

# The Architectural Digital Twin

*A lifecycle approach to designing, delivering, and operating healthcare facilities*

*Powered by TRC Building Data Solutions*

## **Executive Summary**

*Healthcare architecture operates at the intersection of design complexity, regulatory intensity, and long asset lifecycles. Hospitals evolve continuously through renovations, expansions, and technology upgrades - often under changing design teams and leadership. Yet most healthcare organizations still rely on fragmented Building Information Model (BIM) 2D CAD files, siloed systems, and static documentation that rapidly lose relevance once facilities enter operation.*

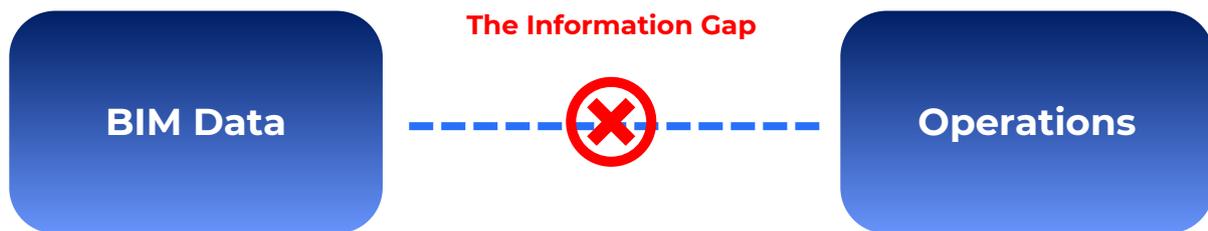
*Architects are increasingly expected to deliver environments that remain adaptable, compliant, and operationally resilient for decades. However, current workflows remain largely project-based, producing deliverables that fail to preserve design intent, standards, and institutional knowledge over time.*

*Lifecycle digital twins address this challenge by creating a continuously evolving, spatially organized, and standards-based digital representation of healthcare facilities. Unlike traditional BIM or document repositories, lifecycle digital twins persist beyond individual projects, integrate multiple data sources, and maintain contextual relationships between spaces, systems, assets, and documentation.*

# The Architectural Reality: Fragmentation & Loss

Healthcare facilities are among the most complex buildings. They operate 24/7, integrate thousands of systems, and must comply with evolving regulatory requirements. Yet most hospitals are not built once; they are built continuously.

Despite advances in BIM, architectural information workflows remain fragmented, project-bound, and fragile over time. The result is a steady erosion of design intent, institutional knowledge, and operational clarity.



## 1.1 Disconnected Teams

Large campuses involve multiple architects/engineers, inconsistent naming conventions, and separate BIM data for structure, MEP, and food service, making a unified understanding impossible.

## 1.2 Systems Without Context

Platforms from vendors like Honeywell and Siemens provide performance data but remain disconnected from architectural layouts. Without a spatial framework, relationships between systems and assets are obscured.

## 1.3 Post-Delivery Decay

BIM files become outdated or locked in legacy software. When facilities directors or project leaders change roles, critical institutional knowledge vanishes.

## 1.4 Reality Capture Silos

Investments in LiDAR, Matterport, Leica, NavVis, or MultiVista often remain isolated archives rather than living building records

## 1.5 Life Safety Complexity

Campuses with connected buildings and varying floor heights create confusion during inspections and emergency response if documentation is disconnected

## 1.6 Loss of Standards & 1.7 Underserved Workflows

Material performance and room templates often reside in static PDFs. Most digital platforms focus on engineering, reducing architecture—finishes, adjacencies, circulation, and patient experience—to static documentation rather than living building intelligence.

## What is a Digital Twin?

A digital twin is a dynamic, virtual replica of a physical building, continuously updated with real-world data. It transcends static documentation, offering a living model that supports both design evolution and operational intelligence.

