With the digital representation of real-world entities, predicting machine maintenance issues to avoid downtime, or improving services can now be done easily.

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How Can Digital Twin Technology Benefit Companies and Manufacturers?
In the age of industrial digitalization, we have seen an increase in investment in tools and solutions that allow companies to integrate processes, machines, manpower and physical products into a single integrated network for data collection and data analysis.

While the movement has been around for a while, the rise of Industry 4.0 and the increased adoption of big data have undoubtedly been driving the need for data and data-driven manufacturing strategies. Digital Twin is now one of the top data-driven concepts enabling companies and manufacturers to build cost-effective, high-quality products faster. Research shows the global digital twin market share is predicted to witness a staggering 31.9% CAGR between 2020 and 2030 (forecast period), and the revenue generated in the industry would see a raise from $3.6 billion in 2019 to $73.2 billion by 2030.1

So, What Is Digital Twin?
Digital Twin (DT) is an Internet of Things (IoT) platform which enables you to create virtual representations of the physical world, be it a process, product or service. They capture the physics of structures and changing conditions internally and externally, as measured by a myriad of connected sensors driven by edge computing. The precise virtual replica of the physical object or process provides you with the means of running simulations within the virtualizations to conduct data analysis, test for problems, monitoring of systems and seek improvements through service updates. All of which can help businesses or manufacturers head off issues even before they occur, prevent downtime, create new opportunities or even plan for the future. From planning, design and construction to operations and maintenance, we can now use a Digital Twin to understand the entire manufacturing, factory or business operations.

With the surging investments in the IT sector, economic prosperity, government initiatives promoting the deployment of artificial intelligence (AI) and IoT, and technological advancements in the region, Asia-Pacific (APAC) is expected to grow at the highest pace in the Digital Twin market until 2030.2 As the pace of adoption picks up, many factories are now capable of lights-off production to meet the increasing production demand while saving significant costs with the help of Sophic Automation Digital Twin Solutions.

What is a Lights-off Factory?
A Lights-off Factory sometimes referred to as a dark factory or lights-out factory is one where fully-automated technology is used to run a production factory and the requirements for human activity are minimal. This allows the facility to operate in the dark with zero human intervention on site. Lights-off factories are possible today because of the support of multiple technologies such as machine learning and high-frequency data collection.

The Five Different Levels of Digital Twin
How Does It Work?
A Digital Twin requires three different elements: the physical object, the digital twin as a virtual object and the information that links these two. The physical object is outfitted with various sensors at the vital areas of functionality. These sensors provide various data about the equipment's performance such as product lifecycle management, demand forecasting and more. This data will then be relayed to a processing system and reflected on the Digital Twin. Based on this data, the Digital Twin can simulate future values, predict how a product or process will perform or identify emerging problems, among other things. This enables innovation and improves performance.
TYPES OF DIGITAL TWINS

In general, digital twin software operates at five different levels of sophistication. The simplest stage is where data is integrated from various sources while the most advanced stage is where the Digital Twin is capable of acting autonomously based on the real-time data, which can even drive closed loop control functions.

Level 1: Descriptive Twin
A digital twin starts with knowledge of the physical object. This descriptive twin is a live, editable version of physical object data such as a visual replica of a machine. The extraction of information and data can be specified based on the user's request. At this level, the descriptive twin provides digital twin operators with the capability to understand the object and conduct a variety of analyses on how the object performs under various conditions. For example, a factory manager or digital twin system operator can study the production line processes to identify the length of the asset's lifecycle.

Level 2: Informative Twin
An informative twin is equipped with an additional layer of operational and sensory data. As more data is added, the Digital Twin is more enriched, and will be able to provide basic insights such as parameters or performance at a particular point of time. At this level, the informative twin provides digital twin operators with the capability to collect and examine historical data for improvement of the physical object or process. This allows the operator to gain information on the physical object and carry out adjustments in the virtual world to rectify an issue, which can then be deployed in the physical world.

Level 3: Predictive Twin
Predictive twin leverage operational data to gain insights. The predictive twin is able to provide data analytics in real-time or near real-time. It is also able to learn from similar events to identify patterns and provide early warnings. At this level, the predictive twin provides digital twin operators with the capability to collect data in real-time or near real-time and compare them to the baseline data. This allows operators to avoid costly downtime of machinery or equipment and predict when preventive and predictive maintenance is needed.

