Whitepaper

Simio Intelligent Adaptive Process Digital Twins

Deployment & Application Workstreams

Simio

Forward Thinking

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1. Introduction

Industry 3.0 was responsible for the computerization and automation of the manufacturing industry, resulting in extensive transactional and execution level data being created, stored, and analyzed to fine tune and improve the system performance, creating a Digital Shadow of the factory (digital snapshot). As part of this Industry 3.0 transformation, data analytics was applied to discover and communicate meaningful patterns and trends. While applying data analytics of historical information is useful, it is tedious and attempts to help companies make decisions about the future by looking in the rearview mirror.

In today's world, companies need to be highly agile to endure a constantly changing and increasingly uncertain business environment – while also dealing with a fast-growing combination of products, services, materials, technologies, machines, and people skills. A successful manufacturing supply chain requires the orchestration, coordination, and synchronization of each of these elements operating independently and cohesively together. As Industry 4.0 unfolds, computers are connected and communicate with the aim to ultimately make decisions and run operations with minimal human involvement, but companies are struggling to manage these multi-faceted and complex digital transformation projects. Below are some of the key challenges stakeholders and transformation projects face in their journey to a highly agile and "smart" (low touch/no touch) manufacturing supply chain:

- **Understanding the current processes and constraints**
  Although people have been working in factories and supply chains for over a century, it is still difficult to fully understand and articulate all the processes in detail since much of the information is compartmentalized between departments or different organizational structures within the company. Understanding starts by identifying all the physical constraints in the process of sourcing material, as well as producing and distributing products to customers. There are also many different documents describing the business rules that govern the process, often contradicting current reality. In most organizations, a large amount of the execution know-how and detailed decision logic is still tribal knowledge and hard to replicate in any system, as it is contained in the minds of people making these day-to-day decisions on the shop floor.

- **Identifying the best data sources and aggregating accurate and relevant data**
  Understanding the current quality and correlation of data between the various enterprise systems is a significant challenge, given that values for identical fields frequently vary

across different systems, making it difficult to ascertain accuracy. The level of detail and recording frequency between systems is different based on the system application, making correlation and aggregation of data even more complex. Synchronizing different data sources to ensure they are all time relevant (same timestamp) is a challenge as some systems are running close to real-time while others are batch-oriented running only once per day. Identifying the sources and flow of data to establish a relevant data pipeline to support process modeling, control, dashboarding and analysis is key to the transformation process.

- **Identifying and exploring areas for transformation and modernization**
  It is difficult to accurately identify and determine the value that certain process changes and optimization can deliver to increase performance in the factory or supply chain. Certain performance or value gains are often overstated, resulting in large capital investments in capacity and extensions to physical infrastructure for future growth and new products without a detailed understanding of the requirements and potential impact on the business. Automation and digitalization initiatives to improve efficiency and performance are also challenging. These projects are often developed in isolation, thereby missing the mark: underdelivering the overall expected value and anticipated process transformation required to advance the business towards reaching its digital transformation goals.

- **Accurately predicting future behavior and performance**
  Transformation usually involves many concurrent aspects of a business, including but not limited to personnel, processes, equipment, new products, sales, global reach and distribution. Without understanding the end-to-end impact of proposed changes on business operations, there is a risk of falling short of expectations, potentially wasting money on investments that do not deliver the expected value. This includes understanding the impact of automation (robotics, AMRs, material handling, etc.), evaluating alternatives to understand the ROI of various options, and visualizing and presenting future results to all stakeholders for buy-in and decision-making.

Based on years of simulation and analysis experience, it is clear that the most effective way to enable and facilitate digital transformation and address the challenges discussed above is by creating and using a detailed simulation-based virtual model or offline Process Digital Twin of the process (i.e., factory and/or supply chain). This model can be used for design and analysis of the current and future processes as a predictive solution. The virtual model can also then be connected to real-time data of the enterprise systems to become the online Process Digital Twin for operational deployment and near-real-time decision making as a prescriptive solution. The underlying technology is described in more detail in the *Simio Simulation Solution Whitepaper,* also available on the Simio website.

This whitepaper describes the Simio Intelligent Adaptive Process Digital Twin solution and the various digital transformation workstreams that can be supported by using this technology. During the lifecycle of a digital and business transformation project, different requirements emerge during the various phases of the project. A single integrated Process Digital Twin of the business can facilitate the continuous evaluation of both current and future performance. Additionally, the Process Digital Twin model can also be deployed on the cloud, providing operational decision support as well as scheduling and orchestration of the ongoing operations.

2. The Simio Intelligent Adaptive Process Digital Twin

Simio is an agile platform for developing Intelligent Adaptive Process Digital Twins which can be deployed offline and/or online for both predictive and prescriptive applications to facilitate comprehensive digital transformation and process re-engineering initiatives. In recent years, the term “Digital Twin” has become popular in describing the use of a simulation model that is connected to real time data and employed in an operational setting for both design and analysis, as well as planning, scheduling, and orchestrating operations in near-real-time. The key components of the Simio Intelligent Adaptive Process Digital Twin are described in Figure 1 below.

