

## Case Study on GIS for Use in Hospital Infection Prevention and Control

Sault Ste. Marie Innovation Centre

### The Challenges of Hospital-Acquired Infections

Super-bugs such as Methicillin-resistant *S. aureus* and spore forming *C. difficile* are becoming an increasingly common trend in Canadian hospitals. During an infection outbreak, additional management of staff, patients and medical equipment/assets are required to control an outbreak. Antibiotic-resistant strains of disease are challenging to eradicate, and the cost to prevent them from spreading increases astronomically when staff are faced with the added task of continually disinfecting entire areas not knowing where the targeted pathogen is actually located. One example that highlights the cost associated with control of outbreaks is from a recent *Globe and Mail* article:

*Andrew Simor, head of microbiology and infectious diseases at Sunnybrook Health Sciences Centre, estimated the treatment, screening and infection control of MRSA to run \$250-million annually...Hospital-acquired infections kill more than 8000 Canadians a year - roughly the same number who die from breast cancer and road traffic accidents. (Priest, Globe and Mail, September 10, 2007)*

These startling statistics cannot be ignored. Without solutions that seek to address the prevention and control of disease outbreaks in hospitals, costs will continue to spiral upward, and more seriously, patients will die from potentially preventable infections.

### The Solution Generated for Sault Area Hospital (SAH)

In October 2006, an investigation was initiated by the Sault Area Hospital (SAH) that identified a *C. difficile* outbreak at SAH, an outbreak that has been estimated to cost the hospital between \$4 to \$5 million dollars. The objective of the SAH investigation was to analyze the spread of *C. difficile* with the intention of using the findings to prevent and improve the management of future possible outbreaks.

The local public health unit; Algoma Public Health (APH), in cooperation with SAH worked on the investigation. APH, having previously worked on projects with the Sault Ste. Marie Innovation Centre (SSMIC), decided to take a novel approach to the method of investigation by requesting that SSMIC provide its Geographic Information System (GIS) mapping tech-

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nology, including its spatial analysis (study of the location of, proximity to, or orientation of objects with respect to one another) capabilities and change management planning services.

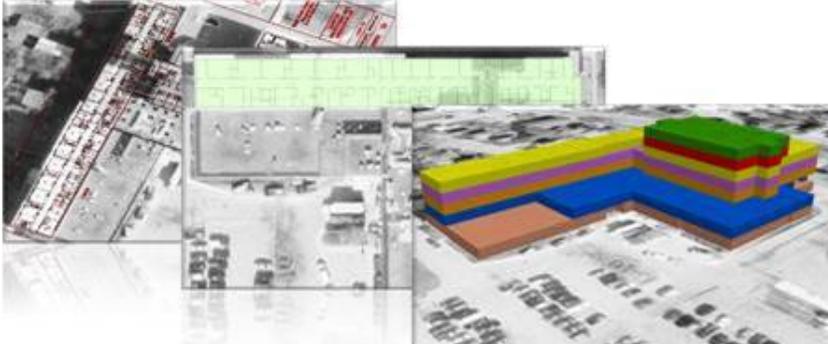


Diagram 1: Depiction of 3D digital mapping of SAH

At the onset of the investigation, SAH Infection Control Practitioners collected relevant data related to the *C. difficile* outbreak. One part of the collection focused on the data related to patient movement. APH inspectors then proceeded to collect the data from the SAH Infection Control Practitioners and medical records department. SSMIC initially created an electronic form to capture the APH collected data, such as date of (infection) onset, hospital assets, and room and bed numbers. Before the data was inputted, to ensure patient privacy, APH formed unique codes for individual patients so that each patient could be uniquely identified but no personally identifiable data would be entered into the database. Upon completion of data entry, SSMIC imported the data and structure of relationships between the data into ESRI ArcGIS 9.0 software for the purpose of conducting spatial analysis.

