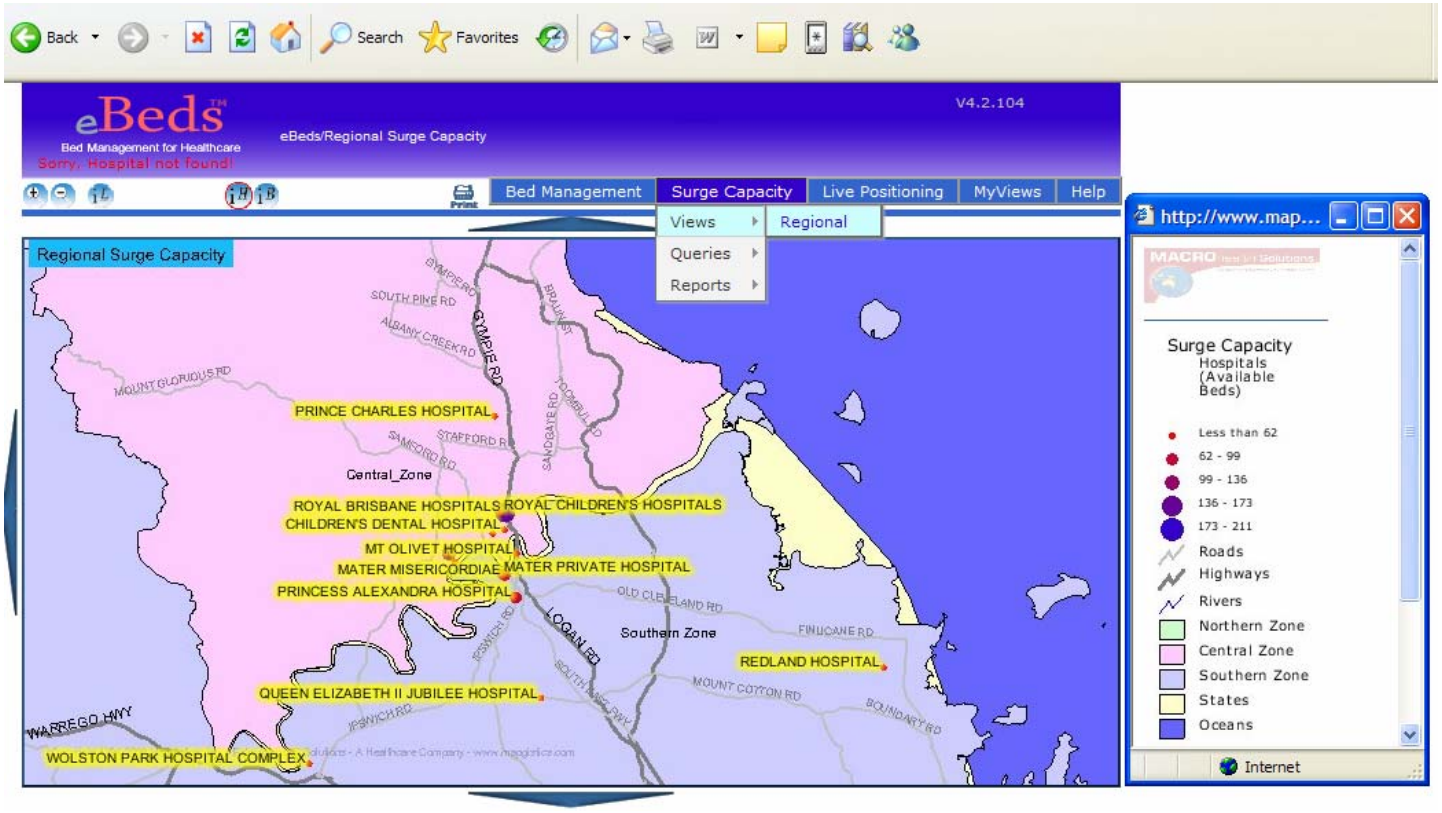


Figure 6. Bed availability for emergency services patient distribution.



