DELMIA

TRANSFORMING RAIL INDUSTRY WITH VIRTUAL TWIN EXPERIENCE

DASSAULT SYSTEMES

RAIL CHALLENGES

Rail operations management is a multifaceted endeavor, encompassing a complex interplay of design, construction, and operation elements. From tracks and stations to rolling stock and regulatory compliance, every aspect demands meticulous planning and coordination. Traditional approaches, characterized by disjointed processes and isolated data silos, struggle to address the intricate challenges of contemporary rail projects. In contrast, a model-based approach facilitated by virtual twin technology offers a transformative solution, enabling seamless collaboration, dynamic simulation, and optimized decision-making across all phases of rail infrastructure management. This integrated approach not only streamlines operations but also enhances efficiency, reliability, and sustainability, setting the stage for a new era of excellence in rail infrastructure management.

INFRASTRUCTURE MANAGEMENT

Make intelligent, financially sound decisions to design and manage rail infrastructure

A rail infrastructure project is inherently complex due to the multitude of interconnected components, systems, stakeholders, and considerations involved in its planning, design, construction, operation, and maintenance phases. The complexity of rail infrastructure is beyond just laying tracks and building stations; it encompasses a comprehensive and integrated system that facilitates the movement of trains, passengers, and freight efficiently, safely, and sustainably.

Rail Infrastructure Complexity

1

Tracks and Rail Networks

Balancing design, alignment, interoperability, and capacity while accommodating diverse terrains and system requirements

2

Stations and Platforms

Incorporating accessibility, passenger flow, safety, amenities, and technological systems while ensuring seamless connectivity with rail networks and urban developments

3

Yards and Depots

Designing layouts for efficient operations, storage, and maintenance while adhering to safety, environmental, and regulatory standards

4

Rolling Stock and Infrastructure Interaction

Ensuring compatibility, performance, and safety between trains and infrastructure components while managing maintenance, reliability, and lifecycle considerations

5

Regulatory, Environmental, and Stakeholder Considerations

Addressing regulatory approvals, environmental impacts, and community concerns through comprehensive assessments, mitigation measures, and stakeholder engagement

6

Project Management and Coordination

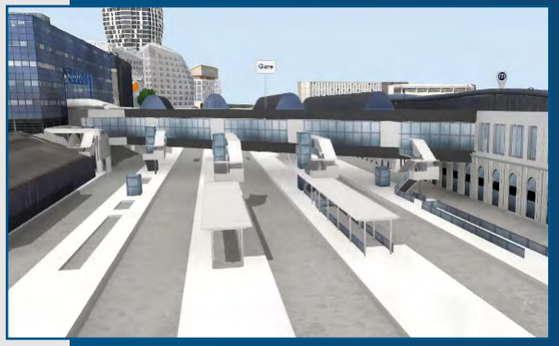
Coordinating diverse components, stakeholders, and phases while managing risks, uncertainties, resources, schedules, and deliverables to achieve project objectives

Virtual Twin: Enabling the Model-Based Approach for Rail Infrastructure Management

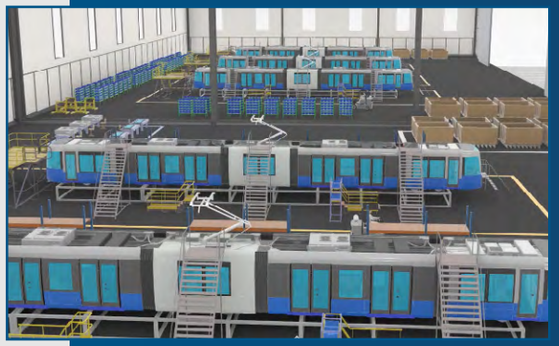
The complexity of rail infrastructure management demands a model-based approach that simplifies and streamlines the vast array of variables involved in the design, construction, and operation phases. Traditional methods, which often involve disjointed processes and isolated data silos, can no longer effectively handle the intricate and interconnected nature of contemporary rail projects A model-based approach addresses these challenges head-on by fostering an integrated framework for efficient project execution, data management, and stakeholder collaboration.

Virtual twins, or digital replicas of physical systems, enable a cohesive and dynamic platform for simulation, testing, and optimization. This technology allows for a seamless flow of information among engineers, architects, project managers, and environmental consultants, ensuring that every decision is informed by real-time data and accurate analyses.