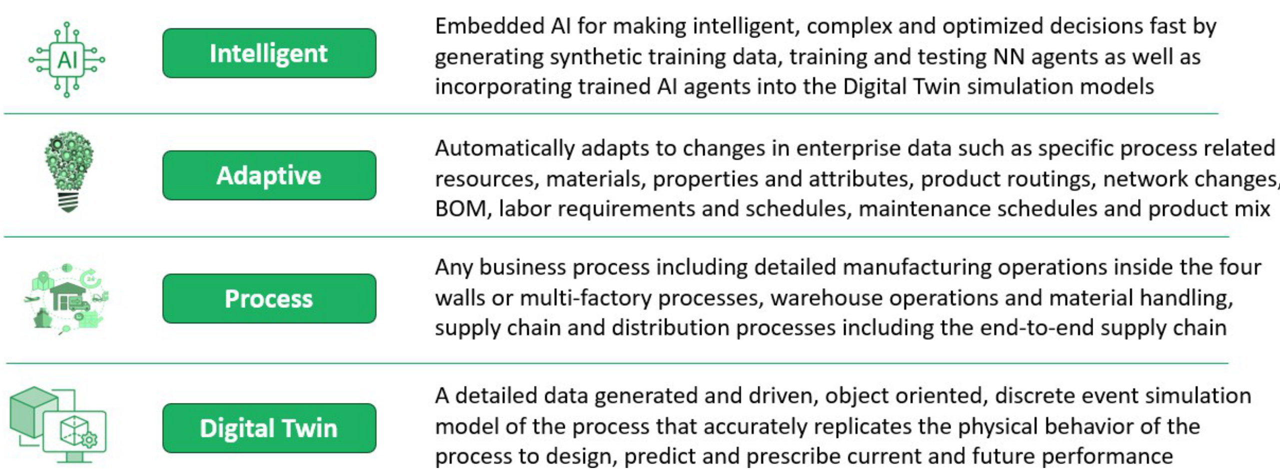


Figure 1: The Simio Intelligent Adaptive Process Digital Twin

The Simio Intelligent Adaptive Process Digital Twin is an object-oriented, data driven, 3D animated model of the process (factory and/or supply chain) that is connected to data, both offline and online, from the ERP, MES, and related data sources. The Process Digital Twin is fully generated and driven by enterprise data, allowing it to adapt to changes in the environment such as new equipment, additional labor and skill requirements, new parts/SKUs, etc.

For the Process Digital Twin to replicate the true behavior of the physical process, the underlying model logic must include the following:

- A detailed constraint model of the process including all the equipment, labor, tooling, transportation, material, etc. as well as the equipment and material characteristics driving the operational decisions.
- The business rules that regulate the operations, such as inventory policies, labor policies, operating and procedures, and transportation restrictions.
- The detailed day to day decision logic as applied by the planners, operators, and supervisors running and managing the process day to day.

The Proces Digital Twin simulates into the future, offering predictive and prescriptive analyses of the system and providing a forward-looking view of the expected performance of the process. From there, the Process Digital Twin generates detailed, feasible operational level results, including schedules showing the relevant resource task lists and associated material requirements at each point in the process.

The Simio Digital Twin is fully transparent in its decision making and optimization methodology (Glass Box approach) versus other optimization algorithms and pure AI engines that typically generate non-transparent results (Black Box approach). This allows the business to understand and adjust the constraints, rules, and decision logic to find better ways of running the process and enable a continuous learning and improvement process.

As part of the overall digital transformation process, the Process Digital Twin provides a systematic way to improve and standardize the data contained in the different enterprise systems (ERP, MES, Excel, etc.). Often, the data in the various systems consists of varying levels of detail or inconsistent values for the same fields. Figure 2 below shows a high level view of the Process Digital Twin concept.

