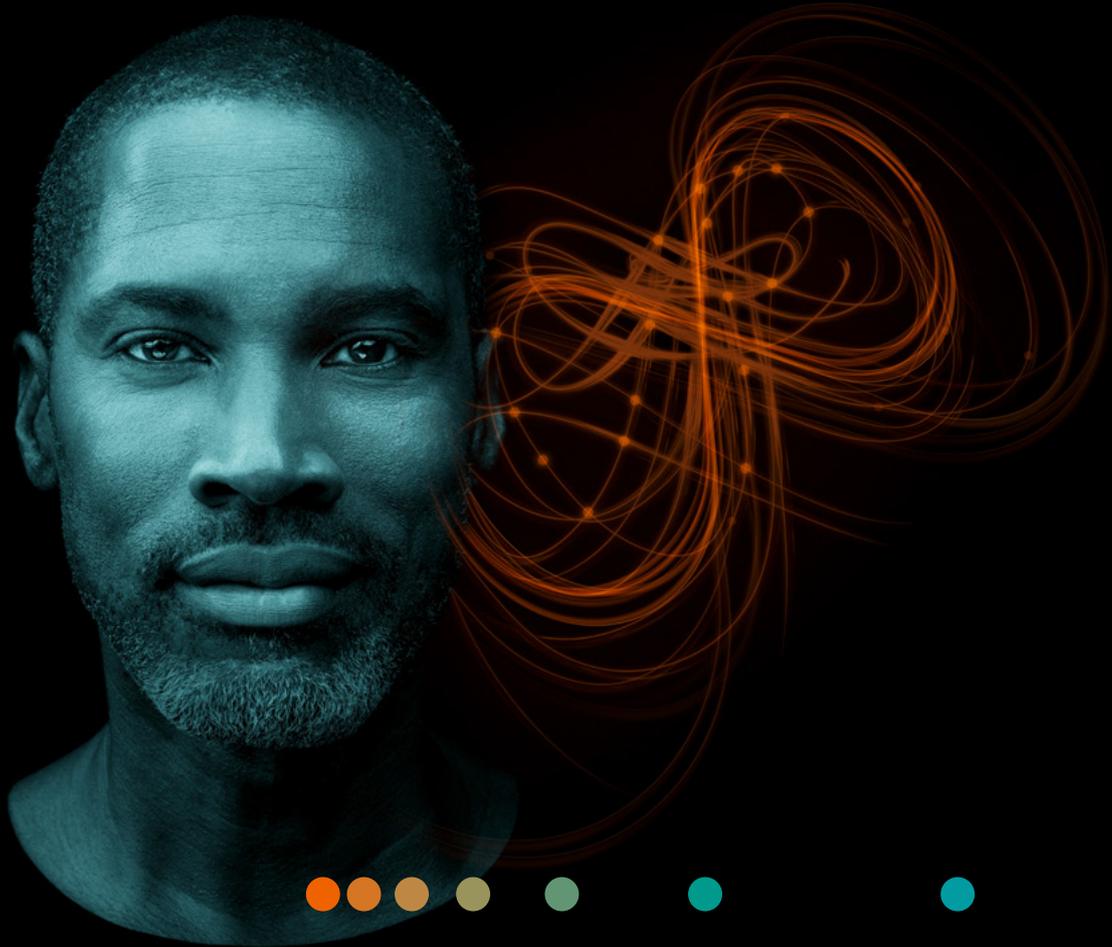**White Paper**

The value of digital twin technology

Transforming care delivery in a single department or an entire healthcare enterprise

siemens-healthineers.com/value-partnerships

Executive Summary

Digital twin technology has proven its value in manufacturing, where use of connected technology to monitor performance, model processes, and optimize efficiency is already a mainstay of "Industry 4.0". The link between the physical and virtual worlds is a key facet of this emerging manufacturing paradigm. Now, through the efforts of multi-disciplinary teams, hospitals are creating four-dimensional digital twins of patient care units. They've realized the value of running "what-if" scenarios for optimizing departmental operations.