A virtual twin of terrain supports design of infrastructure adaptations aimed at enhancing resilience to climate change and extreme weather conditions



By employing the use of a virtual twin, architects, engineers, and project managers of a station can collaboratively explore design options, simulate passenger flow, and evaluate the impact of external factors such as weather conditions or emergency situations



By using the virtual twin of a terminal, stakeholders can effectively plan for peak capacities, optimize logistics, and enhance safety protocols without disrupting actual operations

The Dassault Systèmes Advantage

The **3D**EXPERIENCE platform digitally connects all participants to the innovation process with secure, real-time collaboration across all disciplines. By sharing a common infrastructure, all stakeholders contribute ideas, plan, and work using a common language.

The distinct advantage of utilizing Dassault Systèmes' solutions lies in their capability to facilitate complex simulations, analyses, and optimizations in a virtual environment. This not only accelerates decision-making but also enhances the precision and reliability of those decisions, mitigating risks and improving overall project outcomes. For rail infrastructure specifically, Dassault Systèmes allows stakeholders to anticipate and solve potential challenges long before they manifest in the real world, ensuring that projects are delivered on time, within budget, and up to the highest quality standards.

An example of a unified data platform for a rail infrastructure construction project

ROLLING STOCK AND COMPONENT MANUFACTURING

Building the trains of the future, faster and more sustainably

The landscape of train manufacturing is confronted with a series of interconnected challenges that necessitate not just incremental improvements but comprehensive solutions. Key among these challenges are the lengthy and rigorous certification processes that inhibit rapid innovation, the need for customization amidst varying regional standards which complicates production, and the pressing demand for sustainability that requires a shift towards more energy-efficient designs. Additionally, the industry faces the task of navigating global supply chain disruptions, making production processes more vulnerable to external shocks.

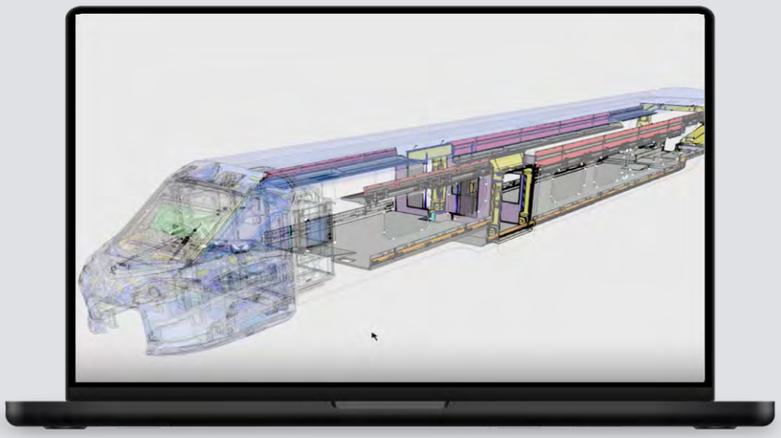
Solution Framework

1 **Systems Engineering Approach**

2 **Modularization to facilitate re-use and standardization**

3 **Accelerate certification with virtual tests**

4 **Reduce time to market and optimize operation efficiency**



Systems Engineering Approach

In the context of train manufacturing, the systems engineering approach ensures that all components of the rail system—ranging from mechanical and electrical systems to human operators and maintenance procedures—work harmoniously to achieve optimal performance and comply with safety standards. By adopting this approach, manufacturers are better equipped to identify, analyze, and manage the interdependencies and interactions between different system elements, which is critical for addressing complex challenges such as regulatory compliance, customization demands, sustainability goals, and supply chain volatility, mentioned earlier.

The system-level virtual twin of rolling stock enables rail operators and manufacturers to simulate various operational scenarios, including extreme weather conditions, mechanical failures, and wear and tear over time

Modularization to Facilitate Re-use and Standardization

Global modular architecture in train manufacturing refers to the approach that enables the development of a set of shared, modular components that can be rapidly and efficiently reconfigured or adapted across different train models to meet specific operational, regional, or customer requirements.

Implementing a global modular architecture in train manufacturing requires extensive coordination among teams and organizations. This coordination ensures modular components meet operational and regional requirements while integrating smoothly. The process involves efforts from design, supply chain, manufacturing, regulatory, and customer service teams, each contributing specialized knowledge.

