Frequency: The New Dimension for Digital Twins

Recent years have been transformative for the construction industry, as technology infuses each part of the building process. From the addition of drones and smartphones to the workforce, to once-futuristic materials becoming reality, buildings in decades to come will look and operate differently from how they do today.[1]

At OpenSpace, we have a front row seat to this transformation. We have the privilege of working with builders large and small as they incorporate cutting-edge technology like AI and passive photo documentation into their workflow, improving the way they get things done.

One area of technological innovation we've recently seen on the rise is the use of "digital twins"— digital replicas of physical spaces and structures.

In the pages that follow, we'll discuss the evolution of digital twins, their benefits to project teams, and how adding a third dimension to their creation and maintenance — frequency — can bring even greater utility to the teams that employ them.

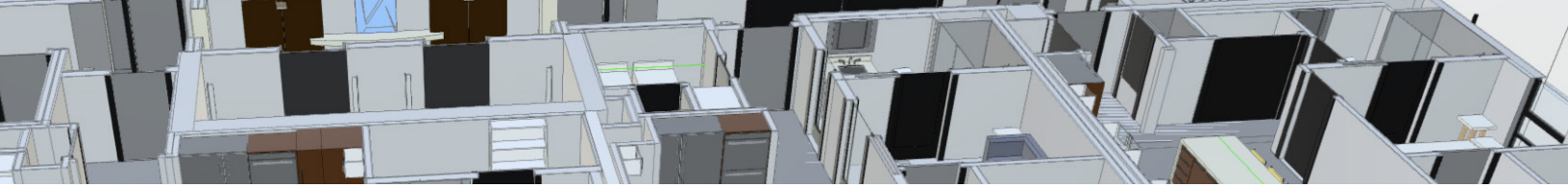
We hope you find this report useful, and invite you to share your thoughts with us at info@openspace.ai.

– The OpenSpace Team

The Rise of Digital Twins

Digital twins were first developed in the industrial manufacturing sector, using the term to describe digital representations that are linked to physical machines. Digital twins differ from previous modeling technologies (like CAD), as they require sensors or videos and images to tie the virtual model to its physical counterpart. Having that connection lets engineers work on the digital, rather than the physical, model—a major benefit for hard-to-reach sites like deep-sea oil rigs or wind turbines.

The rise and affordability of new technologies, such as connected devices, AI and big data capabilities, have allowed digital twins to become a scalable reality. They've quickly become indispensable to many industries, and were included on Gartner's "Top 10 Technology Trends for 2018" list.[2] Many of today's largest technology players, including Oracle, IBM and Microsoft, now have full digital twin offerings.



Digital Twins Come to Construction

Manufacturers developed digital twins as a way to anticipate production problems and collect real-time feedback from their plants, saving significant time and money. These are benefits sorely needed by the construction industry as well. With many large construction projects running up to 80% over budget and taking 20% longer to finish than scheduled, digital twins represent a powerful new tool for improving performance.[4]

The financial benefits are clear as well: Construction productivity lags behind the average sector by almost 2%. If that gap were closed, it could mean an additional $1.6T in added value.[5] Given the scale of the opportunity, a growing crop of players from Leica to 3D Robotics are building digital twin solutions specifically for construction use cases.

> ***With an estimated 21 billion connected sensors and endpoints by 2020, digital twins will exist for billions of things in the near future. Potentially billions of dollars of savings in maintenance repair and operation (MRO) and optimized... performance are on the table"***

David Cearley
VP & Gartner Fellow,
Gartner Research[6]

DEFINITIONS

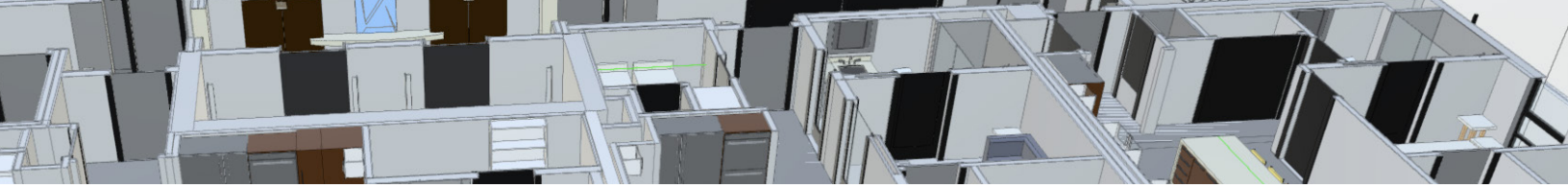
WHAT'S A DIGITAL TWIN?