### 2.1 Digital Twin vs. BIM vs. Document Management

Platforms from vendors like Honeywell and Siemens provide performance data but remain disconnected from architectural layouts. Without a spatial framework, relationships between systems and assets are obscured.

| Capability       | BIM              | Document Management | Digital Twin          |
|------------------|------------------|---------------------|-----------------------|
| Timeframe        | Project-based    | Project-based       | Lifecycle-based       |
| Structure        | Discipline Silos | Folder hierarchies  | Spatially contextual  |
| Persistence      | Archived         | Static              | Continuously evolving |
| Interoperability | Tool-dependent   | Limited             | Standards-based       |
| Operational Use  | Minimal          | Minimal             | Core function         |

BIM remains essential for design and delivery. Digital twins ensure that BIM data remains usable, intelligible, and valuable long after construction ends.

# What is a Lifecycle Digital Twin?

A lifecycle digital twin spans the entire building journey: from design through construction, operations, renovations, and future redevelopment. Instead of transferring disconnected closeout packages, lifecycle digital twins enable continuous information flow across decades and stakeholders.

## Continuity

Data remains usable long after construction teams leave the site.

## Context

All data is tethered to the 3D spatial environment.

## Governance

Version control, approvals, and validation

## Interoperability

Open standards rather than proprietary formats

## Evolution

The twin updates as the physical building changes



## 3.1 Standards-Based Information Management

- ✓ **ISO 19650** - Lifecycle information management
- ✓ **COBie** - Structured asset data exchange (used by NASA & U.S. Military)
- ✓ **IFC** - Open BIM interoperability
- ✓ **DTDL** - Digital Twins Definition Language

# How Lifecycle Digital Twins Solve Architectural Challenges



## Single Source of Truth

Unifies BIM, drawings, specs, and scans into a governed, contextual platform.



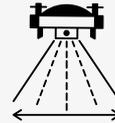
## Resolving BIM Fragmentation

Federates multi-discipline models through open standards for holistic navigation.



## Preserving Standards

Centralized access to room standards, finish systems, and infection control strategies.



## Operational Reality Capture

Integrates 2D, 3D, and LiDAR for fast verification and reduced renovation risk.



## Solving Life Safety Complexity

Spatially organizes life safety drawings and egress paths for improved planning.



