The Value of Partnership in Technology-Enabled Facility Optimization

How the Medical University of South Carolina (MUSC) and Siemens Healthineers use digital innovations to improve clinical layouts and workflows

SIEMENS Healthineers

Executive Summary

Healthcare is in a constant state of change, often leaving administrators scrambling to keep up with new conditions. Construction of new facilities and renovation of existing ones to meet new demands is expensive and time-consuming; failure in this realm comes with an extraordinarily high cost. Additionally, healthcare organizations are under pressure to optimize use of current facilities and resources in cases where construction is not an option.

MUSC and Siemens Healthineers are co-creating digital twins—high-fidelity models of MUSC facilities—to identify and validate optimized facility layouts and processes. These models require an extraordinary volume of meaningful data, massive computational power and deep expertise in healthcare facility design and process optimization. Many healthcare organizations lack the in-house capabilities to create these sophisticated models and seek partners that can help them develop digital twins.

The digital twin projects at MUSC are expected to yield optimized solutions that deliver the efficiency and flexibility needed to provide high-quality care at scale and to respond effectively to changes in healthcare technology, policy and demand.

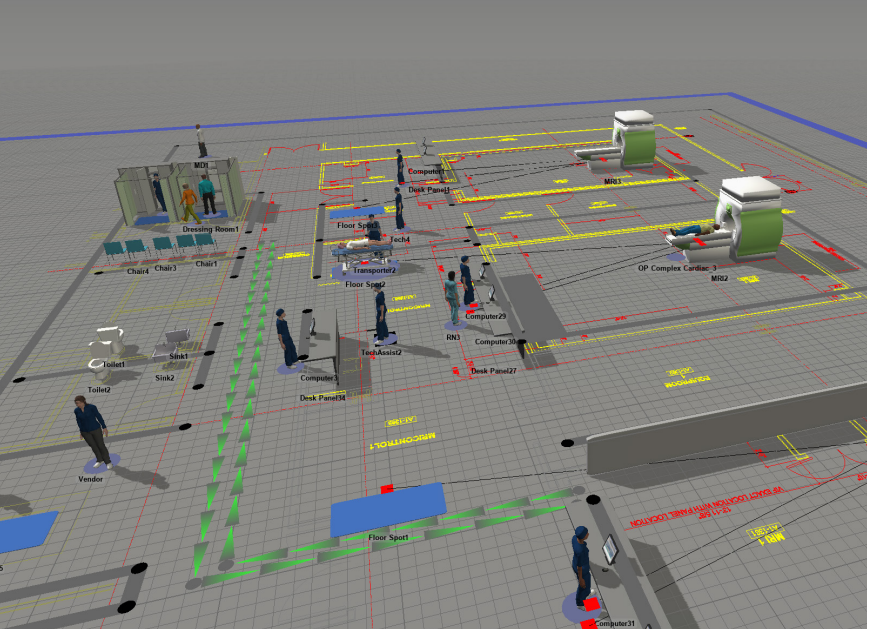
MUSC Shawn Jenkins Children's Hospital and Pearl Tourville Women's Pavilion

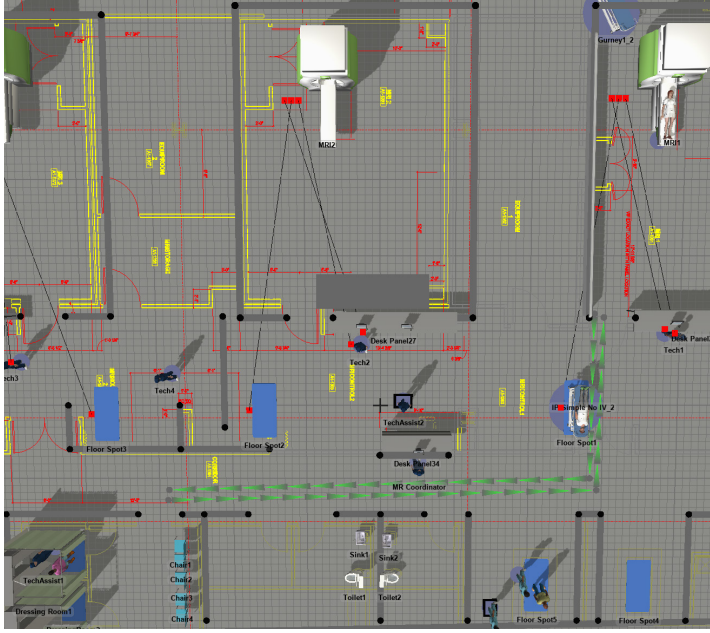
Transforming Healthcare Facilities Through Simulation