A digital twin is a virtual model continuously linked to a physical object, allowing you to foresee issues before they occur, monitor performance and simulate multiple future outcomes. Single machines might have a digital twin, or digital counterparts might recreate an entire construction site. NASA was the first to develop a proto-version of the technology, which it used to stave off disaster during the Apollo 13 mission, using the virtual model on the ground to find a way to steer the spaceship to safety.[3]

What Makes an Effective Digital Twin?

To date, measuring digital twins' effectiveness in construction has relied heavily on two parameters: *resolution* and *completeness*.

Resolution refers to how detailed the model might be. For example, are you able to measure the square footage of drywall installed? Do you know how many bolts are required for an entire project? Completeness, on the other hand, measures how much of the job site is digitally captured. Does the digital twin capture just the building envelope or does it capture every vantage point of the project?



Introducing a New Variable: Frequency

While these parameters are critical to a digital twin's success, they leave out a new, third dimension that proves just as important, especially in construction: frequency. Time is a key component of construction management and documentation. A digital twin that isn't versioned, or isn't versioned frequently, fails to capture the essence of construction itself—creating something that wasn't there at a previous point in time. Things move fast on a jobsite; having more frequent documentation can prevent costly rework and keep everyone on the same page.

> ***Time is a key component of construction management and documentation. A digital twin that isn't versioned, or isn't versioned frequently, fails to capture the essence of construction itself—creating something that wasn't there at a previous point in time.***

Recently, technology and software capabilities have advanced to a point that a **high-frequency digital twin** is now possible. A high-frequency digital twin model can now be updated weekly, or even daily, from groundbreak through closeout and beyond.

The Benefits of High Frequency

Bringing time into the picture offers several benefits to project teams using digital twins.

1. **MORE ACCURATE PAYMENTS.**
   With more frequent updates, subcontractors can be paid according to the exact amount of work

THE DIGITAL TWIN LANDSCAPE

Today's digital twins use a variety of technologies. The main three types are lidar point clouds, drone orthomosaics, and smartphone and 2D camera images.

LIDAR POINT CLOUD

A point cloud is a set of data points in space— in this case, the as-built condition of a job site. Point clouds are generally produced by 3D scanners, which measure a large number of points on the external surfaces of objects around them. This data is then fed into modeling software, where it generates an "as is" image of what's on site, which can be exported into a variety of different 3D CAD and BIM tools. They are great for the detail they provide, but are time-consuming to both generate and process, which results in relatively infrequent captures.

- Resolution: High
- Completeness: High
- Frequency: Low (14,000 square meters scanned in 6 hours)

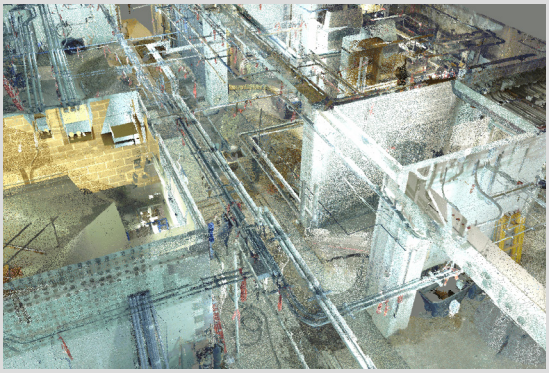
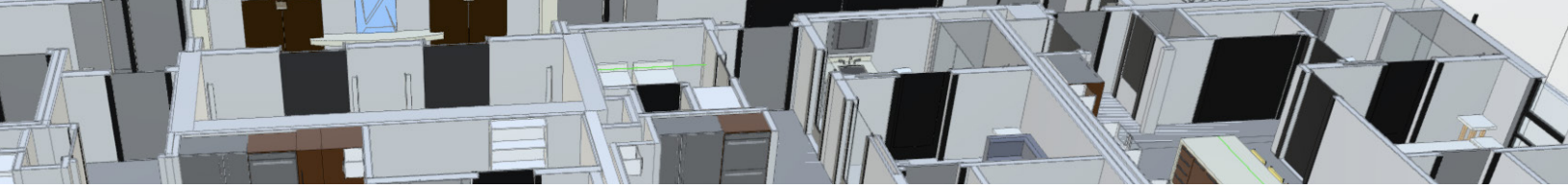