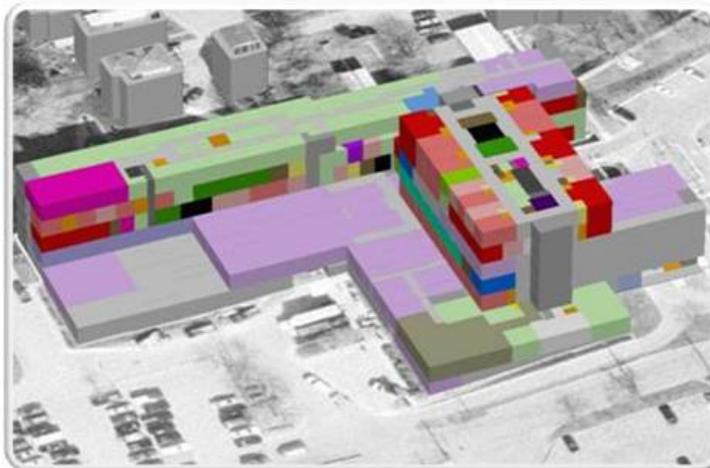


Diagram 2: Process of depicting SAH real world coordinates in 3D: use of orthophotography and blueprints

Orthophotography (digital aerial photography in which the distortions due to camera tilt and topography have been removed thus equalizing distances represented on the image) and blueprints of both SAH's General and Plummer hospital sites were used

to map the real world coordinates of all rooms with ESRI's software. Work was also completed to graphically depict the SAH's General site and a portion of the Plummer site, digitally in 3D. The spatially captured data was queried and analyzed to provide additional information to further examine factors contributing to the spread of the disease. As part of the data analysis, SSMIC took further steps to graphically depict patient flow over space and time to ensure historical patient movement throughout the hospital was captured.

## Results

The information generated from the analysis provided decision makers with a graphical representation of the data and allowed them to promote change within the hospital setting and improve on current procedures to further ensure patient safety. The results provided insight to questions such as: Where was Patient A when diagnosed with *C. difficile* and where was Patient A prior to being diagnosed with *C. difficile*? Where was Patient A transferred to after being diagnosed with *C. difficile*? How many diagnosed patients were in each room over a period of time?

## Overall Benefits

A geospatial tracking solution provides health providers in decision-making roles the intelligence that is critical for managing disease outbreaks and preventing future outbreaks from occurring. When decision-makers are provided with a tool that has the ability to quickly analyze the actual flow of objects, patients and staff, and examine their interaction, they are better able to investigate possible causes related to the spread of infection. They can also work to promote the efficient flow of hospital assets, patients and staff to improve the safety of patients and prevent future outbreaks.

## Further Development

Building on the work done, SSMIC is currently expanding on the solution by incorporating RFID technology to provide live data and reduce the effort required to capture information. Analysis will provide accurate, relevant information that can be used to ensure that assets are managed efficiently, infection outbreaks prevented and patient safety is ensured. In addition, it is planned that the solution will be expanded to support disease and syndromic surveillance, asset management and tracking, patient tracking, staff workflow, bed management, emergency planning and infrastructure mapping.

## Results

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## Benefits of the Innovation Centre Geospatial Solution

Currently, there are several systems on the market with the ability to track hospital assets and patients, but none of these solutions incorporate the advanced GIS technology that is required for a truly robust solution to track, analyze and manage an infection outbreak. A true GIS system, with a spatial database driven representation of the hospital, provides end users with an image that has true space and dimensions that can be queried and updated quickly and easily. In other words, the space has *intelligence*. Some of the distinct characteristics between the current systems on the market and a solution that incorporates GIS are as follows:

Graphics Based System	SSMIC GIS System
Static image that must be rescanned every time the hospital layout changes	The layout can easily be edited on the fly
Layout has no database information associated with it	Hospital layout is database driven; each room, piece of equipment or feature of the hospital has database information associated with it that can be queried
No dimensional space or distance	Layout has true distance and space
No 3D capacity	Has the potential to display hospital in true 3D
No analysis capability, only graphical representations of a performed analysis	Ability to utilize specialized 2D and 3D spatial and statistical analysis tools that are inherent in the GIS to analyze hospital situations that involve space and time such as patient movement and proximity to other patients
Limitations to link with other IT systems	System is built on standards and can communicate and link with other IT standard database or programming environments. It is expandable and scalable

Table 1: Current Market Systems

By incorporating GIS technology, spatial analysis of the data can be carried out to provide decision-makers with the graphical information required for managing staff, patients and medical equipment/assets. It is this information that is critical for managing an infection outbreak.