Hospitals and other healthcare facilities are complex spaces that must accommodate a vast array of technology and the needs of patients and staff. The emergency department, for example, is home to a range of equipment like EKGs, defibrillators, portable imaging systems, point of care testing analyzers and more, all of which must be maintained and sanitized. The ED is also a hub from which patients are sent to various units within the hospital; staff at these destinations must be aware that patients are incoming and be ready to receive them.

Continual advances in medical technology, changing patient demographics and other factors mean that hospital administrators face a constant challenge to match their facilities to the needs of their staff and the patients they serve.

Reconfiguring complex areas, like procedural, imaging and pre-op spaces, is an expensive and time-consuming undertaking, so hospital leadership teams are under pressure to get it right the first time to avoid excess cost and care interruptions.





Digital twin simulations

Simulation of healthcare facility layouts and processes is a relatively new approach that has gained in acceptance as artificial intelligence (AI) technologies have matured. Simulation enables low-cost, low-stakes testing of strategic and operational decisions in a virtual environment.[1]

Useful simulations require high-fidelity models of the systems in question. These models—called digital twins—can be used to pressure test a variety of typical and extraordinary situations, so that facility design professionals can create layouts and spaces that will suit the complex, interrelated demands of a modern hospital. Alternate layouts and models can be studied in virtual space to see how they affect performance and safety before costly construction begins in the physical world. These iterative simulations enable designers to create optimized layouts that are matched to the mundane demands of the hospital and will respond predictably to extraordinary situations. Digital twins can be useful in both new construction and to improve workflows and performance in existing facilities.

MUSC: New Facilities and Expanded Services Require Optimized Layouts

MUSC has completed construction of a new children's hospital (MUSC Shawn Jenkins Children's Hospital) and women's pavilion (Pearl Tourville Women's Pavilion) to transform fetal, women's and children's care in South Carolina and the southeast region. Hospital leadership wanted a clean slate with this new facility—old, siloed departmental models, they recognized, would compromise the quality of care and the patient experience. Instead, they sought maximum flexibility in procedure and perioperative facilities.

Elsewhere in the MUSC system, demand for ambulatory cardiac care was surging. The time between referral and first appointments for most patients was unacceptably long in the eyes of MUSC leadership. They looked for ways to decrease the time to first visit without adding new staff or more exam rooms.

MUSC had also upgraded technology in its NeuroEndovascular Surgery (NES) program, which triggered construction of new procedure labs. With the new labs, NES care is now delivered on two separate floors, whereas prior to construction, this care was provided on a single floor. MUSC leadership needed to understand and mitigate potential bottlenecks related to the new arrangement to ensure that patients received the highest possible quality of care.

Procedure room in use

MUSC Leverages Value Partnership with Siemens Healthineers to Optimize Facility Design

As part of an extensive, 10-year Value Partnership, Siemens Healthineers is supplying the expertise and technology needed to help MUSC optimize the layouts of clinical spaces for improved performance, safety and patient experience.

The Siemens Healthineers team is working together with MUSC clinical and operations teams to first understand the current situation in each of the areas. The next step is creation of a digital twin of each of these spaces for use in iterative simulations to determine the optimal layouts; the Siemens Healthineers team was creating these models at publication. Candidate designs will be stress tested to ensure that they are up to the task, even when unexpected or unpredictable conditions (e.g., infectious disease outbreaks) occur.

Robust data inputs ensure valid simulation outputs

The value of digital twins in simulating outcomes is directly tied to the quality and relevance of the data used to construct them. To make the simulations as true to life as possible, Siemens Healthineers is using a variety of datasets to create a detailed model. The sophisticated digital twins will then be used to conduct iterative, multivariable simulations, the results of which enable informed decisions by MUSC leadership.