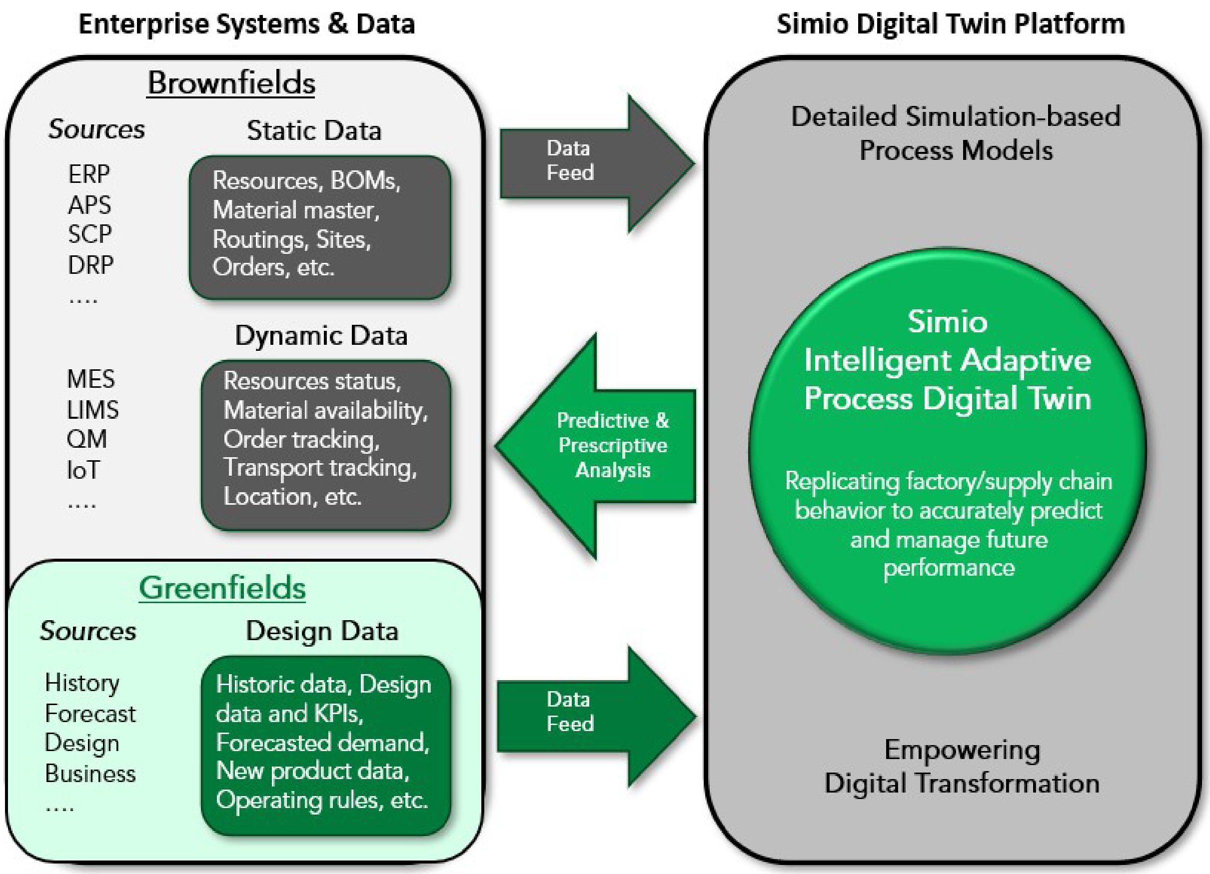


Figure 2: High-level Data Flow

2.1 Why Develop a Process Digital Twin

As part of the digital transformation process, the agile Simio Intelligent Adaptive Process Digital Twin platform supports multiple workstreams as part of the identification, design, analysis, and running of the operations, which are all necessary to develop a complete Process Digital Twin of the current and/or future process. These workstreams and Simio's support of each of them will be discussed in more detail in Section 3 of this whitepaper. Four of the primary reasons for using the Simio Process Digital Twin technology platform for both the design/analysis phase as well as the operational level planning /scheduling phase are as follows:

Knowledge Base

Developing a Process Digital Twin provides an accurate and dynamic way to capture the existing operational or business processes. This includes all physical constraints, business rules and detailed decision logic within a 3D simulation-based model to serve as both a knowledge base and reference model for the current or planned future state of operations. This Process Digital Twin development process enables stakeholders and subject matter experts to verify and validate that the processes have been captured and replicated accurately for future reference. This will instill confidence for the model to be utilized for design- or process-improvement type initiatives – including complete digital transformation.

Performance Benchmark

Developing a Process Digital Twin of the operations or business processes is the most accurate way to create a detailed performance benchmark for understanding current performance and accurately predicting future performance of a process. This benchmark model can then be used to validate and measure the benefit/value of any proposed changes in a transformation project, such as increased automation, new equipment, product introductions, changes to replenishment policies such as DDMRP, or new labor policies. The Process Digital Twin will help to identify, evaluate, and quantify all transformation initiatives to ensure that the projected ROI is achieved.

Feasible Predictions and Execution Plans

Since the Process Digital Twin accurately replicates the operational or business process behavior, it generates accurate simulation results predicting current or future performance. This allows for informed decision-making when selecting between competing transformation or business reengineering initiatives/proposals. In an operational mode, the Process Digital Twin will also create feasible plans and schedules for shopfloor, warehouse, factory, and supply chain execution for all the relevant time ranges by ensuring that all operations are resource capacity, material, and timeline feasible to enable fully autonomous/low touch execution. These are all key steps in enabling the “Smart” factory/process of the future.

Business Reference Model

As the business progresses with digital transformation projects and beyond, maintaining an adaptive, data-generated and data-driven Process Digital Twin helps the business maintain a “current status” reference model of the operations or business process. This model is then available to evaluate the impact on future system performance and weigh investment decisions for ongoing transformation or process improvement projects. The reference model also serves as a platform for training and testing AI agents to improve the speed and quality of the decision making and process optimization initiatives. The Process Digital Twin reference model can also be used to generate synthetic training data for the external training of AI agents to be used within the process. If the Digital Twin is connected to the relevant enterprise data, it will remain current and provide accurate results for current as well as future operations than can be used for both predictive and prescriptive applications.

3. Application Workstreams

In the rapidly changing landscape of today's world, the reality is that we are living in a state of VUCA. VUCA stands for volatile, uncertain, complex, and ambiguous. Most would agree that VUCA is not desirable, and it is also not something many companies had planned for – especially related to the design and operation of their supply chains. Companies that rely on complex supply chains to control the flow of products from raw material supply through manufacturing through distribution to customers are experiencing severe VUCA effects upon the operational efficiency and effectiveness of their supply chains. VUCA is a concept highlighted by Carol Ptak and Chad Smith in their book "Adaptive Sales and Operations Planning" where this concept is described in more detail.