Image courtesy of NavVis



completed each month, with visual documentation to back it up — rather than basing payments on a predetermined contract that doesn't match reality.

2. **BETTER INCIDENT TRACKING.**
   Let's say a safety issue occurs on a Wednesday, but is reported the next time the worker visits the job site the following Monday. Project teams will need to assess the conditions of the job site when the accident happened—not when it was reported. This can only be achieved if the digital twin has frequent updates.

3. **IMPROVED QUALITY CONTROL.**
   As we all know (or have learned the hard way), quality issues can appear days, weeks or even years after a project is completed. You want to be able to review the ground truth of what happened during construction with ease—and without encountering gaps in your twin's documentation after the fact.

4. **AUTOMATED MAINTENANCE UPDATES.**
   Perhaps the largest benefit of all relates to the key driver of cost in the total cost of ownership of a building or any ongoing project: maintenance and periodic inspections. The core question becomes: How can you automatically spot deficiencies or changes from last construction or maintenance inspection? With frequency, change detection built into the AI makes this process seamless.

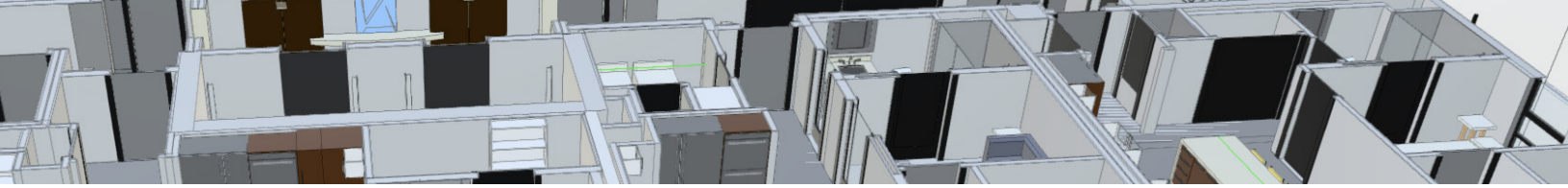
THE DIGITAL TWIN LANDSCAPE

DRONE ORTHOMOSAIC

An orthomosaic, also known as an "orthophoto," is an aerial image of an area, comprising multiple images stitched together. Drone mapping software, such as DroneDeploy, Kespry or Pix4D, uses drones to capture numerous photographs that are stitched together to create a comprehensive digital twin. They can be quite accurate, but are necessarily limited in completeness to the area that the drone can view. This means they are only good for ground-up projects, and only during the site works phase.

- Resolution: Medium (more detailed than satellite imagery)
- Completeness: Low (aerial view only)
- Frequency: Variable