## Description of our Services

The Sault Ste. Marie Innovation Centre uses Geographic Information System mapping technology to provide health indicators mapping, public health disease mapping, managed and strategic planning services related to target marketing, demographic/analysis projections, change management, and municipal and utilities infrastructure. SSMIC's staff use a 'spatial thinking' approach for systems analysis, system requirements planning, data scrubbing and capture, project management, systems reengineering, process mapping, application and database design and creation, system integration and implementation, system hosting and maintenance.

## Sault Ste. Marie Innovation Centre - Community Geomatics Centre

The Sault Ste. Marie Innovation Centre is a not-for-profit organization founded in 1999, that operates as a catalyst for growth in the information technology (IT) and knowledge based sectors fostering economic development in the City of Sault Ste. Marie and Algoma District. In the area of market development SSMIC offers Geographic Information Systems consulting services based on the impressive expertise of its GIS team. In 2000, the SSMIC formed the Community Geomatics Centre (CGC) to assist the City of Sault Ste. Marie and PUC Inc. (the local public utilities commission) in the efficient retrieval, reproduction and analysis of spatially related municipal and utilities infrastructure.

The CGC developed an award-winning Integrated Geomatics Model, touted the most comprehensive in Canada, to support multiple applications. At the core of the CGC solution is a dynamic team of highly skilled IT professionals, cutting edge municipal, utilities and health data models, tools and a highly secure data warehouse.

It currently delivers a community-based GIS solution to more than thirty organizations at affordable costs. Enormous amounts of data are being shared by all organizations to solve enterprise and inter-enterprise issues allowing the entire community to



## Facts

The Sault Ste. Marie Innovation Centre was founded in 1999 to serve as a catalyst for growth in the IT and knowledge-based sectors. It operates the Community Geomatics Centre (CGC). The CGC is unique in Canada, in that it functions as a not-for-profit organization to promote and establish partnership and technological means to efficiently share geospatial data, tools and knowledge amongst community organizations to create a safer, healthier and more prosperous community. The CGC provides award-winning Geographic Information System services for most of the municipal, utility, health and social service organizations in Sault Ste. Marie, Ontario and the Algoma District.

Diagram 3: Community Geomatics Centre, 65 Willow Avenue, Sault Ste. Marie, ON

benefit from the enhancement of the IT expertise.

In recent years, the CGC has expanded the municipal and utilities GIS in innovative ways in order to address health and social issues in the community. Using the already established CGC GIS solution and the municipal dataset as background layers, social and health agencies were approached to join the CGC partnership to improve the community's overall operation and health. This approach brought about significant improvements in services from all sides thus allowing services to be optimally delivered to areas where they are needed most. Early results have indicated improvements in public safety and health delivery, reductions in municipal liabilities and more effective use of budgetary resources.

## Awards and Achievements

The Sault Ste. Marie Innovation Centre has won numerous awards for its work in the GIS field, including:

- ESRI User Conference - International Special Achievement in GIS (2007)
- URISA Leadership in the Field of GIS (2006)
- URISA Best Municipal GIS Award (2006)
- ESRI Canada Award of Excellence (2006)
- URISA – Silver Award – GIS Leadership in Ontario (2005)
- URISA Best Municipal GIS Award (2003)
- Designated Most Comprehensive Municipal GIS Dataset in Canada by ESRI Canada (2003)
- ESRI Canada Business Partner Award (2002)



ESRI User Conference—  
International Special  
Achievement in GIS; past  
winners include the United  
Nations, New Zealand  
Ministry of Health and the  
Geneva International Cen-  
tre for Humanitarian  
Demining (GICHD)

*For a complete list of publications featuring the Sault Ste. Marie Innovation Centre, visit [www.ssmic.com](http://www.ssmic.com) and look under 'Community Geomatics Centre'.*

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