Federal Register Notice: 89 FR 51554, Federal Register :: Networking and Information Technology Research and Development Request for Information on Digital Twins Research and Development, June 18, 2024.

Request for Information on the National Digital Twins R&D Strategic Plan

Plato Systems

Plato Systems in Response to the Networking and Information Technology Research and Development Request for Information on Digital Twin Research and Development

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Digital Twins in Manufacturing

Since the turn of the millennium U.S. share of global manufacturing has declined, with one-third of manufacturing jobs disappearing in just the first ten years. By 2030, it is projected that 2 million manufacturing jobs will be unfilled in the U.S., including 150,000 in the semiconductor industry alone. Without urgent and tactical action to bridge the talent gap, the U.S. risks minimal return on an over $300B investment to build manufacturing infrastructure through the CHIPS and Science Act and the Bipartisan Infrastructure Law. Technology is a key part of the solution, with digital twins emerging as frontrunners for rapidly scaling capacity and driving efficiency in labor-constrained environments.

Digital twins are part of a larger smart manufacturing trend, which has collectively garnered more than $50B in annual investment, but has yet to realize significant returns. According to Forbes, only 14% of smart factory installations are considered successful. Industry must examine why these initiatives are unsuccessful and how new technologies can leverage existing investments to realize the promised productivity gains.

A critical shortcoming of current digital twins in manufacturing is that they were designed prior to the age of big data analytics and AI, thereby rendering these tools less effective and inefficient in addressing systemic operational productivity gaps that lead to higher production costs, lower production capacity, and lower quality. More specifically, manufacturing data is stored across several disparate and disconnected digital twins, each producing a lot of the "what" data (i.e. "when" did "what" happen) but they don't enable or help with understanding the "why" data; Additionally, manufacturing is a complex ecosystem, and the data that is currently available lacks critical context that would disentangle the complex interactions that lead to poor productivity. This combination results in overburdensome and costly root cause analysis which is beyond the resources of most companies. Presently, an analyst must manually review siloed, fragmented, and often incomplete machine data to determine the root causes of anomalous adverse events. To address these challenges, a new modular digital twin is needed that is purpose-built to provide actionable insights and enable rapid scalable root-causing of productivity issues. This new platform should be able to ingest existing data streams as well as new sources of data that add critical contextual information, provide a replica of all physical operations (including crucially the operator-machine interactions), and be paired with a set of AI copilot tools that can help objectively measure, identify, root-cause, and predict systemic issues automatically at scale.

Plato has developed a streamlined method to contextualize manufacturing operations data using novel approaches of spatial data and spatial intelligence, unlocking rapid AI-assisted root cause analysis and corrective action that enables the digital twins to have proven impact on real world operations. In Plato's solution, proprietary sensors and cameras digitize operator-machine interactions. This missing piece of data is critical for both facilities that haven't undergone digital transformation (by digitizing their physical operations) and those that have (by complementing and contextualizing their data), giving the model the necessary context to identify *why* an anomalous event occurred. Plato has deployed this system in multiple global electronics manufacturing and semiconductor fabs, demonstrating 20% productivity increases over manufacturing execution systems and machine data collection schemes alone.

Therefore, Plato recommends that:

1. Manufacturing should be considered a critical domain across R&D topic areas. The manufacturing sector provides a necessary real-world deployment environment for digital twin learnings to demonstrate measurable productivity improvements.
2. An R&D topic should be focused on identifying the data gaps preventing current digital twin efforts from realizing productivity gains, as these learning will extend beyond the manufacturing domain to areas such as smart cities and energy, which resemble complex factory environments, with many actors, subsystems, and interactions.
3. An R&D topic focused on developing complete digital twin solutions that use spatial data and AI to determine the root causes of failures and provide recommendations on mitigating these failures in the future by leveraging AI.