Now more than ever, organizations must deal with a large and often distracting combination of products, customizations, services, materials, technologies, machines, and people skills. A successful factory, warehouse or supply chain requires the orchestration, coordination, and synchronization of each of these elements operating independently and cohesively together. Selecting the right business and digital transformation strategy for success is always complex, and the challenges of VUCA exacerbate this difficulty. How should corporations identify the right strategy to use in the design of complex supply chains and the required process changes and digital transformation strategies required to enable and sustain the next era of business?

There is no singular or simple approach to address this challenge and the scale and complexity of transformation is different for each organization. It requires a methodical process of analysis, design, and transformation on many different levels along a continuously progressing timeline (Simio refers to this timeline as the digital continuum), to successfully transform the business to not only deal with the current challenges as described above, but also manage the ongoing changes in a sustainable way to ensure longer term success.

A key emerging technology enabler of this transformation process is the development platform that allows organizations to construct complete Process Digital Twins of the business or a specific focus area of their business. Digital Twins are becoming a more widely used technology in manufacturing, warehousing, and supply chain applications. As the name implies, Process Digital Twins mirror real-life complex business operations and processes with powerful built-in functionality to manage orchestration, coordination, and synchronization with a very high degree of accuracy and precision. Process Digital Twin technology is ideally suited for facilitating and supporting business and digital transformation initiatives.

Simio is a pioneer in the development of Discrete Event Simulation technology. At Simio, we have leveraged our Discrete Event Simulation expertise to create an agile platform for developing Intelligent Adaptive Process Digital Twins that can be used to facilitate these comprehensive digital transformation and process re-engineering initiatives. These transformation projects can be performed at various levels of detail and areas of focus. Each of these focus areas can be conducted within a specific application workstream within the project to analyze, design, and implement specific initiatives contributing to the overall transformation goals of the project.

The Simio agile Intelligent Adaptive Process Digital Twin development platform is a versatile technology with a broad range of applications. Some application workstream examples include:

- Simulation and analysis
- Process design and optimization
- Planning and scheduling
- Shopfloor orchestration
- Design-to-operate process management

Four primary application workstreams will be discussed in more detail and illustrated in Figure 3 below. Each of these workstreams, depending on the overall requirements, can be conducted individually or concurrently as part of the overall process of creating an Intelligent Adaptive Process Digital Twin in support of the transformation project. The different design and analysis type initiatives may result in the evaluation and design of specific focused process improvement initiatives, not necessarily resulting in a complete Process Digital Twin.

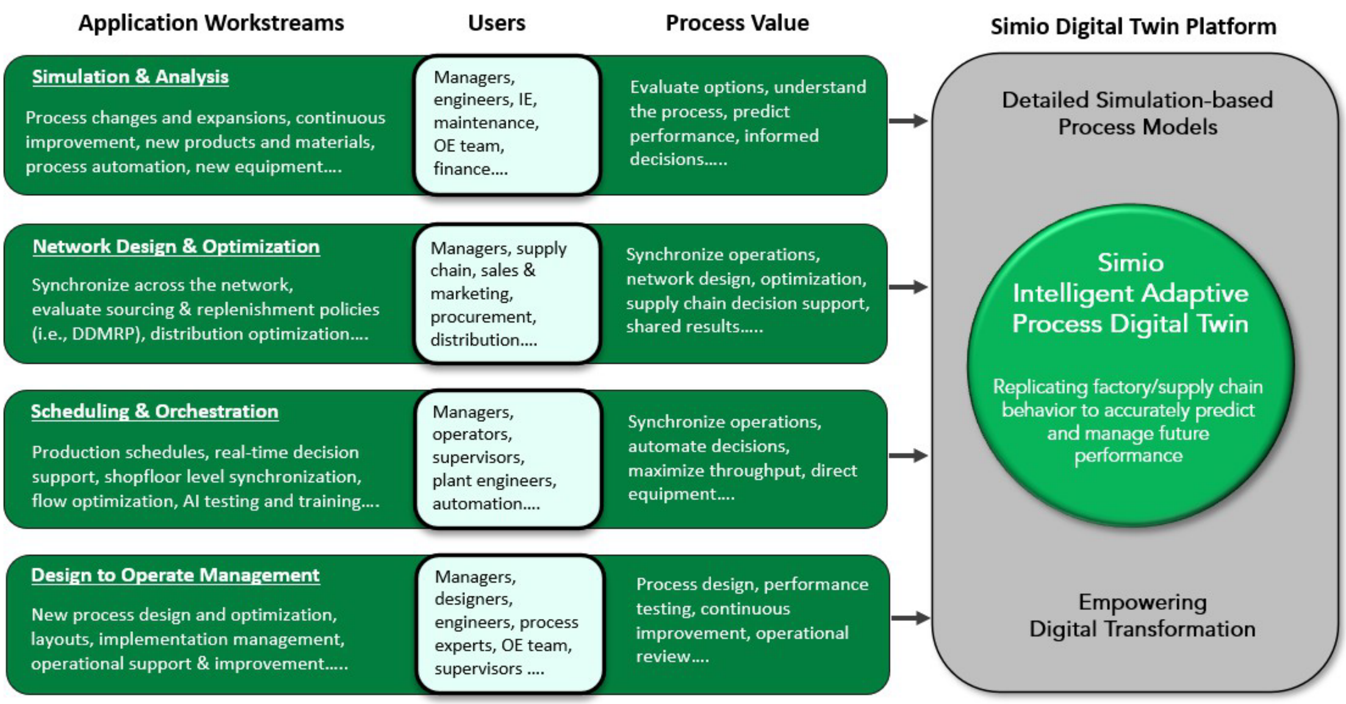


Figure 3: Typical Application Workstreams

3.1 Simulation and Analysis

Many business and digital transformation projects begin by identifying and evaluating potential improvement opportunities such as the addition of new equipment, automation of certain parts of the manufacturing and/or distribution process and new product introductions. Simulation has long been known as the premier tool to capture and understand any existing or new process (i.e., part of or the full factory). Simulation models are used to evaluate the impact of proposed changes to ensure that goals are met, and capital expenditures maximized by achieving the projected ROI targets set for these change initiatives.