Image courtesy of Construction World



The Need for User–Friendly Technology

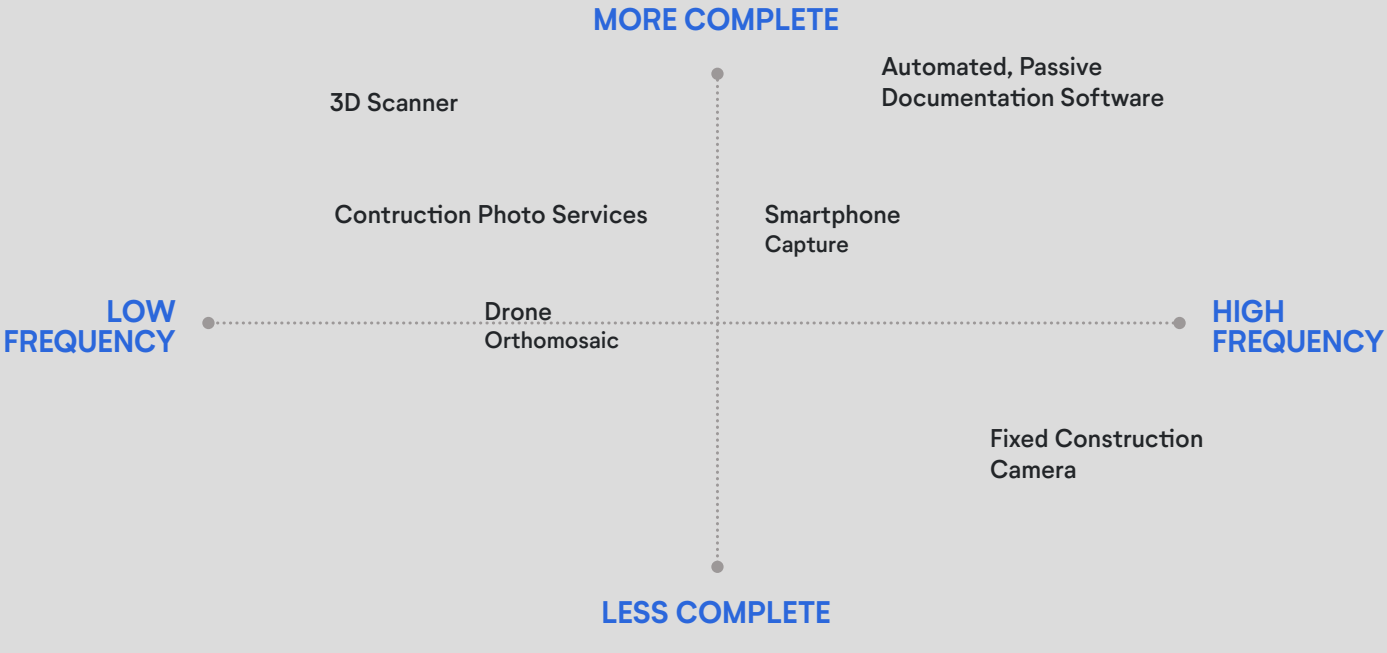
High–frequency twins clearly offer huge opportunities to the industry, but for adoption to succeed they need to integrate easily into the average project. Finding workers with the technological knowledge to create and manage digital twins is challenging, to say the least. A recent study by Harvey Nash and KPMG found that only 13% of IT leaders in the construction industry felt they were effective at hiring people with adequate digital skills.[w] Pair that with an acute labor shortage—91% of those surveyed in the 2018 Commercial Construction Index reported "having a difficult or moderately difficult time finding skilled workers"—and it's clear we the industry need technological solutions that don't overtax workers or require complicated new skillsets to implement.[9]

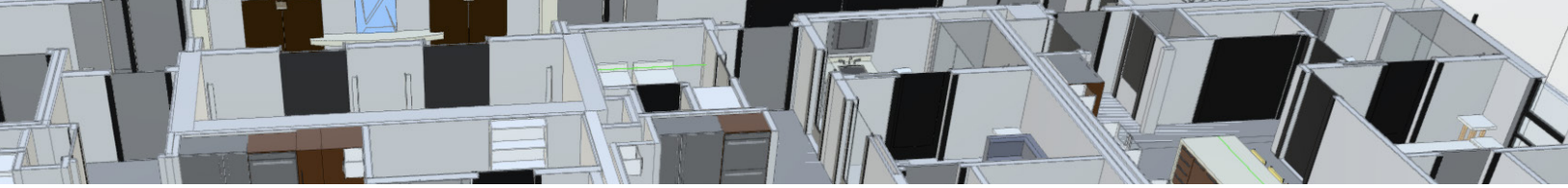
THE DIGITAL TWIN LANDSCAPE

SMARTPHONE AND 2D CAMERA IMAGES

Captured manually on the ground by field teams or outsourced photography professionals, these images can be mapped (manually or automatically with software) to project plans. Smartphone images are high–resolution and very detailed, but robustness and frequency rely on human beings to undertake extremely comprehensive documentation under the same conditions to generate an effective digital twin.

