From Process Simulation to Operator-in-the-Loop Training

An Integrated Human-Centric Digital Twin in AnyLogic

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Presenters: Salman Sangi, Hamid Tikani

ALSANX
VIRTUAL POWER
REAL SOLUTIONS

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ALSANX, headquartered in Canada, is your strategic partner in digital transformation. We lead innovation by integrating digital twins, AI, advanced analytics, and immersive technologies. By empowering human capabilities with intelligent systems, we deliver expertise in simulation, production optimization, and real-time operational intelligence, positioning your organization for the next era of intelligent operations.

Our vision is to prepare the industry for the next generation, through the convergence of digital intelligence and human expertise.

Presenters

Salman Sangi is Co-founder and Business Development Manager at ALSANX Inc., with dual academic credentials in Engineering and International Business from HEC Montréal. He brings more than 15 years of experience in international industrial project management, industrial innovation, and engineering integration across greenfield and brownfield projects. His expertise spans digital twin technologies, simulation, and AI-driven solutions for industrial plants especially Metallurgical and Mining.

Hamid Tikani is Technical Manager at ALSANX Inc. He holds a PhD in Industrial Engineering and brings over seven years of background in simulation modeling, mathematical optimization, and digital transformation of manufacturing and supply chain systems. His expertise includes the development of optimization algorithms in logistics, network design, energy optimization, and plant operations and engineering integration. He also has strong proficiency in data analysis, business intelligence, and economic evaluation of industrial projects.