01

Design teams collaborate closely for standardization while maintaining adaptability

02

Supply chain managers synchronize procurement and logistics with production timelines

03

Manufacturing adapts assembly processes for efficient configurations without compromising quality

04

Legal and regulatory teams ensure compliance with regional standards for certifications

05

Customer service teams align customization requests with modular architecture possibilities

06

Effective communication, management skills, and technological infrastructure support this coordination

The Dassault Systèmes Advantage

The **3D**EXPERIENCE platform connects an organization's entire ecosystem – people, ideas, data, and processes – in a single unified environment. By using a unified data model and ontologies that combine knowledge and know-how, it supports all disciplines and acts as a single version of the truth. As a unified collaborative environment, the platform brings together all participants and enables secure, real-time collaboration on any device. Its user experience brings web-style simplicity and speed to individuals, teams, and departments even when dispersed across different locations.

Accelerate Certification with Virtual Tests

A virtual twin is a highly detailed and dynamic digital simulation of a physical system or product which mirrors real-world conditions and performance in a virtual environment. In the context of train manufacturing, this means that manufacturers can simulate the performance of trains under various operational scenarios, including stress, safety, and efficiency tests, without the need for physical prototypes at the initial stages.

Using a virtual twin of a train to run simulations and identify critical speed and vibrations

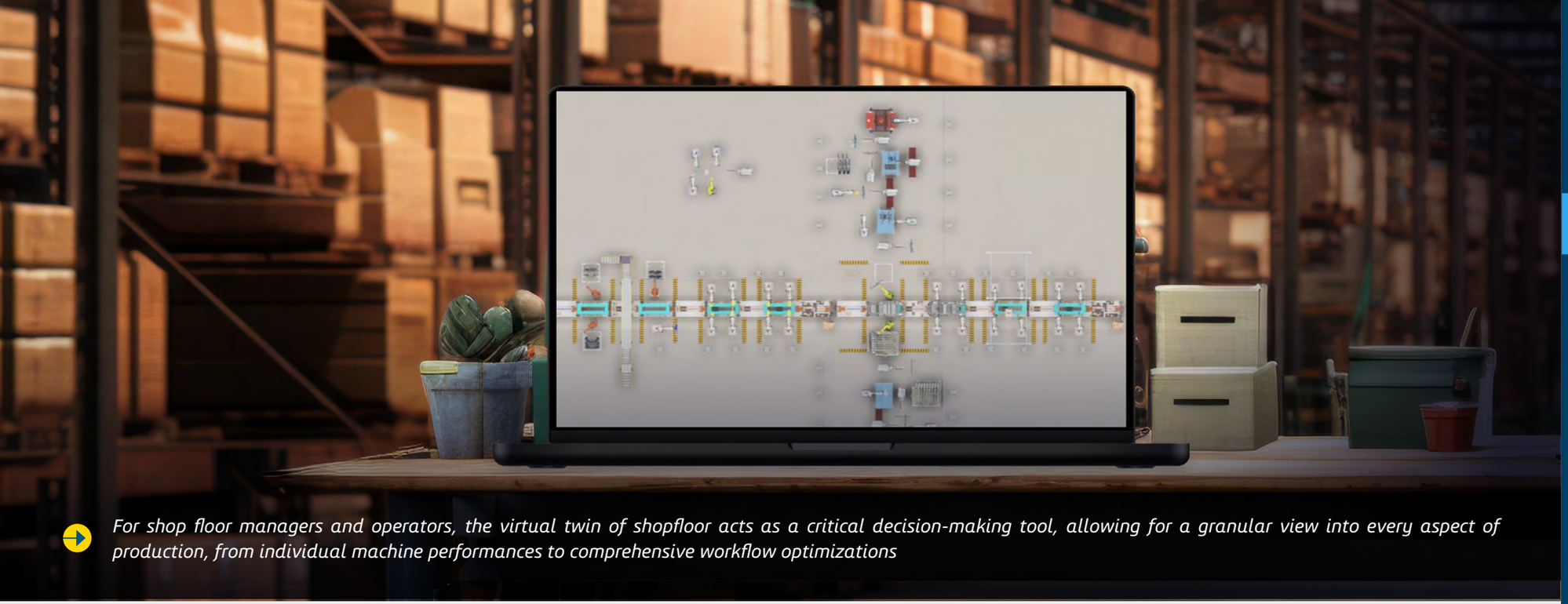
The Dassault Systèmes Advantage

The **3D**EXPERIENCE platform entails the Multibody System Simulation (MBS) that makes it possible to build up a virtual prototype, allowing virtual testing early in the development cycle. MBS enables engineers to analyze and understand complete system dynamics without requiring a physical prototype.