<u>Data: Expanding Data Collection to Enable Digital Twin Development</u>

<u>Success of AI and big data analytics relies on having access to data that is both high volume and has high quality in terms of its completeness and correctness.</u> Relying solely on machine data to construct digital twins poses a problem to manufacturers. Machine data provides an abundance of data on what happened, but little insight into why. This makes employing analytical tools challenging, as models do not contain the information required to diagnose the cause of an anomalous event. As a result, data analysts must manually investigate across disconnected and incomplete data sources to determine root causes and the corresponding corrective actions, wasting time and resources.

The inclusion of spatial data in manufacturing digital twins is critical to extracting actionable insights from these models. Spatial data is required to accurately capture machine-operator interactions, as self-reporting and other mechanisms have proven unreliable. With spatial data, digital twins can determine the operator's relation to the machines and other operationally critical areas (such as inspection stations, warehouse, etc) during an anomalous event. With this context, AI can analyze how an ideal operator minimizes machine downtime in a digital twin. These insights can be incorporated into training material for workers to increase their productivity, and resolve systemic issues such as those related to facility layout planning, scheduling, capacity planning, staffing, material preparation, and standard operating procedures. While machine data enables part of a plant's story, spatial data is imperative for developing comprehensive and reliable digital twins that enable effective root cause analysis for anomalous events.

The Digital Twins R&D Strategic Plan (The Plan) should include a robust data collection system that includes spatial intelligence. The Plan should seek to incorporate a variety of data streams including machine operations data, scheduling, material data, and other organizational data consolidated into one platform, with the goal of establishing a complete digital twin able to explain *why* anomalous events occurred. Digital twins of this nature are the key to demonstrating the business value of smart manufacturing initiatives.

Plato's Expertise in Data Collection: Plato captures data continuously on a 24/7 operative basis and uses AI-enabled sensor technology to digitize operator activity onto Plato's cloud platform. The Plato Cloud further integrates into and ingests manufacturers existing operations, MES, or ERP data to create a highly contextualized Operations Digital Twin with a demonstrated 20% productivity improvement in electronics and semiconductor manufacturing facilities.

AI and Digital Twins:

In modern manufacturing, data and technology play a crucial role in driving productivity. With the increasing reliance on automation, there is a near infinite amount of machine and other factory operations data available to manufacturers. The challenge is extracting actionable insights and trends from a vast amount of data. This is where AI thrives.

AI models can detect and identify patterns between data and incidents, identifying the biggest causes of inefficiency at greater speed than previous analytical methods. While machines can make parts, they cannot solve problems autonomously. When equipment is down or needs maintenance, human interventions are critical to optimizing uptime. Digital twin environments that leverage AI allow managers to proactively receive insights into how machines and operators are interacting to better respond to problems in real-time and plan for future operations.

The Plan should prioritize the use of AI within digital twins technology in manufacturing processes to focus on technologies that can proactively deliver actionable insights on the data collected and thus efficiently deliver productivity gains. Moreover, conversational AI models that allow the user to interact and analyze data using conversational prompts can further contribute to the utility of these tools by removing the need for end users to have advanced data science skills. The Plan should prioritize R&D efforts that effectively collect data that can be easily integrated into ML and AI systems for digital twin environments, and provide interactive AI insights in a streamlined manner.

Plato's Expertise in AI with Digital Twins: Plato's AI assistant allows the production facility to identify root causes of manufacturing efficiencies across shifts, lines, and plants, with the promise to deliver actionable data for productivity improvement within 8 weeks of deployment.

The incorporation of AI with digital twins in manufacturing sites is critical to helping plant management address efficiencies with speed and simulate future environments. Rather than spending hours every week to root-cause a single adverse event such as a downtime, AI-assisted Digital Twins allow managers to quickly identify where issues are stemming from and access insights immediately and at scale.

AI enables the ability to quickly collect insights from the data and facilitate the future modeling and simulation of facilities for long-term and strategic planning.