A digital twin can help healthcare enterprises identify ways to enhance and streamline processes, improve patient experience, lower operating costs, and increase higher value of care. The digital twin creates models of physical spaces and processes. Then, cost and quality optimization parameters are examined and ultimately selected based on the insights gained from simulations leveraging the digital twin. Digital twins insights can be further enhanced with complimentary technologies like Real-Time Locating Systems (RTLS), which provides a robust data source and a means to test changes in layout, process, etc.

A digital twin can have tremendous real-world impact. Mater Private Hospital in Dublin, Ireland partnered with Siemens Healthineers to create a digital twin of its radiology operations. The identified improvement potential was a nearly half-hour reduction in patient waiting time, and significantly reduced staff overtime costs.

The key to success of a digital twin is a strong partnership between the hospital and a technology provider who understands the clinical, workflow, and financial imperatives of healthcare providers. Siemens Healthineers creates Value Partnerships with provider organizations in order to help them create value and optimize care delivery.

This white paper will discuss the successful implementation of a digital twin, and the vital role Value Partnerships play in building a digital twin.

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Introduction

Simulations are commonplace in many work environments. They help to identify strategies that work, and possible avenues for improvement, without the time and expense of rearranging real-world enterprises.

Simulations are especially important for complex, high-risk and/or technical tasks. Aircraft pilots train on simulators all the time. Medical students perform tasks on simulation mannequins so that they can identify issues with a technique in a safe, controlled environment.

A digital twin is a four-dimensional model (here, time constitutes the 4th dimension) of a care unit, multiple departments or even an entire hospital. A digital twin links the physical and virtual worlds, turning data into actionable insights. This is a key facet of the emerging manufacturing paradigm known as Industry 4.0.

Digital twins model key aspects of a healthcare enterprise:

Physical layout – the spatial dimensions for a specific department or function. This includes reception, registration, waiting areas, doctor's offices, exam rooms, equipment and furniture placements, and more.

Flow and Resources – robust data captured on doctor, patient and equipment movement is incorporated into a digital twin, adding an invaluable layer of process-related insight to the model.

A digital twin enables healthcare providers to move assets around, reconfigure departments, and see the effects of changes to the simulated environment. Because it models so many dimensions, the twin produces a detailed look into how the hospital is working. The effectiveness of a healthcare facility digital twin can be enhanced by leveraging powerful data sources like Real-Time Locating

Systems. RTLS tracks the movement of equipment, files, even individuals, and can refine the twin's accuracy in simulating processes. RTLS data can also enable use of the digital twin to predict the availability of equipment and resources, and can rapidly assess the real-world effect of changes suggested by simulations.

Key uses for digital twins in healthcare institutions

There are three primary domains where digital twins can be effective in healthcare:

- Predicting the outcome of a specific scenario; perhaps a reorganization of the patient flow and clinical workflow in a specific department.

- Evaluating, on a quantitative basis, the impact of different layout scenarios, such as re-arranging waiting areas or distributing and splitting waiting areas for specific modalities.

- Performing operational stress testing on a department or an entire hospital.