Reduce Time-to-Market and Optimize Operation Efficiency

Virtual twin technology serves as a central hub for information and operations, facilitating a seamless flow of data across all these elements.

A virtual twin of the manufacturing process ensures that all data and information flows seamlessly across different stages of the product lifecycle, maintaining integrity and accessibility at every step. This uninterrupted flow of information eliminates data silos, significantly reducing the risks of misinterpretation, errors, and rework.

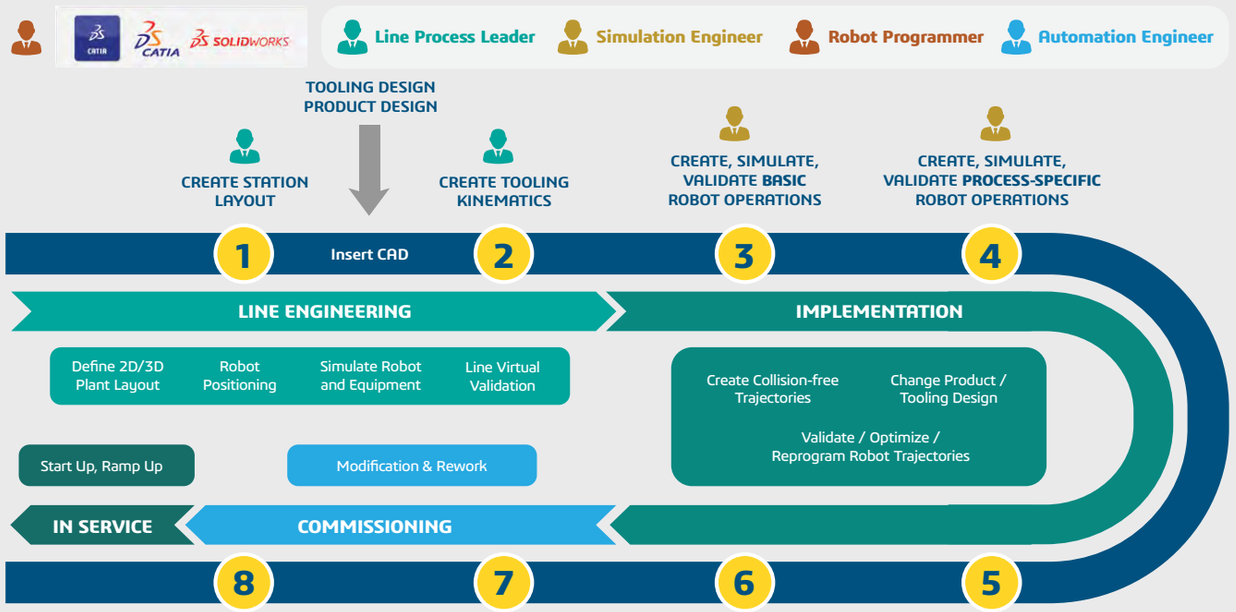


For shop floor managers and operators, the virtual twin of shopfloor acts as a critical decision-making tool, allowing for a granular view into every aspect of production, from individual machine performances to comprehensive workflow optimizations

The Dassault Systèmes Advantage

The robotic virtual twin, powered by Dassault Systèmes' **3D**EXPERIENCE platform, is the essential link between the virtual world of design and process engineering and the tangible world of production.

