



Reflections of Reality: Digital Twin Technology

Digital transformation is reshaping industries by integrating advanced technologies that enhance efficiency and foster innovation. An emerging component of this transformation is digital twin technology, which constructs detailed virtual models of physical objects, processes, or locations to serve as real-time digital counterparts. For example, airlines have used a digital twin of an aircraft to dynamically update and optimize operations based on continuous sensor data.¹ While the concept of digital twins has been around for decades, recent advancements in computing power, network connectivity, cost-effective data storage, deep learning, and cloud computing have significantly increased their utility. Further, digital twins are not standalone technologies; they are part of a comprehensive ecosystem that includes databases, software, and sensors providing continuous feedback (see image 1).

Although public discourse around digital twins has often focused on consumer applications like the Metaverse, where users virtually interact through avatars, these technologies are making significant strides in enterprise settings. Today, companies are utilizing digital twins to fundamentally transform how decisions are made across industries such as construction, real estate, manufacturing, and logistics. Moreover, with advancements in data analytics and computing, companies implementing digital twin technology can now leverage Generative Artificial Intelligence (GenAI)—AI that can analyze and create new data like text, images, videos and 3D models—to

help predict outcomes and provide actionable insights. This paper delves into these enterprise applications, exploring how digital twin technology, enhanced by GenAI, is setting the stage for the next wave of industrial innovation.

Construction and Infrastructure

To understand the transformative impact of digital twin technology, we turn first to the construction industry. Historically, construction has been one of the least digitized industries globally, marked by manual regulatory processes and operating inefficiencies. However, companies like Procore, a provider of construction management software, are incorporating the use of digital twin technology to revolutionize how construction projects are managed and executed. By using digital twins, these companies enable real-time documentation and sharing of construction progress, which significantly optimizes workflow and resource management. Procore employs drones and sensors to survey sites, automatically processing the data to generate high-resolution maps, models, and virtual tours (see image 2).² This technology not only minimizes the need for onsite visits but also enhances regulatory and contractual compliance, thereby boosting overall project efficiency.

Building on the applications in construction, digital twin technology extends its utility to encompass broader urban and infrastructure projects. Companies like Autodesk utilize this technology for city planning and critical infrastructure monitoring. These

Image 1: **The Three Elements of a Digital Twin**

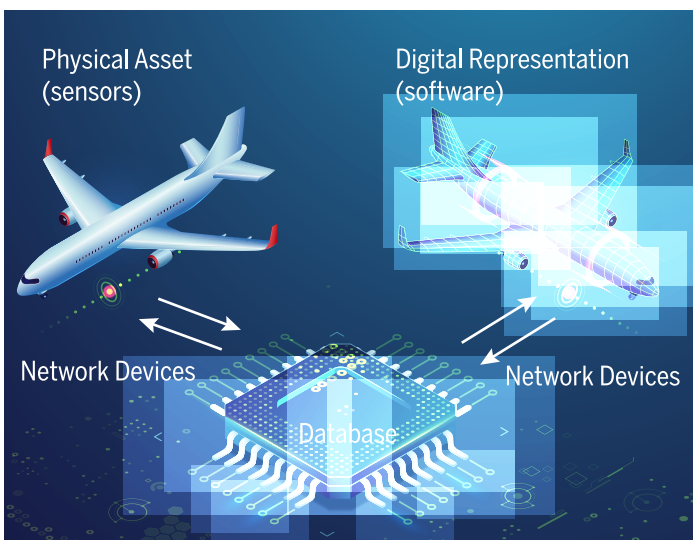
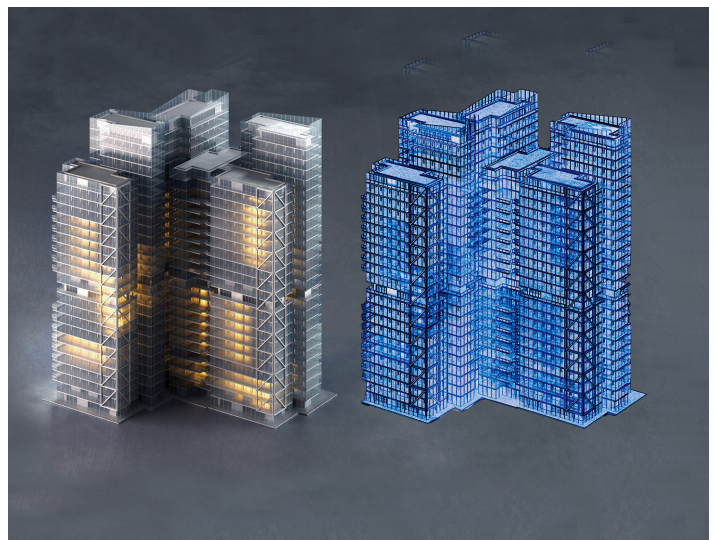