WHAT WE'LL COVER TODAY

Presentation Outline

Section 1

Redefining the Digital Twin: The Human-Centric Approach

Section 2

Technical Depth & Architecture

Section 3

AI-Driven Coaching & Automated Insight Reporting

Section 4

NVIDIA Omniverse Integration

Section 5

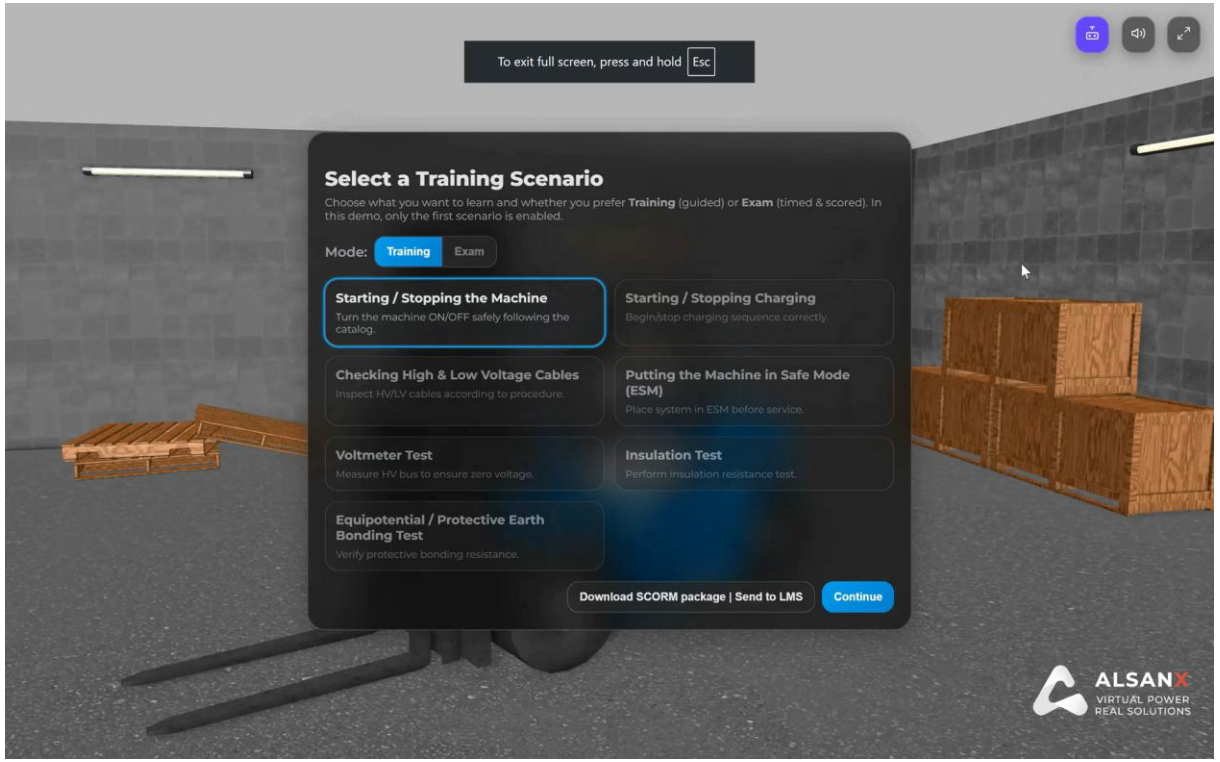
The Vision: Remote Operation

Section 6

Summary

From static 3D training to interactive simulation intelligence

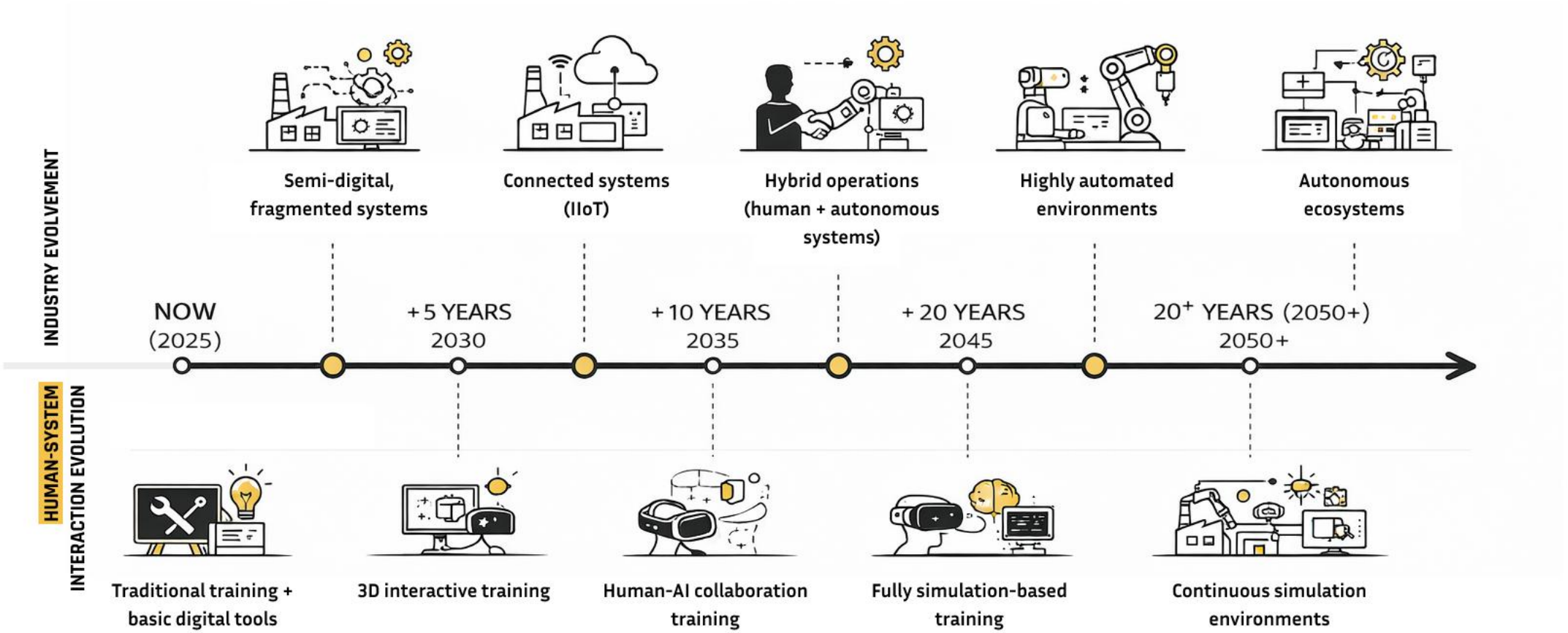
Standalone 3D Training



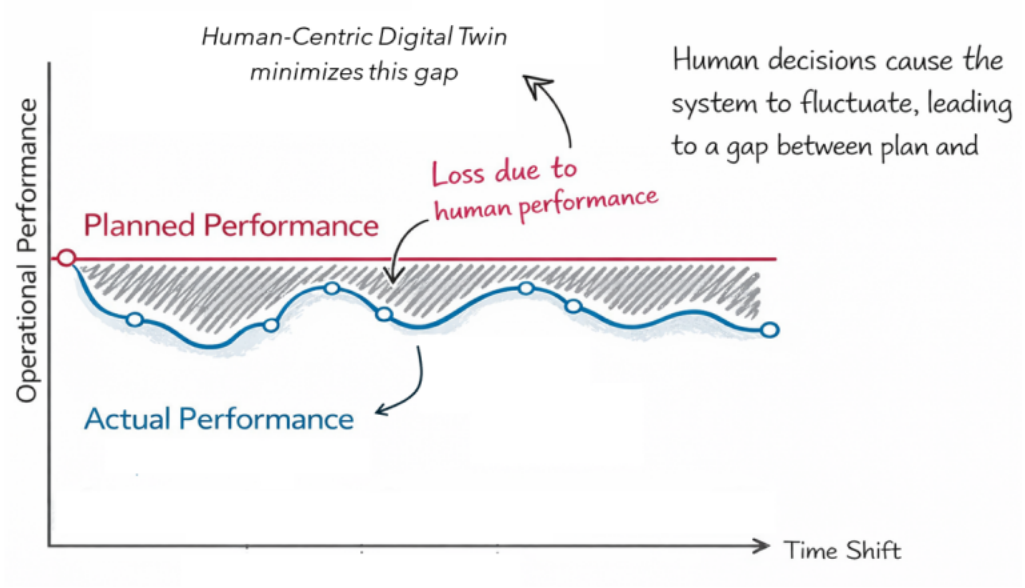
In-the-Loop Training AnyLogic + Omniverse

The Importance of Human-Centric Digital Twins

Why Human-Centric Digital Twins Matter in the Age of AI and Automation



Why Process Simulation Alone is Not Enough?