"Simulation modeling is common when designing robust production lines in various industries" notes Nicolai Gossmann, Senior Management Consultant at Siemens Healthineers. "The same idea can be applied to designing efficient and patient-centric hospital operations. So, for example, what happens if we have a very high incoming flow of patients in the emergency department? That's a very specific scenario, but you can also evaluate the operational impact of increasing patient demand in certain services and its additional effects on assets, utilization, staff, and more. The more handovers there are in [a patient's] journey, the more opportunities there are to improve," according to Gossmann.
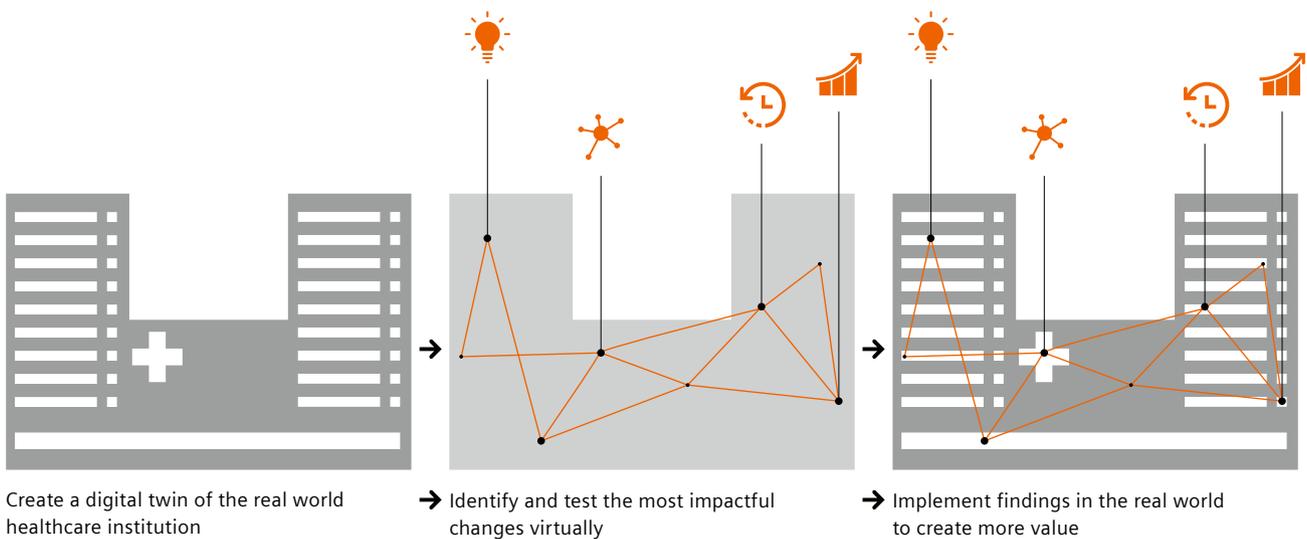
Digital twins in medical imaging

Medical imaging facilities are in high demand. In the US, for example, there are more than 80 million CT scans performed annually[1], and that number is continually increasing. This huge demand for diagnostic medical imaging is a logistical challenge for providers around the world. How can they make the best use of space, equipment, and staff to provide the best possible care for patients? The value of a robust, high-fidelity simulation in this situation is clear.

"We're tracking the patient from check-in to reports being furnished to the patient," says Helen Calvey, Country Lead Ireland, Enterprise Services for Siemens Healthineers. "All of that information is put into the model. We come up with a very patient-centered workflow." By building a dynamic model of a care facility, a provider organization can identify and spread best practices in order to improve efficiency, patient experience, and quality of care.

Partnership: The key to successful development

A partnership with multiple parties, both internal and external, is necessary to make the digital twin work. Clinical staff, hospital workers, receptionists, appointment schedulers, administrative team members, hospital architects, and a committed, qualified technology partner all play key roles in creating an effective digital twin.

And that technology partner has to be much more than a vendor. Healthcare organizations are looking for guidance on how they can optimize performance, expand capabilities, and advance innovation to deliver higher value of care. Siemens Healthineers has developed Value Partnerships, enduring relationships with healthcare providers that help transform care delivery and create higher value. The Value Partnerships framework enables us to bring complimentary services – like digital twins and RTLS – to bear for our partners.

Create a digital twin of the real world healthcare institution

→ Identify and test the most impactful changes virtually

→ Implement findings in the real world to create more value

[1] *Harvard Business Review: Radiation risk from medical imaging*
 https://www.health.harvard.edu/cancer/radiation-risk-from-medical-imaging

Case Study: Mater Private Hospital

Mater Private Hospital in Dublin is one of Ireland's leading institutions for radiologic imaging and cardiac care. The desire to update the hospital's imaging fleet and to maximize efficiencies in departmental workflows led to conversations about the benefits of digital twin technology between hospital management and long-standing partner Siemens Healthineers. "We were running late on some evenings in order to accommodate the increasing demand for medical scans," said Associate Professor Paddy Gilligan, chief physicist at Mater Private. "That wasn't ideal from a staff or patient point of view."