Image 2: **Real-time Documentation of Construction Progress**



companies survey large areas and then feed the data into GenAI software programs to rapidly create detailed virtual models of urban layouts.³ This enhanced modeling capability allows for the simulation of various environmental scenarios, providing tools to stress test buildings and infrastructure against extreme weather events such as an earthquake or major flooding. For example, a GenAI-enhanced digital twin of an electricity grid could forecast potential bottlenecks in anticipation of an expected heatwave. Such foresight enables utility companies to adjust electricity supply proactively, mitigating the risk of overloads during peak demand periods caused by increased air conditioning use, thus preventing potential power outages (See image 3).⁴

Real Estate

The innovations brought by digital twins in construction and infrastructure pave the way for similar advancements in the real estate sector. Just as digital models streamline project management on construction sites, they also transform property buying and remodeling by providing detailed virtual replicas that potential buyers and developers can explore remotely. Matterport, an AI-powered spatial data platform owned by CoStar Group, uses digital twin technology to create detailed tours and inspections of homes from remote locations, facilitating decision-making without the need for physical visits (see image 4).⁵ For remodeling, digital twins also offer homeowners and designers the ability to experiment with different layouts, materials, and designs in a virtual environment before any physical changes are made. This not only ensures that the final design is well-considered but also helps in managing budgets more effectively, reducing the risk and cost associated with trial-and-error methods in physical spaces.

Manufacturing and Logistics

While digital twins revolutionize property management and development, their utility extends beyond real estate. In the manufacturing and logistics industry, the growing complexity of warehousing and logistics has driven the need for innovative tools to enhance efficiency and productivity. To create a digital representation of a warehouse, companies are increasingly relying on sensors to modernize the industry. As more sensors are integrated into factory systems, the demand for connectors that enable continuous digital representations of these facilities grows. Amphenol, a provider of highly engineered connectors that efficiently transmit and receive data, plays a critical role in this process. By incorporating numerous sensors on machine tools and robotics throughout a factory, manufacturing companies can leverage their digital twins to analyze operations in real time and significantly improve efficiency (see image 5).⁶