Key data sources for MUSC digital twins

- Direct observation and process mapping (by the Siemens Healthineers team)
- Electronic medical record data
- Facility floorplans
- RealTime Location Solutions (RTLS) data

RTLS is a group of technologies that keep track of the physical location of personnel and equipment. Since RTLS relies on passive, automated collection of data, it can shed light on real-world processes without the need for tedious manual data entry. RTLS technology has a number of safety, efficiency, inventory control and workflow optimization use cases in healthcare.

Learn more about RTLS in healthcare

Key goals of the digital twins

Children's Hospital digital twin

The digital twin project at Shawn Jenkins Children's Hospital is active as of August 2022. MUSC expects this deployment to assess patient volume growth and measure its impact on care, inform staffing decisions and encourage adoption of data-driven process and culture changes.

Ambulatory Cardiac Care digital twin

MUSC leadership looks to this project to deliver results in clinical and non-clinical operations in ambulatory cardiac care:

- Inform optimized appointment templates
- Develop data-driven staff and provider scheduling systems
- Increase efficiency of workflows

These improvements will be important steps to help MUSC achieve its key care goals of increasing total appointment volume, while decreasing time from referral to first visit.

NeuroEndovascular Surgery digital twin

MUSC expects the NES digital twin project to deliver similar process improvements as those described for ambulatory cardiac care. In addition, the digital twin will enable MUSC to deliver high-quality care, particularly with respect to emergent stroke cases. Minimizing door-to-thrombectomy cycle time in acute ischemic stroke patients can lead to better clinical outcomes, so it is vital to preserve or even improve the cycle time during any transition in department layout. Lessons learned from this project will also inform operations going forward, enabling MUSC to increase procedure volume and deliver improved outcomes and patient experience.

What the future holds

The digital twin projects at MUSC will continue for the foreseeable future. As real-world performance data accumulates, it will enable MUSC and Siemens Healthineers to further refine the models and increase their predictive power. These powerful models will also help MUSC manage changes in patient demographics, assess the feasibility of incorporating new technology and techniques and further refine staffing strategies. This continuous performance innovation is one of the keystones of the Value Partnership between MUSC and Siemens Healthineers.

Favorable outcomes from these initial projects may lead to more widespread adoption of digital-twin–based simulation modeling across the organization.

"We feel confident that digital twin technology will be instrumental in maximizing efficiency and optimizing the patient and family experience. It will ultimately enable better outcomes at a lower cost, by helping forecast how well possible workflow solutions or health innovations may essentially work in our new facility."

-Mark Scheurer, MD, MSc. Chief of Children's & Women's Services, MUSC

Conclusion

Changes to the physical layout and processes of healthcare facilities are expensive, time-consuming—and necessary—as optimal care delivery is very much a moving target. Inefficient use of existing spaces can also compromise clinical and financial outcomes. Digital twin technology enables provider organizations to assess a variety of potential solutions before committing to any path of action, in both new construction and optimization of existing facilities. MUSC is using these complex simulations to optimize real-world performance, while maintaining the flexibility needed to respond to unusual or "outlier" events that put the healthcare system under great stress.

Useful digital twins require robust data sources, including physical layout, observed processes and electronic medical record (EMR) data. RTLS data can be collected automatically to give deeper transparency into hospital operations, vastly improving the fidelity and predictive ability of digital twins.

MUSC and other health systems are using digital twins to not only increase efficiency, but also to increase flexibility and resilience to unforeseen stressors, like infectious disease outbreaks and natural disasters.

Adoption of digital twins to optimize the physical layout of care facilities is part of a larger movement to create data-driven healthcare systems and processes. The continuing maturation of the technologies that power digital twins means that this approach to facility design will only grow more popular—and more powerful—in the coming years.

Reference

1. "Accelerating digital transformation in healthcare through simulation." Google Cloud Blog. Accessed 8/23/2022 at https://cloud.google.com/blog/topics/transformation/improving-healthcare-outcomes-with-simulation-tech.

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