Project teams can evaluate simultaneous initiatives in parallel workstreams where one team can look at adding new manufacturing equipment in the factory while another team can review the value of adding automation to the warehouse. Mapping and modeling each part of the process allows the transformation team to develop detailed models or objects of each section/department of the overall Process Digital Twin. This process also enables teams to understand the existing data sources and access the data quality. This supports not only the initial offline analysis but also aids in the development of the data pipeline in support of an online Process Digital Twin of the factory or warehouse. The operational deployment occurs once all the factory or associated business components have been modeled and are included in a single Process Digital Twin.

Using the Simio data-generated and data-driven approach ensures that each sub-model becomes a building block or object in the larger end-to-end model of the factory, warehouse, or the whole supply chain. Process mapping and modeling work done during the transformation project will contribute to the same end goal when teams follow the same modeling protocol and use the same model/data templates. This approach can also be used to develop a company-specific set of objects and business-specific templates that enable project teams to rapidly replicate the development process across other facilities within the organization. This Process Digital Twin then becomes the reference model of the current state and can be used to evaluate any future business changes.

Businesses considering deploying AI to enhance decision making and optimization results benefit from the speed and self-learning advantages offered by this technology. A key requirement of using AI agents is the need to train them using the appropriate accurately-labeled training data in order to ensure valid and feasible behavior of the agents. A Process Digital Twin is the single most accurate mechanism for creating this labeled training data and accommodating all future changes to retrain AI agents as changes occur in the environment. Examples of changes include additional resource constraints, new equipment, new product introductions, new replenishment policies such as DDMRP, new labor requirements or inventory policies. AI agents can also be embedded directly into the Process Digital Twin model to enhance decision making and optimization capabilities of the model.

3.2 Network Design and Optimization

Based on business priorities, some transformation projects may start by modeling and optimizing the distribution network and flow of material to their customers before starting detailed modeling of the factories and warehouses. It is also possible to have teams work at a factory and network level at the same time, building out the full set of objects and data templates for the overall business as they move forward modeling and analyzing the complete end-to-end process.

The network model can start by using simple planned production rates as input data. To improve overall supply chain integration, more accurate production data may be available once detailed factory or warehouse models are available. These models can be run over any time horizon, ensuring synchronization not only across all the business processes but also across all the business planning and execution timelines to avoid any disconnects between the long-, medium- and short-term planning horizons.

This simulation-based, technology-driven approach enables the business transformation process to be conducted simultaneously at both the network planning and optimization levels as well as at the detailed site level (i.e., factory or warehouse). From here, the models can then be combined to become a complete Process Digital Twin of the end-to-end business process. The Process Digital Twin is now ready to be used as a platform to project future performance and used both as a predictive engine to support operational decision making, or as a prescriptive engine to generate the actual production schedules, resource task lists and detailed material requirements at any level in the process.

3.3 Scheduling and Orchestration

While part of the transformation team may be focused on specific improvement initiatives, another part of the team could be focused on production or supply chain planning, scheduling, and even near-real-time orchestration. The ability to operate with this parallel approach will depend on the digital maturity and level of automation currently implemented at each respective business unit or site. One possible way to operate the Process Digital Twin is by running the simulation into the future to provide predictive and prescriptive analysis, offering a comprehensive forward-looking view of the expected production and delivery performance of the factory or supply chain. This allows the Process Digital Twin to generate detailed, feasible operational schedules including all the relevant resource task lists and associated material requirements at each point in the manufacturing or distribution process. The Process Digital Twin can also perform a risk assessment of defined targets, such as delivery dates and cost, to highlight the associated risk for all the orders in the system due to variability and random events. This enables planners to act proactively to avoid or minimize customer service issues.

As mentioned previously, a Simio Process Digital Twin is fully transparent in its decision making and optimization methodology (Glass Box approach) versus existing optimization algorithms and pure AI engines which typically generate non-transparent results (Black Box approach). This allows planners to understand and adjust the constraints, rules, and decision logic for finding better ways to operate the factory and enables a continuous learning and process improvement process that is synchronized with the overall transformation team goals.

As part of the overall digital transformation of the business, the Process Digital Twin also provides a systematic way to identify, improve and standardize the production data contained in the different enterprise systems (ERP, MES, Excel, etc.). It is often found that the data in the various systems consists of varying levels of detail or inconsistent data for the same fields. The true accuracy of the results generated by the Process Digital Twin is tested when detailed task lists and material requirements are produced and presented to the shop floor for execution, highlighting potential errors in the data and/or decision logic.