Image 3: GenAI Software Programs Create Detailed Virtual Models



Image 4: Detailed Virtual Tours of Homes from Remote Locations



Image 5: Incorporating Numerous Sensors in Factory Systems

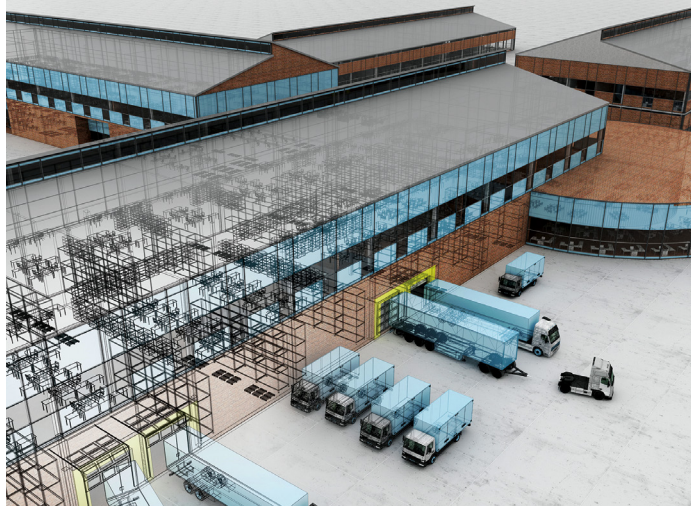


Outside the factory, Manhattan Associates—a leading provider of software solutions designed to manage supply chains, inventory, and omni-channel operations—is leveraging AI to optimize warehouse and transportation planning. Their approach includes a digital twin of the yard—the loading area outside the warehouse—offering real-time insights and updates. This system lets users clearly see the location of every dock and yard area, check the status of trailers, see what they contain, and monitor the progress of goods coming in and going out. As a result, this digital visibility helps optimize the loading and unloading queue, saving time and costs as fewer trailer goods sit idle (see image 6).⁷

Leveraging Generative AI and the Path Forward

Digital twin technology, as we have demonstrated, is not confined to a single industry but serves as a versatile tool that enhances decision-making and operational efficiency across various sectors. The real-world applications—from refining construction processes and enabling remote real estate inspections to optimizing manufacturing and logistics—showcase the tangible impact of digital twins on enterprises. Although still in its early stages, the integration of GenAI with digital twins provides intense computational analysis capabilities that could dramatically accelerate digital transformation in the coming decades. As GenAI continues to evolve, we anticipate that digital twin technology could revolutionize fields such as

Image 6: **Using AI to Optimize Warehouse and Transportation Planning**



healthcare, where it could predict individual health risks and tailor treatments, thereby significantly shortening clinical trials and reducing R&D costs for biotechnology companies. As these technologies develop further, we believe their synergy could unlock unprecedented opportunities for addressing complex and dynamic global challenges. At Alger, we are enthusiastic about the ongoing integration of digital twin technology and GenAI across industries, where their full transformative potential is yet to be realized.

¹Rolls-Royce. (2019). How digital twin technology can enhance aviation. Retrieved from <https://www.rolls-royce.com/media/our-stories/discover/2019/how-digital-twin-technology-can-enhance-aviation.aspx>

²DroneDeploy. (n.d.). Retrieved from <https://marketplace.procore.com/apps/dronedeploy>

³Autodesk. (n.d.). Digital twin for architecture, engineering & construction. Retrieved from <https://www.autodesk.com/solutions/digital-twin/architecture-engineering-construction>

⁴Schneider Electric. (2023, November 9). Capital Markets Day

⁵CoStar Group. (n.d.). CoStar Group to acquire Matterport, global leader in immersive 3D digital twins and artificial intelligence for the real estate industry. Retrieved from <https://www.costar.com/article/628706126/costar-group-to-acquire-matterport-global-leader-in-immersive-3d-digital-twins-and-artificial-intelligence-for-the-real-estate-industry>

⁶Amphenol Industrial. (n.d.). Factory automation. Retrieved from <https://amphenol-industrial.com/factory-automation/>

⁷Manhattan Associates. (n.d.). Manhattan Associates launches next-generation yard management. Retrieved from <https://www.manh.com/about-us/newsroom/press-releases/manhattan-associates-launches-next-generation-yard-management>

The views expressed are the views of Fred Alger Management, LLC ("FAM") and its affiliates as of June 2024. These views are subject to change at any time and may not represent the views of all portfolio management teams. These views should not be interpreted as a guarantee of the future performance of the markets, any security or any funds managed by FAM. These views are not meant to provide investment advice and should not be considered a recommendation to purchase or sell securities.