Level 4: Comprehensive Twin
The comprehensive twin uses data to run real-time simulations for possible future scenarios and considers “what-if” questions. Running prescriptive analysis allows the twin to leverage on trends and data to recommend the best course of action to take next. At this level, the comprehensive twin provides digital twin operators with the capability to analyze data from the production operation to carry out informed decision-making processes. This allows operators to work faster and efficiently. The comprehensive twin will also suggest enhancements to optimize operations with processes that are more efficient, effective and reliable.

Level 5: Autonomous Twin
This autonomous twin will have the ability to learn and act on behalf of the users. It can make the necessary decisions to correct issues without the need of interference from humans. At this level, the autonomous twin allows digital twin operators to obtain multiple perspectives of the entire process, allowing the digital twin to perform self-optimization processes through autonomous control. It also promotes inter-department collaboration across the factory and enables fast decision making to resolve any issues that may occur within the facility and mitigate risks such as mechanical failure or downtime.

Unique Advantages of Digital Twin in a Factory

MAKING DATA VALUABLE

DATA

PHYSICAL SYSTEM

VIRTUAL MODEL

Planning Design Construction Maintenance Operations

OPTIMIZE

DIGITAL TWIN

Figure 1: Types of Digital Twins

Figure 2: Benefits of Digital Twins
About Sophic Automation
A pure-play technology company that has been a proven automation solution provider to more than 50 MNCs & SMEs in Southeast Asia. Sophic aims to be a global specialist in enabling the concept of SMARTer into Factories and Cities worldwide via our integrated Industrial Internet of Things (IIoT) solutions.

Partnering with Intel, Sophic Automation started to deliver i4.0 design win case study in the rubber glove and semiconductor industry (forefront in IIoT) and later expanded their success story into the IPC Catalyst Program, Lighthouse Factory, and Smart City. Now with digital twin solutions, Sophic Automation is equipping businesses with smart automation solutions that transform smart factories into smarter factories, allowing them to employ lights-out manufacturing techniques. As a result, it has allowed businesses to understand the entire manufacturing processes, factory environment or business operations to help improve overall performance with enhanced risk management by helping minimize uncertainty. Sophic Automation digital twin solutions serve as the base platform for the command center (refer to Figure 3) that integrates and analyses all data gathered across the smart factory, from Manufacturing Execution System (MES), Enterprise Resource Planning (ERP), Material Management System (MMS), Automated Retrieval System (ARS), Warehouse and Surface-Mount Technology (SMT) Lines to enable seamless operation within the factory. The digital twin functions as a real-time collaborative space created for monitoring, organizing, controlling, planning, and decision-making within the different roles of the users in the smart factory. Users are able to design and simulate actual production processes, and the environment of the factory and train the digital twin with the use of multiple source data collected to perform routine tasks by itself without any human intervention. Moreover, the digital twin promotes inter-department collaboration across the factory in tackling and resolving any issues that may occur within the factory. Apart from enhancing the overall collaboration process, the digital twin can support the users in resolving issues associated with the current implementation by providing the ideal recommendations.

**THE DIGITAL TWIN - A COMPLETE COMMAND CENTER PACKAGE**

![Diagram of Digital Twin Command Center](image-url)

**Figure 3. Digital Twin Command Center**
This section explores the unique advantages of Sophic Automation digital twin in a factory and how it can solve issues, prevent downtime and promote innovation.

**Digitization of a Factory**
One of the common issues of poor management of digitization is having various different data source locations for every machine within a factory. This hinders access of information as it is difficult to locate a particular set of data on request. Retrieving data in summary or bulk from unorganised sources takes up time, which can prolong unnecessary downtime. Furthermore, users may find it difficult to visualise the floor layout or dimensions of these machines within the factory itself. Without proper digitalization, user will have to perform site visits to collect measurements and conduct inspections onsite. All these setbacks are costly as production may halt.

How can Sophic Automation Digital Twin Solutions help in digitalization?
- With the digital twin solution, factories are able to centralise their data into one hub. The digital twin connects every production machine in the factory by gathering data from the sensors fitted onto it. This allows the virtual model to receive real-time feedback and store all important data for analysis.
- Manufacturing plants can now use a Digital Twin to design a 3D model of a component, be it a piece of particular machinery or the entire floor plan of the factory in a digital format. This allows the program to use real-world data to create simulations on the 3D virtual model to predict how a process is performed. Moreover, with the virtual 3D simulation of the actual plant which consists of the real-time data of the factory dimension and machine size...
and layout, managers can plan and redesign the factory to further improve or expand the production line. Simulations can be run on the virtual model to identify the amount of machinery and space required for a different production line setup.