The Process Digital Twin also provides a mechanism to harmonize personnel and processes by evaluating all the best practices deployed within each facility or across similar facilities in the same network. Planners often follow different processes at different facilities based on their prior experience or level of success performing their daily routine in a certain way. This allows the business to select the best practices and methods for implementation and training across all similar facilities, creating a baseline for training, resource mobility, and potential automation.

3.4 Design to Operate Management

Within a given network, organizations may also decide to build new facilities such as factories or warehouses to extend or grow the capacity of the network. The project team can leverage existing data templates from similar facilities in the network to develop a detailed model of the new site. This allows for optimizing equipment layout and labor planning, ensuring that expected performance KPIs are met before construction begins.

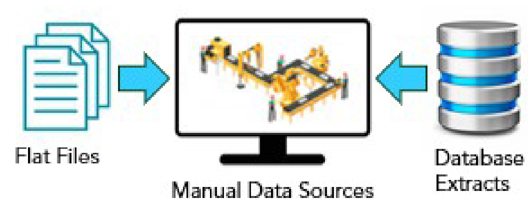
The Process Digital Twin's data schema can become the template for the development of the naming conventions and fields within the supporting execution and transaction systems. As these systems are implemented, the Process Digital Twin can be connected to the development instances to start testing system performance by replicating actual factory/warehouse operations. Any nuances or performance issues can be identified and corrected before construction of the actual facility has been completed. Automation equipment simulators can also be connected to the Process Digital Twin for even more accurate and detailed replication and analysis of the process before go-live to help mitigate any last-minute concerns.

The connected Process Digital Twin, along with the supporting execution and transaction systems in simulation mode, can also be utilized to train new personnel on system and process behavior before they set foot on-site. This approach provides additional stress testing of all processes and systems, further reducing go-live risk. The Process Digital Twin facilitates the entire lifecycle from design and testing to training and eventual operation by generating detailed production schedules and orchestrating near-real-time shop floor activities.

4. Typical Deployment Phases

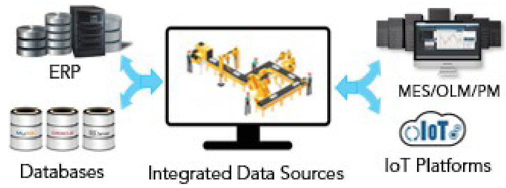
Depending on the process and digital maturity of the organization, the Process Digital Twin can be deployed in various steps of progression based on the use cases and overall business goals and transformation requirements. Each deployment step may include the work of one or multiple workstreams as described in section 3 above. The steps below are illustrative to show what the deployment phasing can be, given the scope of the business requirements and actual digital maturity of the organization. Each of these steps can deliver value as part of the overall transformation journey. The example below is focused on a manufacturing process.

Step 1: Offline Process Digital Twin



A typical process will start with a simulation and analysis of the factory processes to better understand the current constraints and identify improvement opportunities. The simulation model facilitates the evaluation of any proposed process improvement, modernization, or automation initiatives. This allows for unlimited what-if analysis and experimentation to evaluate and determine the best course of action. The model can be generated and driven by offline data, including current, past, and future (predicted/forecasted) data, for validating, evaluating, and comparing results. This process not only facilitates the capturing of all process details and decision logic but also enables the digital replication (i.e., Process Digital Twin) of the actual process to be used as a benchmark for evaluation and decision making.

Step 2: Online Process Digital Twin (Integrated)



Once a complete and fully validated simulation model of the factory has been created, it can be connected to the relevant data sources and used to support day-to-day operations. This process also supports the identification of the valid/best data sources, storage, and transfer mechanisms (data pipeline) to be used to generate and drive the Process Digital Twin. The Process Digital Twin also becomes a magnifying glass to highlight the inconsistency and inaccuracies in data, both in and between systems. It will support the enterprise data cleanup and standardization efforts required as part of any digital transformation or "Smart Factory" initiative. The Process Digital Twin is considered online once it is connected to the enterprise data. At this stage, the Process Digital Twin can be used to facilitate the planning process and create constraint-based feasible schedules for production, facilitating an integrated planning process across all timelines.

Step 3: Operational Process Digital Twin

After connecting the Process Digital Twin to real-time enterprise data (Step 2) and allowing all stakeholders to validate the results and schedules in an operational setting, the Process Digital Twin can then be deployed on a private or public cloud for global availability. This allows access to all stakeholders in the process to perform what-if analysis for predictive applications for evaluating day-to-day improvement opportunities as part of the decision process. It also supports all the prescriptive activities, such as creating detailed production schedules for the factory, including all resource (primary and secondary) tasks and material requirements at every step in the process. These results are visualized through interactive dashboards and Gantt charts within a web interface for all stakeholders to access using laptops, tablets, and smart phones. The Process Digital Twin can also provide visibility on selected dashboards and reports to third-party services or material providers external to the organization to help synchronize global operations on all levels.

Step 4: Orchestration Process Digital Twin

The Process Digital Twin can be used for shopfloor orchestration and execution management as the digital transformation progresses towards a "Smart Factory" operation. This sophisticated level of automation might include robotics for production, AGVs or AMRs for product transport between locations, smart glass-assisted operators, and more. At this stage of the deployment process, the Process Digital Twin should now be integrated to all the relevant static and dynamic operational systems for demand, current status and progress updates for near real-time scheduling and orchestration of the factory floor to enable fully autonomous execution. The Process Digital Twin will auto-adapt based on changes in the real-time data feeds to always remain current in its execution decisions. The same Process Digital Twin can also be used in a predictive mode for event planning and what-if analysis for decision support.