Risk Disclosures: Investing in the stock market involves risks, including the potential loss of principal. Growth stocks may be more volatile than other stocks as their prices tend to be higher in relation to their companies' earnings and may be more sensitive to market, political, and economic developments. Local, regional or global events such as environmental or natural disasters, war, terrorism, pandemics, outbreaks of infectious diseases and similar public health threats, recessions, or other events could have a significant impact on investments. Investing in companies of small capitalizations involves the risk that such issuers may have limited product lines or financial resources, lack management depth, or have limited liquidity. Assets may be focused in a small number of holdings, making them susceptible to risks associated with a single economic, political or regulatory event than a more diversified portfolio. **Past performance is not indicative of future performance.** Investors whose reference currency differs from that in which the underlying assets are invested may be subject to exchange rate movements that alter the value of their investments.

Investing in innovation is not without risk and there is no guarantee that investments in research and development will result in a company gaining market share or achieving enhanced revenue. Also, developing technologies to displace older technologies or create new markets may not in fact do so, and there may be sector specific risks as well. As is the case with any industry, there will be winners and losers that emerge and investors therefore need to conduct a significant amount of due diligence on individual companies to assess these risks and opportunities. **Companies involved in, or exposed to, AI-related businesses may have limited product lines, markets, financial resources, or personnel as they face intense competition and potentially rapid product obsolescence.** These companies may be substantially exposed to the market and business risks of other industries or sectors and may be adversely affected by negative developments impacting those companies, industries, or sectors, as well as by loss or impairment of intellectual property rights or misappropriation of their technology. Companies that utilize AI could face reputational harm, competitive harm, and legal liability, and/or an adverse effect on business operations as content, analyses, or recommendations that AI applications produce may be deficient, inaccurate, biased, misleading or incomplete, may lead to errors, and may be used in negligent or criminal ways. Companies exploring new technologies may face regulatory, political or legal challenges that may adversely impact their competitive positioning and financial prospects.

Important Information for US Investors: This material must be accompanied by the most recent fund fact sheet(s) if used in connection with the sale of mutual fund and ETF shares. Fred Alger & Company, LLC serves as distributor of the Alger mutual funds.

Important Information for UK and EU Investors: This material is directed at investment professionals and qualified investors (as defined by MiFID/FCA regulations). It is for information purposes only and has been prepared and is made available for the benefit investors. This material does not constitute an offer or solicitation to any person in any jurisdiction in which it is not authorized or permitted, or to anyone who would be an unlawful recipient, and is only intended for use by original recipients and addressees. The original recipient is solely responsible for any actions in further distributing this material and should be satisfied in doing so that there is no breach of local legislation or regulation. Certain products may be subject to restrictions with regard to certain persons or in certain countries under national regulations applicable to such persons or countries.

Alger Management, Ltd. (85 Gresham Street, Suite 308, London EC2V 7NQ, UK) is authorized and regulated by the Financial Conduct Authority, for the distribution of regulated financial products and services. FAM and/or Weatherbie Capital, LLC, U.S. registered investment advisors, serve as sub-portfolio manager to financial products distributed by Alger Management, Ltd.

Alger Group Holdings, LLC (parent company of FAM and Alger Management, Ltd.), FAM, and Fred Alger & Company, LLC are not authorized persons for the purposes of the Financial Services and Markets Act 2000 of the United Kingdom ("FSMA") and this material has not been approved by an authorized person for the purposes of Section 21(2)(b) of the FSMA.

Important information for Investors in Israel: This material is provided in Israel only to investors of the type listed in the first schedule of the Securities Law, 1968 (the "Securities Law") and the Regulation of Investment Advice, Investment Marketing and Investment Portfolio Management Law, 1995. The Fund units will not be sold to investors who are not of the type listed in the first schedule of the Securities Law.

The following positions represent firm wide assets under management as of April 30, 2024: Procore Technologies Inc., 0.03%; CoStar Group Inc., 0.15%; AutoDesk Inc., 0.00%; Amphenol Corp., 0.08%; Matterport, Inc., 0.00%; and Manhattan Associates Inc., 0.17%.

Alger pays compensation to third party marketers to sell various strategies to prospective investors.