- Digital Twin system users are now able to visualise all the parameters via an actionable dashboard or through a website in real-time, instead of manually extracting the production data onto the Excel sheet or PowerPoint presentation, where oftentimes, this data may not be up to date.

- Utilising a Digital Twin allows factories to opt for a paperless system. Not only does it eliminate manual process of data collection and the usage of paper, but a Digital Twin is able to link every data to the operating system through the sensors fitted on the machines. Traditionally, when a machine requires maintenance, the technician will have to perform the maintenance on the machine. All the maintenance performed are recorded on paper and signed by their supervisor for validation. With the help of Digital Twin, the system will notify the Digital Twin system operator through a mobile app. Once the maintenance is done, the sensor automatically captures the data and updates accordingly. A new checklist will be sent to the supervisor prompting for a review and digital signature to verify the completion of the task. This significantly shortens the entire process flow and increases the efficiency.

- Through the digitization of the factory with digital twin, businesses see a return on investment (ROI) such as a 30% improvement in production Overall Labor Efficiency (OLE) to manage over 800 machines and about 15% - 20% improvement in Overall Equipment Efficiency (OEE) across all machines. A paperless and digital SOP system eliminating human error in manual data record process into the paperwork or checklist as well as recompilation of data into Excel has reduced the time for system users to generate reports which brought about a 15% improvement in OLE:

1 Intel does not control or audit third-party data. You should consult DimKuan (DK) from Sophic Automation to evaluate accuracy. Results have been estimated or simulated.

- Advanced digital twin functions can include factory-wide policy management, orchestration, and connectivity.

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**Digital Thread**

1. Collect data
2. Analyze data
3. Run simulations, make predictions
4. Visualize insights decisions
5. Make data-driven decisions
6. Optimize production

Real production

Digital twin

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**Figure 4 : How Does Digital Twin Technology Work**

**Virtual Operating System/Virtual Operation Manager**

Without the adoption of Digital Twin, production lines in a factory can face unnecessary prolonged downtime. Traditionally, when a machine is faulty, technicians are required to perform onsite inspections and occasionally may have to invite the technical support team from the machine vendor to be onsite for inspection. This not only extends the waiting time for data collection but also results in a slower response time when an error occurs within the factory.

**How does Sophic Automation Digital Twin Solutions solve this problem?**

- For instance, with IoT sensors and AI-powered analytics ability, Digital Twin is able to act as a virtual operation manager. As all the data captured from the machines are aggregated back to the server for processing, the Digital Twin works in sync with a smart engine (Robotic Process Automation/AI) that is running on the server to help manage the operations of the production line. Once production starts, the Digital Twin is able to mimic processes or machines within the factory, and simulate nearly every aspect of the operations without needing access to the physical machine.

- The factory manager or Digital Twin system operators are able to streamline and scale decision-making processes across the production line, learn about operations and experiment with changes. With the application of Sophic Automation Digital Twin solution, machines are now able to perform recurring and standard procedural tasks without any human intervention.

- For instance, if an alarm was triggered by a machine, traditionally it can only be reset by pressing the reconnect button. This course of action requires the operator to physically access the button displayed on the screen affixed on the machine to restart the machine. But with the help of a smart engine, the AI-based SW stack is not only able to recognize the alarm, but it will also carry out the resetting procedure remotely by sending out reconnecting signals to the machine through industry protocol. All these steps ensue without human intervention. In addition, the smart engine supports end-to-end automation processes. For example, a protocol to resolve a triggered alarm might involve multiple steps to achieve it. The smart engine will learn the steps in a sequence that was traditionally done by the operator using a mouse to hover over and click on specific buttons on the screen. When the same alarm is triggered in the future, it will be able to mimic the exact problem-solving technique and stimulate the same course of action previously done by a human.

**Preventive and Predictive Maintenance**

In a manufacturing factory, the tendency of experiencing long downtime is high. This is due to the lack of updated data for operators to keep track of when it comes to machinery maintenance. It is common for technicians to perform maintenance only when an error occurs or the machine is down. The financial implications of a long downtime can be significant as the factory faces a loss of production capacity.