Gilligan said growing the size of the radiology department in order to meet increasing demand for services was difficult for several reasons, including space in a confined city center location, not to mention the overall cost. Leadership at Mater Private recognized the opportunity to make the right changes by creating a digital twin of the radiology department and partnered with Siemens Healthineers to make it happen.

The combined Mater Private Hospital / Siemens Healthineers Value Partnership team built a representation of current radiology operations while working to review current layouts and identify potential improvements. A one-week on-site assessment was conducted, including workshops, stakeholder interviews, and process observation. In the end a digital twin was created allowing the partners to run different scenarios and identify the best use of equipment, and pressure test a physical layout.

Gilligan said the four-dimensional view of the department unearthed heretofore hidden insights. "We verified data at every step to be sure it was realistic," he explained. "Once the model was available, we could run scenarios and see the value-add to changes we make. We could also see the impact changes to layout and operations have on other parts of the hospital. Improvements that previously took months or years of trial and error can now be achieved in a matter of days or weeks."

Some of the identified improvement potential from Mater Private's digital twin include:

- **Shorter wait times** for patients – a **reduction of 13 minutes** for CT scans **and 25 minutes** for MRIs.

- **Faster patient turnaround** (arrival to departure) which **shrank to 28 minutes** for CT cans **and 34 minutes** for MRI.

- **Increased equipment utilization** – MRI usage went up by **32 percent and** CT usage went up by **26 percent**.

- **Lower staffing costs**, including **50 minutes less MRI overtime** pay per day.

The most important benefit the partnership can bring is to improve patient experience. The Mater Private digital twin shows how long the patient will spend at each stage of their journey through radiology. This allows planning for waiting times in each section maximizing the use of space and optimizing the patient experience.

Future applications

According to Sören Eichhorst, Head of Healthcare Consulting and Transformation for Siemens Healthineers, digital twin applications provide great opportunities in healthcare. "You can apply it everywhere – e.g. in radiology, lab, for interdisciplinary pathways or for non-medical processes."

Indeed, digital twin technology can yield efficiency and patient experience benefits for almost every part of a healthcare enterprise, including:

- Prostate Cancer treatment, where the victim interacts with multiple departments and disciplines.
- Cardiology operations – Mater Private performs more than 6,000 angiograms annually.
- Intensive care units, where a four-dimensional redesign of the overall operation can yield improved quality of care and greater operational efficiency.

Creating a digital twin represents a break with established ways of doing business, yet it pays tremendous dividends. "It takes a lot of dedication and commitment to sign up for a digital twin application," said Calvey. "A healthcare partner can bring the knowledge and commitment where the technology partner can bring the technical expertise; together we can make this successful."

Value Partnerships leverage evidence-based solutions and tailor them to the situation at hand. In this case, using a digital twin helped Mater Private plan the modernization and expansion of their radiology department armed with foresight on how to optimize workflows, capacity, and patient experience. It is a good example of how Value Partnerships create value for all stakeholders.

Conclusions

- Digital twin technology is most effective in the context of a partnership.
- A high-fidelity, effective digital twin requires collaboration among hospital executives, clinicians, administrative staff, the building architect, and the technology partner.
- The multi-disciplinary team should continuously evaluate the digital twin to confirm it is delivering robust insights and enhancing efficiencies in hospital operations.
- Technologies like RTLS can provide a rich data source and significantly enhance the effectiveness of a digital twin model.

- With RTLS, changes made to layout or workflow from the digital twin simulation studies can be quickly measured for impact and success.
- A digital twin can help plan changes or expansion to care units, and minimize the need for costly changes after a department has been reorganized.
- Value Partnerships enable healthcare providers to leverage the clinical and technology know-how of Siemens Healthineers to create value for stakeholders.

To learn more about Value Partnerships go to siemens-healthineers.com/value-partnerships or read the full Mater Private case study at siemens-healthineers.com/mater-private-case-study.

The outcomes achieved by the Siemens Healthineers customer described herein were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, and level of IT adoption), there can be no guarantee that others will achieve the same results.