- Resolution: High
- Completeness: Medium (human–dependent)
- Frequency: Medium (human–dependent)





To achieve daily or weekly frequency, the technology needs to be simple to use and seamless to incorporate into workflows. Successful high-frequency digital twin solutions must be passive, or partly automated, as well as being capable of handling large datasets. As we've seen firsthand at OpenSpace, the last thing a project team wants to do is sort through hundreds (or thousands) of unmapped smartphone images, or interact with an overly complex digital model. The good news is that recent advances are making passive capture possible, since AI can manage large datasets and map jobsite images to project plans automatically.

Conclusion

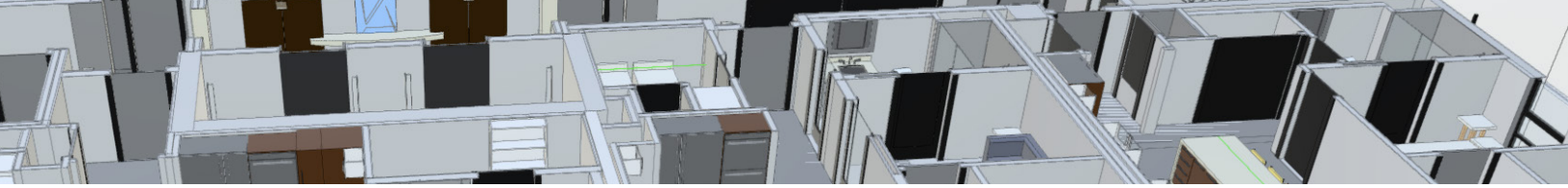
High-frequency digital twins are worth the effort—especially as technology reduces the amount of labor needed to create and maintain them. By combining resolution and completeness with time, high-frequency digital twins can deliver immediate and long-term value to all the stakeholders in a project, from construction field teams to facility managers and owners.

CASE STUDY

USING TECHNOLOGY TO REDUCE DOCUMENTATION COSTS

NOVO Construction's jobsite documentation process was manual, time-consuming and inconsistent. NOVO worked with OpenSpace to use technology to make the process more efficient. NOVO used OpenSpace's jobsite capture technology, which runs through a standard Garmin 360°camera mounted on a hard hat, to start automating its jobsite documentation. NOVO's PEs were able to incorporate documentation into their day-to-day work as they walked around the job site. OpenSpace's AI technology automatically mapped the captured images to NOVO's project plans, making documentation and image mapping 20X faster, and allowing them to capture 100X more images. By using technology, NOVO's labor costs and time spent on documentation were drastically reduced.[8]

> *With the time savings we see with OpenSpace, we can now* ***document all active areas of the project daily.***
>
> Tyler Rohde, *PE*, Novo



Next Steps

How can you leverage the promise of high-frequency digital twins in your organization? Start by asking yourself these key questions:

1. **What technology is currently in place to support model creation and development? Does my organization use digital twins effectively?**

2. **What job functions would be best to support the development and maintenance of an effective digital twin? Do you currently have those people in-house or would they need to be sourced?**

3. **Evaluate your current jobsite documentation process. How often are you able to capture your jobsite? How many man-hours does the process take?**

4. **Could that frequency by improved? Set goals for improvement. If you are currently capturing your jobsite weekly, aim for biweekly. The most complex projects should aim for daily capture.**

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OPENSPACE

OpenSpace is the leader in 360 visual job site documentation. Just tap record and go, and OpenSpace's automated AI technology does the rest. OpenSpace helps builders document their sites 10X–20X faster and more completely, automatically mapping progress photos to project plans to create a 360o living record of any job site.

To learn how to capture your job site with more frequency, email info@openspace.ai or visit https://openspace.ai/a/overview.html to learn more.