## Future-Proofing BIM Data

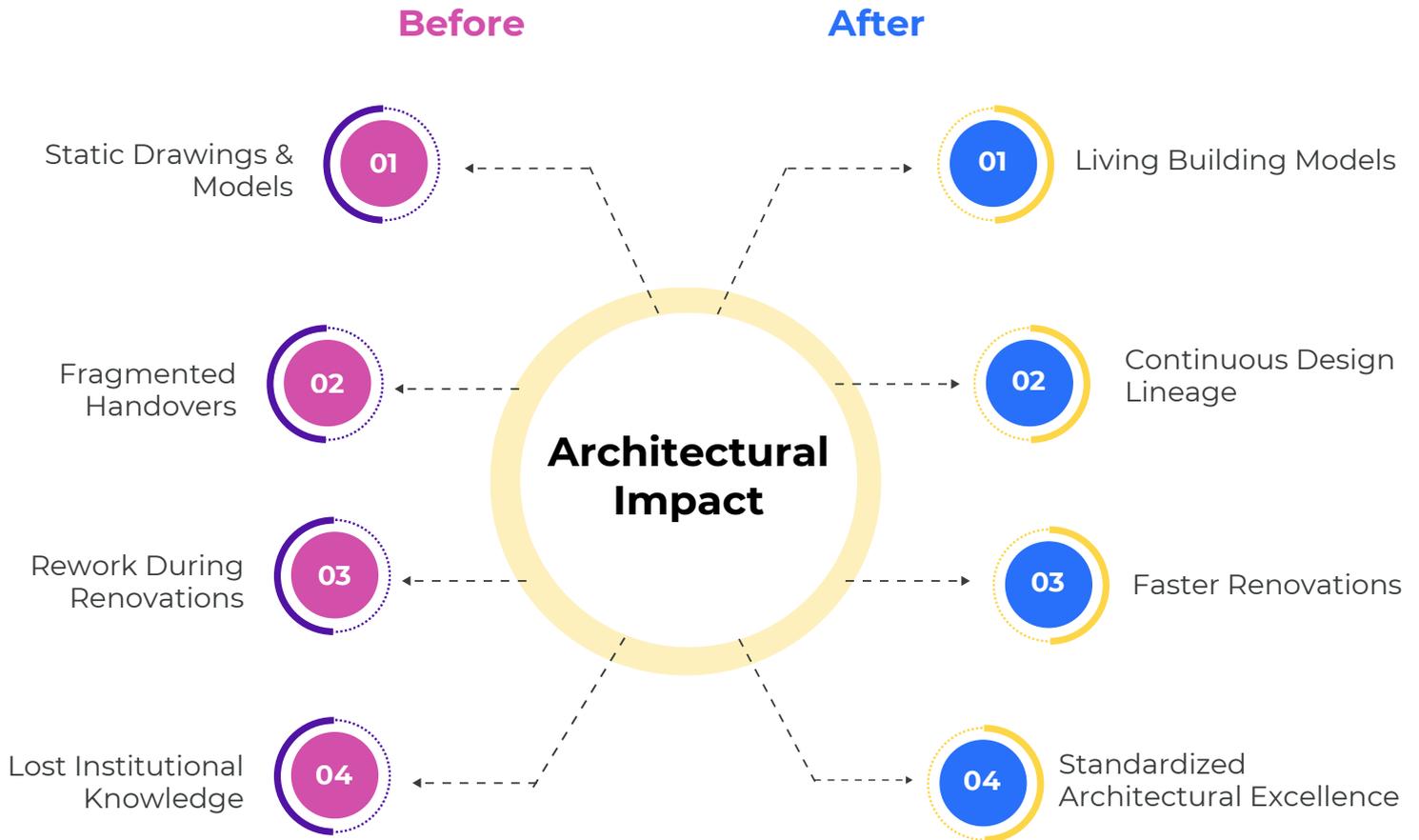
Translates BIM into open standards (IFC, DTDL) for enduring architectural knowledge

# Capabilities Required of a Lifecycle Digital Twin Platform

- **Unified Spatial Intelligence**  
Seamless navigation across 2d drawings, 3D BIM, and reality scans
- **Common Data Environment (CDE)**  
Microsoft Azure-based hosting with version control and audit trails
- **AI-Powered Assets**  
Nameplate recognition and automated asset registry creation
- **Mobile & QR Access**  
Field-ready access to room & equipment data
- **Compliance Tracking**  
Digital logs for exit signs, critical doors, and life safety audits
- **Sustainability & Material Intelligence**  
Embodied carbon tracking via EC3 & material benchmarking
- **Virtual Training**  
Staff orientation & pre-occupancy walkthroughs
- **Project Workflow Management**  
Digital soft landings & structured closeouts

# Architectural Impact

Lifecycle digital twins shift architecture from project deliverables to continuous building intelligence.



The shift is fundamental: from producing artifacts to contributing to enduring systems.



## Conclusion: Architecture That Endures

Healthcare buildings are among the most complex environments humans create - yet traditional workflows treat them as finite projects.

Lifecycle digital twins change this.

By unifying BIM, reality capture, standards, assets, materials, compliance, and operations into a spatially contextual digital model, digital twins create architecture that:

- ✓ **Remembers**
- ✓ **Learns**
- ✓ **Improves**
- ✓ **Endures**

For healthcare architects and owners alike, digital twins are becoming foundational infrastructure for modern facility delivery.

## About TRC Building Data Solutions

**At TRC, we transform complex facilities into intelligent, data-driven environments through our tailored Building Data Solutions (BDS). By combining expert services with advanced digital twin technology, we support complete facility lifecycle management, from design and construction to ongoing operations.**

## About e-Magic

**Founded in 1998, e-Magic is a global leader in Industrial IoT and Azure Digital Twins. e-Magic designs and integrates large-scale digital twin solutions for Smart Buildings, Healthcare, Infrastructure, and Manufacturing - deployed on-premise and in the cloud with Microsoft Azure.**