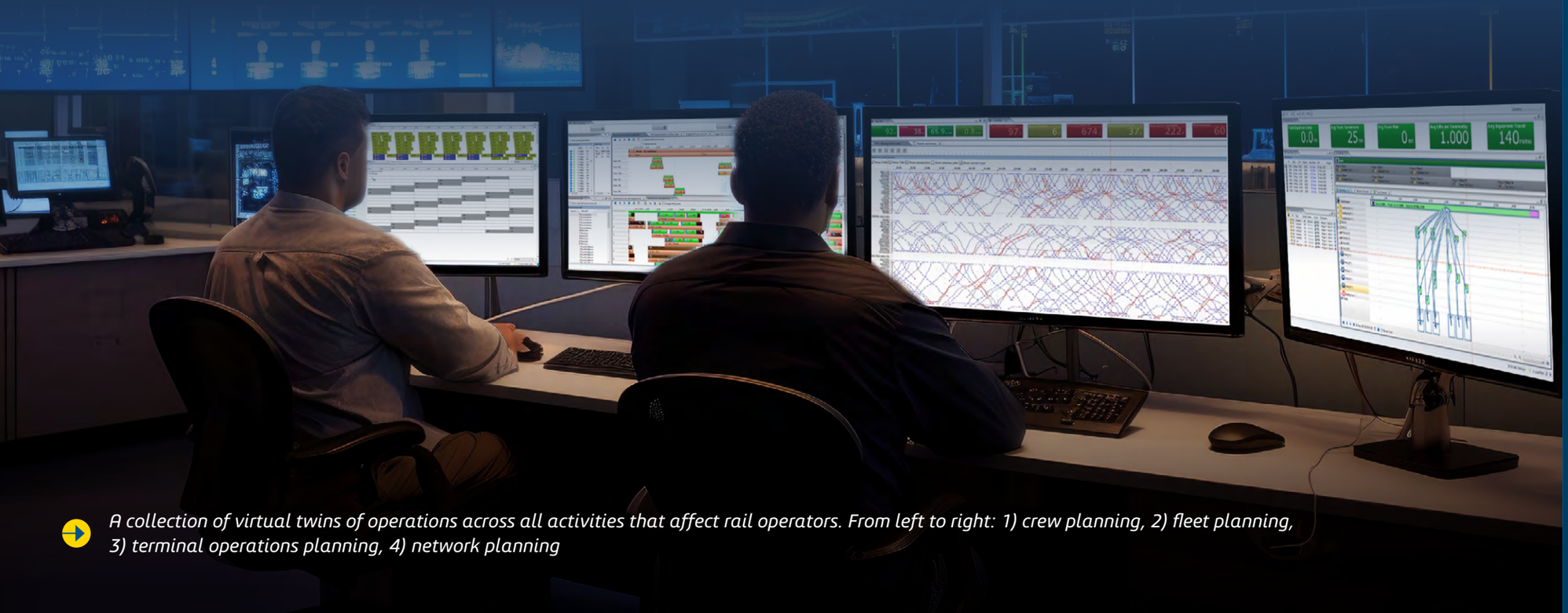
This solution facilitates a seamless flow of information, data, and knowledge, allowing users to gain an integrated and comprehensive view of the entire manufacturing process.



PASSENGER TRAIN AND FREIGHT OPERATORS

Over the past few decades, major IT companies have focused on creating essential office and enterprise asset management systems for rail operators. These systems targeted maintenance, planning, and execution, but largely overlooked fundamental railway operations like service scheduling, capacity planning, and crew management. As a result, railway operators had to create their own tools or modify systems from other sectors, with the aviation industry often serving as a reference point. Often, adapting solutions from different sectors demanded significant modifications to meet railways' unique needs. This left railway companies grappling with the challenges of fast-paced expansion and growing demand while being tethered to outdated technological infrastructures. Furthermore, when the railway industry adopts technology from other sectors and modifies it for its specific needs, it often leads to a collection of separate, specialized solutions. While these solutions can solve particular problems, they usually work independently, creating a fragmented approach to rail operations.

Virtual twin technology tackles rail operations challenges by providing a unified platform that integrates diverse data and systems, eliminating silos and improving communication among stakeholders. It leverages real-time data and analytics to optimize operations, allowing for more efficient resource allocation and scheduling. By simulating the entire rail network, virtual twins enable operators to anticipate and mitigate risks, enhancing overall system reliability. This integrated approach simplifies decision-making processes and facilitates continuous improvement, ultimately supporting the industry's goals for efficiency and sustainability.