Every corporation's environment will be different, and the deployment steps will be dictated by their transformation goals, specific requirements, and timelines. The Simio Intelligent Adaptive Process Digital Twin platform provides full support for all steps regardless of the process, scope and timeline of the modernization or digital transformation process.

5. Business Value of the Simio Process Digital Twin

The Simio Intelligent Adaptive Process Digital Twin provides value to all stakeholders during the different phases of the digital transformation process including the final operational deployment. It addresses questions both in the design and investment phase of the transformation and business re-engineering process as well as for operational day-to-day management of the active ongoing process.

To highlight the overall business value that can be derived by various stakeholder teams, here are a few high-level examples as illustration. The Simio Process Digital Twin will support the leadership team in understanding the impact of initiatives such as future factory expansions, new product introductions, new market sectors as well as the impact of business rules such as new labor policies, inventory policies and minimum order quantities. The operations team can receive detailed tasks and material instruction for execution to ensure synchronization across the end-to-end process. The planning and scheduling team can quickly generate detailed feasible schedules for any time horizon (hours, days, weeks, months and even years) while maintaining absolute feasibility. They can also easily re-plan based on events driven directly from the enterprise system such as the detection of a machine breakdown or a manual machine interruption by the schedulers. Based on replenishment policies and detailed schedules, the procurement team can receive detailed material requirements for every time period to ensure the correct and timely placement and receipt of raw material orders. The supply chain team can receive detailed reports when production orders will be available for shipment as well as reports detailing the inventory to ship to each customer or storage location at any time. Supervisors on the factory floor can receive detailed task lists for every resource including secondary equipment such as fork trucks to accurately manage and monitor execution. The finance team can get detailed insight as to the impact of capital investment proposals and expected ROI of these proposed projects for making informed decisions. The operational excellence or continuous improvement teams can use the Process Digital Twin to explore improvement initiatives by making changes to the current process flows and business rules to test and quantify potential improvement. Extensive what-if analysis can also be performed to determine the optimal parameters for specific operational changes, such as the number of AGVs required to replace the current forklifts to maintain or increase throughput.

The value proposition will be different for each customer depending on the project phase, the current initiative under review or operations under management. Below shown in Figure 4 is a graphical view of typical use cases and potential business benefits for some of the key stakeholders and teams in the organization.