**How does Sophic Automation Digital Twin Solutions solve downtime issues?**

- By mimicking the physical assets, frameworks or operations, Sophic Automation Digital Twin enabled factories to anticipate downtime in advance and react to variables that change circumstances fast. With the constant transmission of data, Digital Twin system operators can easily access, inspect and evaluate the performance across the plant life cycle captured by the Digital Twin.

- A Digital Twin equips system operators with enhanced visibility across the factory. This helps to facilitate preventive and predictive maintenance within the plant.
Preventive maintenance involves setting the machinery maintenance schedule based on data collected throughout the operations. It will study the production line processes, and identify the length of the asset's lifecycle before the next scheduled maintenance. The system proactively identifies any possible shortcomings that can impact the machinery’s continuity, and triggers an alarm for the technician to conduct maintenance well in advance of its usual maintenance schedule. This solution enables factories to reduce the downtime for maintenance as the failures were identified by the system beforehand.

- Predictive maintenance on the other hand allows the Digital Twin to forecast potential faults or failures by running predictive diagnostics on the virtual copy. This is an upgrade of preventive maintenance, whereby the system learns and understands the pattern curve of the maintenance period of a machine and its production life cycle, and utilises various parameters of the machine in real-time to calculate the ideal maintenance schedule well ahead to prevent performance loss, thus reducing unplanned downtime. For example, the system discovered a recent drop in speed in a machine of a production line which was due to the lifespan of the mechanical movement of the conveyor system. With this information, the system sends an alert to the engineer to inform that if continued operations are allowed, the speed and performance will see a further drop compared to the target value. It will then prompt technicians to conduct maintenance in order to maintain the machine's alignment with production performance.

Intelligent Digital Command Center
One challenge many current factories face is a lack of proper system integration, whereby factories end up having multiple systems with different paths or URLs. The absence of an effective system hinders the access of these data as it cannot effectively handle multiple paths without disruptions. Digital Twin system operators may find it difficult to hover over large data on multiple monitors with a mouse, as navigation across various monitors will result in mouse latency and possible errors in detection.

How does Sophic Automation Digital Twin Solutions provide the solution?
- A digital twin system enables a video wall system in the control room to be represented by a single server PC to project the virtual model of a production environment straight to the workspace where users can visualise production floor and understand important information with ease on a single platform.
- Another digital twin advantage is the implementation of smart actions with gesture and voice commands. Users are able to remotely control the machines within the factory or perform switching, selection and browsing of operations on a specific machine selected. Profiling a machine can be done with just a voice command, and when requested, any information of the selected machine will automatically be populated and shown on screen. Moreover, with voice command, users will be able to control the PC remotely such as increasing speakers volume, generating reports of the machines in a production line, etc.
- Sophic Automation Digital Twin solution serves as the base platform for the command center (refer to Figure 4) that integrates and analyses all data gathered across the smart factory, from Manufacturing Execution System (MES), Enterprise Resource Planning (ERP), Material Management System (MMS), Automated Retrieval System (ARS), Warehouse and Surface-Mount Technology (SMT) Line to enable seamless operation within the factory. The Digital Twin functions as a real-time collaborative space created for monitoring, organising, controlling, planning, and decision-making within the different roles of the users in the smart factory. Users are able to design and simulate actual production processes, the environment of the factory and train the digital twin with the use of multiple source data collected to perform routine tasks by itself without any human intervention. Moreover, the Digital Twin promotes inter-department collaboration across the factory in tackling and resolving any issues that may occur within the factory. Apart from enhancing the overall collaboration process, the Digital Twin can support the users in resolving issues associated with the current implementation by providing the ideal recommendations.

Seamless Remote Operation
In a factory, the frequency of an error occurrence in a machine is relatively fast. Sometimes, these errors can occur across multiple machines at the same time, with the numbers reaching 100 - 200 machines. Under these circumstances, the Digital Twin system operator on duty will not be able to attend to all the errors at the same time to carry out the necessary corrective measures.

How does Sophic Automation Digital Twin Solutions benefit the manufacturing plant?
- One of the key benefits of Digital Twin features is enabling end-to-end automation which aids in the digital transformation of a factory. By utilising the linked digital twins, users are able to access any machinery's screen remotely. The system coupled with IoT uses smart technology to divide the request of video signal on a selected machine from the server and aggregate back to the physical monitor affixed on the machine and the video receiver to the command center room respectively.
- This gathers Digital Twin information for the Digital Twin system operators faster, so that they can determine the capabilities of these machines, run prognostics and test operating parameters to effectively and efficiently deploy proactive countermeasures to resolve the issue on the targeted machines at the same time.