A collection of virtual twins of operations across all activities that affect rail operators. From left to right: 1) crew planning, 2) fleet planning, 3) terminal operations planning, 4) network planning

The Dassault Systèmes Advantage

In a silo-based approach, each planning component—crew, fleet, terminal operations, and network planning—operates independently, leading to isolated decision-making and fragmented operations. This lack of integration often results in suboptimal outcomes, as planners focus solely on optimizing their specific area without considering the broader impact on the entire rail system. For example, a crew scheduler might optimize crew assignments without considering the availability or condition of the fleet, leading to inefficient resource utilization and increased downtime. On the other hand, an integrated approach connects these planning components, allowing for holistic decision-making and coordinated optimization across the entire rail network. This integrated viewpoint enables operators to identify and address interdependencies between different planning areas, leading to more effective solutions and improved overall performance. For instance, by synchronizing crew schedules with fleet maintenance and terminal operations, operators can ensure that crews are available when trains are ready for departure, minimizing delays and improving service reliability.

Furthermore, an integrated approach enables operators to proactively identify and mitigate potential challenges, such as capacity constraints, scheduling conflicts, or resource shortages, which were often overlooked or difficult to address in a silo-based system. By leveraging real-time data and advanced analytics across all planning components, operators can make informed decisions, adapt quickly to changes, and optimize resources more effectively, leading to enhanced operational efficiency, reduced costs, and improved customer satisfaction.

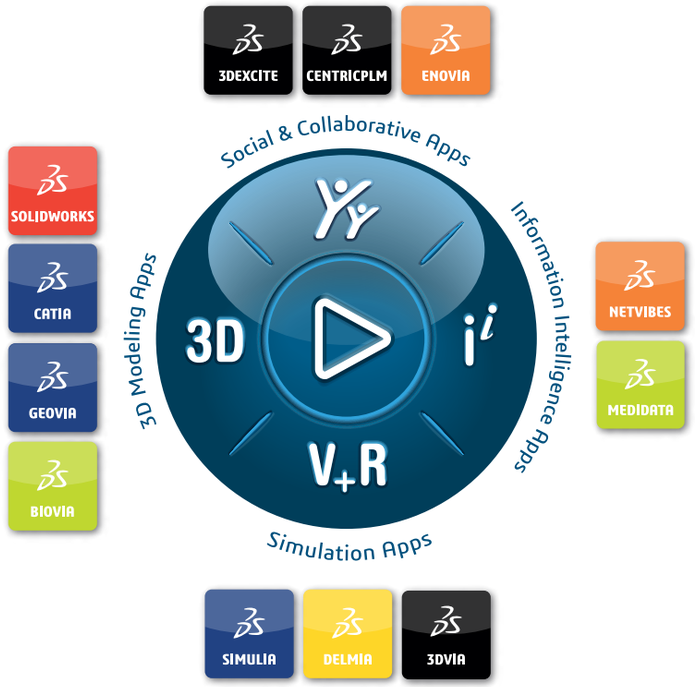
CONCLUSION

As the rail industry continues to evolve, the imperative for integrated, data-driven solutions becomes increasingly evident. Virtual twin technology, backed by the robust capabilities of the **3D**EXPERIENCE platform, emerges as a game-changer, bridging the gap between traditional silo-based methods and the demands of modern rail infrastructure management. By fostering collaboration, enabling real-time insights, and supporting informed decision-making, virtual twins pave the way for more resilient, responsive, and efficient rail systems. As rail operators and stakeholders embrace this innovative approach, they stand to unlock new possibilities, drive sustainable growth, and deliver unparalleled value to passengers, freight customers, and communities alike.

Our **3D**EXPERIENCE® platform powers our brand applications, serving 12 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the **3D**EXPERIENCE Company, is a catalyst for human progress. We provide business and people with collaborative virtual environments to imagine sustainable innovations. By creating virtual twin experiences of the real world with our **3D**EXPERIENCE platform and applications, our customers can redefine the creation, production and life-cycle-management processes of their offer and thus have a meaningful impact to make the world more sustainable. The beauty of the Experience Economy is that it is a human-centered economy for the benefit of all –consumers, patients and citizens.

Dassault Systèmes brings value to more than 300,000 customers of all sizes, in all industries, in more than 150 countries. For more information, visit **www.3ds.com**.



Europe/Middle East/Africa
Dassault Systèmes
10, rue Marcel Dassault
CS 40501
78946 Vélizy-Villacoublay Cedex
France

Asia-Pacific
Dassault Systèmes
17F, Foxconn Building,
No. 1366, Lujiazui Ring Road
Pilot Free Trade Zone, Shanghai 200120
China

Americas
Dassault Systèmes
175 Wyman Street
Waltham, Massachusetts
02451-1223
USA