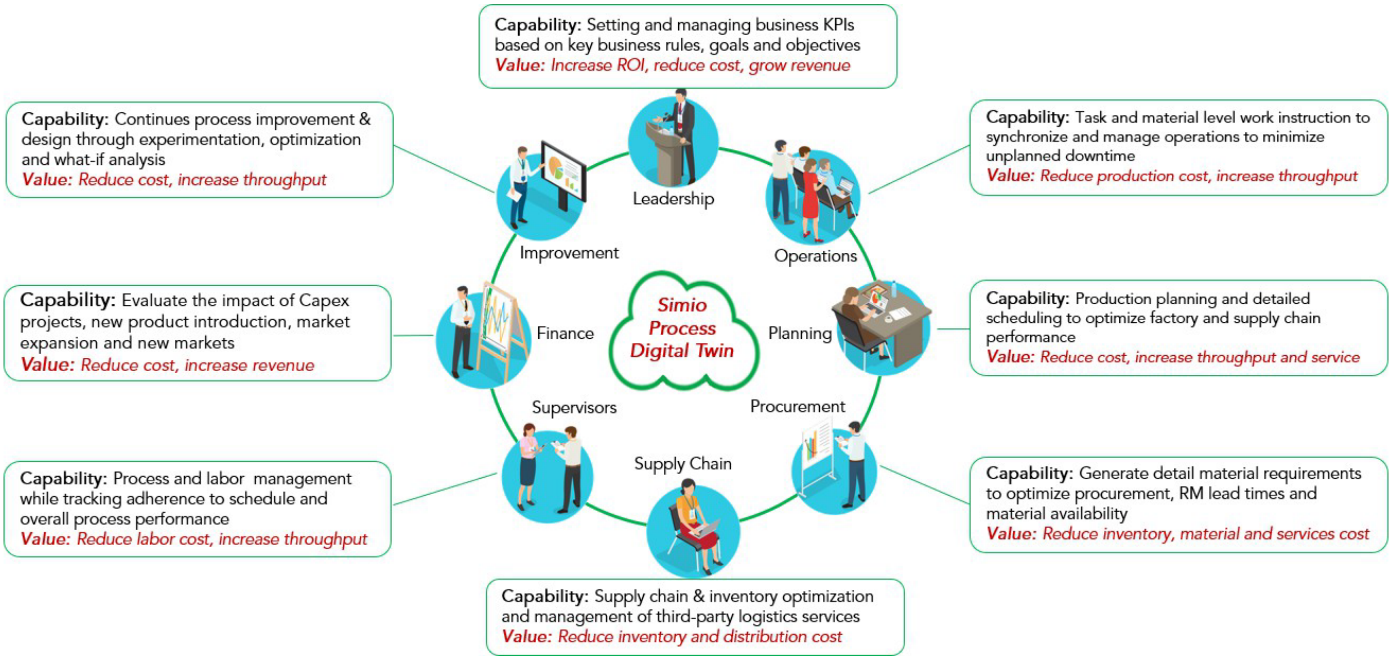


Figure 4: Typical Value to Stakeholders

6. Enterprise Deployment

During the design and analysis phase of developing a virtual factory model, it is often preferred to deploy Simio on a laptop or desktop. This supports offline work by project team members, as models are stored as XML files that can easily be saved to a central server and transferred between computers or emailed to team members for review and testing. This desktop option is also valid for operational deployment of the scheduling system if the desktop or laptop has access to the network-based operational data required to run the model and generate the schedule. This option works particularly well during the early deployment and testing phase of the solution while ongoing enhancements and model changes are required to fine-tune the schedule before final enterprise deployment on a cloud-based platform.

Simio Portal, Simio's cloud-based application, supports both a public cloud offering hosted on Microsoft Azure or Amazon AWS, as well as a private cloud offering hosted on-premises. The on-premises version is designed to comply with the most stringent corporate IT deployment and operating policies for production systems. To host Simio Portal on-premises, customers are required to procure the hardware infrastructure needed to create the hosted environment behind the company's security systems (firewall). This can also be outsourced to a private hosting service, depending on company policy. Simio Portal can also be used to broaden stakeholder engagement through experimentation, allowing them to evaluate operational strategies by fine-tuning data sets and parameters defined during the model development phase.

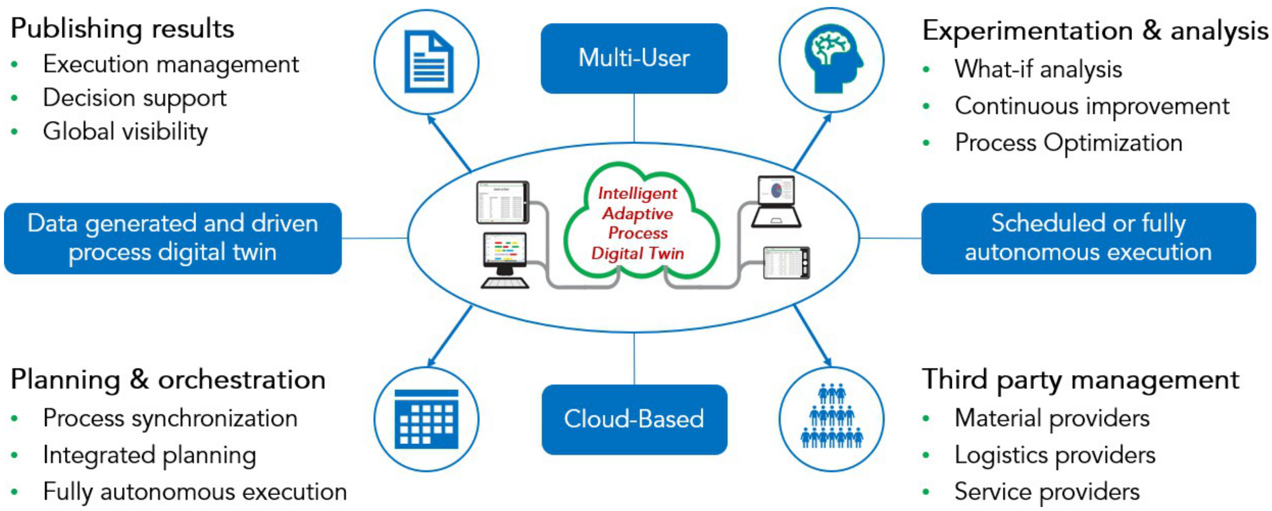


Figure 5: Simio Cloud Deployment

7. Summary

Simio provides an agile development platform that facilitates and streamlines the process of developing Intelligent Adaptive Process Digital Twins of any process. Because of their size and complexity, factories, warehouses, and entire supply chains are excellent applications of Intelligent Adaptive Process Digital Twin technology. Intelligent Adaptive Process Digital Twins are object-oriented, data-driven, 3D animated models that can run offline or online using data from the ERP, MES, and related data sources. A Simio Process Digital Twin is fully generated and driven by enterprise data, allowing it to adapt to changes in the environment such as additional equipment, new labor and skill requirements, or new parts/SKUs.

A Simio Process Digital Twin can simulate into the future to provide predictive and prescriptive analysis of the system to provide a fully forward-looking view of the expected process performance. This allows the Process Digital Twin to generate a detailed, feasible operational schedule, including all the relevant resource task lists and associated material requirements at each point in the process. The Process Digital Twin can also use embedded Neural Networks and/or train Neural Networks. Users can build and train models in third-party tools and then import them into Simio for complex decision making within a simulation model using the ONNX model exchange format.

Simio's Intelligent Adaptive Process Digital Twin platform is uniquely capable of supporting any business and/or digital transformation project while also supporting continued process improvement initiatives. There are many project workstreams that can be supported such as simulation and analysis, network design and optimization, scheduling, and orchestration as well as a complete design-to-operate end-to-end process throughout the lifecycle of the project. A Simio Process Digital Twin can be deployed on the cloud to provide both predictive and prescriptive decision support and deliver value for a wide range of stakeholders including executive leadership, planning, and scheduling, finance, procurements, operations, and more.