Outcomes

The *eBeds* system is addressing the critical challenges for today's health care providers in the management of the patient discharge process. Through the application of *eBeds* the benefits so far demonstrated include:

- Assistance to solve one of the biggest problems in most hospitals: knowing when a bed is vacant, being remade, or remade/ready for the next patient.
- A reduced need for alternative patient placement for apparent overflow bed conditions caused by incomplete information.
- A reduced wait time for admitting surgery patients.
- A reduced wait time for entering the system through the Emergency Department.
- An increased effectiveness in providing patient discharge services, such as home care transition and follow-up; physical therapy and social services (arranging for equipment; wheel chairs and other patient required services).
- Providing a tool for Admissions to use in scheduling and assigning beds.
- Providing Nursing Administration with a tool for managing beds across the enterprise.
- Shows a regional view of available beds to emergency dispatching units.
- Providing a foundation for more sophisticated patient, staff, and asset tracking tools.

Hospital administrative and nursing staff has found the system easy to understand and use. The more comprehensive single information access and the visualization aspects were the major benefits and they felt more inclusive in the bed management system and confident in assessing the bed status of a ward. Medical practitioners are enthusiastic and delighted to support any bed management improvements, but need to see more development in patient information assigned to beds to address their concerns and evaluate that part of the concept.

Part of the outcome of the development built into *eBeds* has been an application for RFID (Radio Frequency Identification). The RFID component allows beds (the physical bed regardless of whether it has a patient in it or not) to be tracked throughout the hospital by sensors located in corridors. An active tag attached to the bed causes the sensor to pass a signal to *eBeds* which graphically displays the exact location of that bed. Hence, when the bed is moved from a room, ward or floor the staff can locate the bed's position in real-time. An active tag can cost from $10 to $30 and the sensors approximately $250 each and provide an affordable monitoring system when compared to the costs associated with loosing or mislaying beds. The active tags can also hold data such as warranty information, age of bed, phone numbers, or any other type of information that the hospital would like to include. The data can be deleted and the tags reused.

Conclusions

The research highlighted a very complex and difficult issue of hospital bed allocation experienced by most major hospitals. The current systems have vast amount of written information located in a variety of computer and hardcopy file areas which require specific targeted searching. *eBeds* has integrated these existing information systems and formats and provides a level of visualization which allows health care professionals to make informed and more accurate decisions for patient administration. Efficiencies in bed allocation provide increased economical, appropriate and beneficial patient care and a vital service to the emergency services.

Hospitals without effective bed management practices face increased staff time in planning and assigning patients to beds in addition to increased costs through alternative placement of patients when beds are not ready or available when needed. Accuracy and efficient use of information is highly dependent on the established patient discharge process and related bed management function. Applying *eBeds* spatial technology is addressing these information needs. Hence, the *eBeds* system is a practical, flexible and dynamic tool and has also demonstrated that spatial technology has a beneficial role within the hospital environment.

REFERENCES

Australian Institute of Health and Welfare (2003). *Australian Hospital Statistics 2003-04*. Australian Institute of Health and Welfare (2003), Health Services Series No. 23.

Commonwealth Department of Health and Aged Care (1999), *Managing Beds Better: Balancing Supply and Demand. The NDHP 2 Experience July 1997 to June 1998.* Commonwealth Department of Health and Aged Care, Canberra.

Kirby, A., and Kiesbo, A. (2003) *Tapping into hidden hospital bed capacity – Business.* Healthcare Financial Management, **11**, p38-41.

Nairn, G. (2006). Quote from the Government's e-government strategy, *Spatial Science*, **2**, p.9.

Richardson, Drew B. (2003) *Reducing patient in the emergency department*. The Medical Journal of Australia, **170** (10), p.516-517

Shaw, P.K. (1998) from *What is a Bed? – Beds as a Measure of Resource Usage and Demand,* Walsh, M, Better Outcomes Health Newsletter, V4 N3.

Walsh, M. (1998) *What is a Bed? – Beds as a Measure of Resource Usage and Demand.* Better Outcomes Health Newsletter, V4 N3.

Ward, Dr Michael (2004). *Bed Management Collaborative*. Queensland Health Quality and Safety Improvement Program, Queensland.

Wikipedia 2006. *The Free Dictionary*. www.wikipedia.org.