Long Term

Forward-looking digital twins allow for thorough validation of designs before actual construction begins, identifying potential flaws and bottlenecks early in the design phase where they can be ameliorated at a fraction of the cost compared to during or post construction. By including spatial data in forward-looking digital twins, manufacturers can reap several impactful benefits:

1. Optimized performance: digital twins can simulate how different designs will perform under various conditions. With the inclusion of spatial data, the manufacturer can understand where the operator will have challenges maximizing machine effectiveness. Through modeling, designs can be optimized for the operators, ensuring that the factory and workers operate at their best from day one.
2. Enhanced Training: digital twins can simulate the optimal workflow for each individual operator before a factory is built. Training materials would be developed based on the optimal workflows, and used to educate staff *before* the factory is built. The workforce will be able to hit the ground running on day one, reducing ramp time and enhancing productivity from the outset.
3. Continuous improvement: insights gained from simulating designs, optimizing performance, constructing the optimized designs, and then analyzing how well the optimizations performed in the real world can inform future projects, leading to constant improvement in industrial design. Long term, this practice enhances innovation and competitiveness within the U.S. manufacturing sector.

Workforce

Significant workforce challenges are expected in the U.S. manufacturing sector due to high turnover rates and projected talent shortages. According to the U.S. Bureau of Labor Statistics, there is over a 40% turnover rate in manufacturing and the industry is projected to face 85 million unfilled jobs globally by 2030, leaving a significant gap for the sector to fill over the next 5 years.

To truly overcome the aforementioned labor challenges, digital twins should enable a more productive workforce in two ways. First, the workforce of tomorrow should be empowered by providing them the ability to take advantage of feedback loops from an AI-assisted digital twin that allow the operator to access and analyze data and retrieve best practices using simple conversational prompts. Second, by leveraging spatial data, an AI-enabled digital twin can identify root causes of inefficiencies and directly lead to improved standards of operation and training material that address any missing procedural or skills gaps. With these insights, managers can tailor training programs to address specific needs, enhancing the overall skill set of the workforce.

The Plan should include a key topic for workforce demonstrating how digital twins can enhance workforce development efforts to fill the manufacturing talent gap. The Plan should consider how digital twins can be used as an effective training tool for upskilling talent and understanding the operations of the existing workforce to plan for future talent.

Plato's Expertise in Digital Twins for Workforce Development: Plato Systems is an expert in this area, offering proven monitoring and proactive solutions for manufacturing plants. Plato's unique spatial-based solution unlocks an understanding of human-machine interactions that helps companies upskill their operators. Plato has developed training materials for multiple multinational electronics and semiconductors companies based on their spatial digital twin, resulting in an average 20% increase in worker productivity. Additionally, Plato's software provides insights that allow plants to plan future facilities with better layouts for employees that streamline workflows. The system also constructs training materials for future operators, who may lack experience, enabling accelerated on-boarding and training.

International: Digital Twins for International Collaboration and Insights

Southeast Asia has over 50 years of advanced electronics manufacturing experience and is continuing to attract global investment, rapidly extending its integration of automation to meet growing demands. Modern day technology involves complex manufacturing processes made up of specialized tooling and well-trained operators, forcing manufacturers to constantly improve operationally in order to remain competitive.

Digital twins are an effective solution for the enhanced productivity and observability of manufacturing processes onshore and for cases where they do need to be observed overseas. Incorporating machine and spatial data into a digital twin monitoring system, companies can remotely solve for inefficiencies and understand how operations are being conducted overseas. This remote monitoring can help U.S. companies learn from operator’s best practices and plan for replicated, optimized processes in manufacturing facilities on U.S. soil, while developing a playbook of best operating strategies for manufacturers.

The Plan should incorporate methods for integrating digital twins for the remote monitoring and replication of international facilities, to gain insights that will enable the U.S. to improve its manufacturing methods and effectiveness onshore.

Plato’s Expertise in Remote Data Collection: Plato’s solution offers a valuable solution for remotely monitoring factories through the ability to collect, track, and monitor a database of historical and real-time machine and operations data of the factory floors.

About Plato Systems

Plato Systems has developed an AI-Powered spatial intelligence platform to optimize manufacturing processes and productivity. Plato has developed the first ever tagless Spatial Intelligence Platform (SIP) to track spatial activity patterns of operators and machines. Founded in 2019, the team consists of experts from industry and academia with deep expertise in machine perception, multimodal AI and analytics, software reliability, and manufacturing processes.