Sophic Automation Server Monitoring Tool
Using the watchdog monitoring system developed by Sophic Automation, it helps businesses to monitor all servers' status, health, storage and applications. As every sensor data captured from the machines within a factory are aggregated back to the server for processing, periodic monitoring is important. Once the Digital Twin captures the data and sends the information to the server, the control room dashboard will be able to depict the real-time results from the server. Besides that, users are also able to view and access this information in real-time via mobile devices. Hence, maintaining and monitoring the health status of the server is extremely crucial to provide a seamless end-to-end automation.

How Does Intel Empower Digital Twin?
Creating a Digital Twin requires specialised software tools and a high-performance processor to develop the virtual model, run simulation, optimisation and visualisation of the physical object. With Intel's cutting edge technology, Sophic Automation is able to provide a seamless Digital Twin solution, built for connectivity that empowers factories today.
High-performance Intel hardware found in Sophic Automation Digital Twin solution:
**Intel® Xeon® Scalable Processors**
A balanced architecture that delivers built-in AI acceleration and advanced security capabilities, which allow you to place your workloads more securely where they aim to perform best-from edge to cloud. It is used in the Server PC to host web applications, database systems and perform heavy workload processing tasks like ETL, algorithm logic, etc.

**Intel® Core™ i7 Processors**
These processors power high-end industrial PCs (IPCs) with an industry-leading CPU performance for discrete-level graphics, and AI acceleration. With Intel® Core™ i7 Processors, operators are able to host system applications like control room dashboard, website management, digital twin system and more.

**Intel® Celeron® Processors**
Intel® Celeron® helps users collaborate, create and learn with great security and connectivity options for a more protected work environment. Used in Embedded PC, the Intel® Celeron® enables the PC to host small window applications and middleware to send commands to the machines.

Where is Digital Twin used?
In recent years, with the increasing adoption of IoT, the world has seen Digital Twin used across a variety of industries for various range of applications and purposes. See examples below:

- **Manufacturing**
  Digital twin improves manufacturing productivity, streamline processes and reduces throughput times, which can ultimately improve yield.

- **Automotive**
  Digital Twin gathers and analyses operational data from a vehicle to assess conditions in real-time to enable product improvement.

- **Healthcare**
  Digital Twin allows hospitals to identify potential infections and track possible points of contact to help reduce the chances of high rate spreading.

- **Disaster Management**
  Digital Twin helps cities combat climate change impacts by generating emergency responses in advance through climate change monitoring and data collected from smart infrastructures.

- **Smart Cities**
  Digital Twin helps cities to be more economically, environmentally and socially sustainable through guidance in decision planning and solutions offerings based on challenges faced by smart cities.

Time to Adopt Digital Twin Technology
When it comes to manufacturing operations and production line performance in the Industry 4.0 era, digital twin can be an innovative solution and the backbone of the industry's future. Creating one allows virtual representations of any real-world object, process or product that continuously evolves with the flow of data, new information input and user experience and feedback. Given the accelerated pace of technological change these days, simulations conducted on the digital twin allows Digital Twin system operators to evaluate assets' health, identify equipment reliability, run tests on machinery or reconfigure processes to improve efficiency faster. This has greatly impacted the manufacturing processes to the point where digital twin can remotely deploy and prescribe actions in the physical world, in real-time to mitigate issues like machinery or plant downtime or process bottlenecks at production lines.

Today, Intel and Sophic Automation are driving the future of Industry 4.0 in the South East Asia region, equipping businesses with smart automation solutions that allow factories to employ lights-out manufacturing techniques. With the deployment of digital twin, factory operations can now be reliably predicted in a shorter amount of time and sudden disruptions will become a thing of the past. A digital twin breaks the traditional paradigms of manufacturing and has opened up endless possibilities.

That is why digital twin is critical in realising massive business improvements and disruptive innovations today. For more information, contact your Intel sales representative.

Learn More
- To know more about digital twin: https://sophicautomation.com/solutions/

References and Resources:
   https://www.researchandmarkets.com/reports/5128896/digital-twin-market-research-report-by-type
3. Smart Innovators: Digital Twins For Industrial Facilities Report

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