The "Deterministic Operator" Flaw

Perfection vs. Reality

From Perfect Operators to Real Human Behavior

Static Logic vs. Behavioral Dynamics:

Process Flow vs. Operator Influence

Missing Real-Time Feedback Loops:

How human decisions propagate through the system.

The Industry Need

We don't just need a model that calculates the process; we need a human-centric digital twin that integrates the human variable.

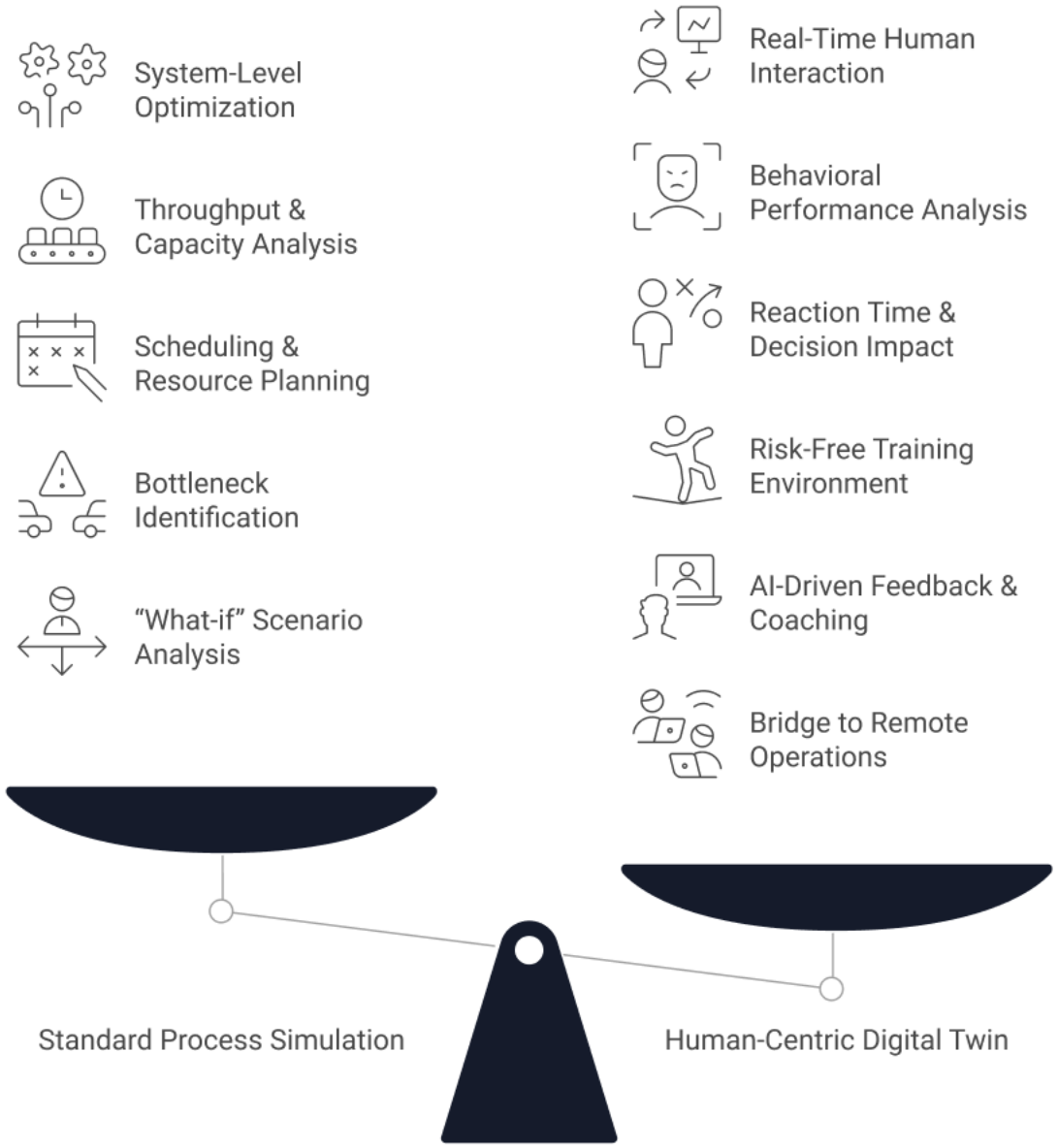
The Evolution of Human-Centric Digital Twins

Bridging the Gap Between System Simulation and Human Behavior

Industrial excellence has long been divided between Process Modeling (Macro) and Operator Training (Micro), but these two worlds rarely meet. ALSANX Hybrid Twin disrupts this paradigm by unifying high-fidelity AnyLogic process dynamics with a human-centric layer, transforming traditional sensitivity analysis into a holistic, Human-in-the-Loop Digital Twin.

Bridging Macro Logic with Human-Centric Execution

From System Optimization to Human Performance Excellence



Use Case

Aluminium Continuous Homogenizing Line Operation

The Continuous Homogenizing Line (CHL) is a thermal treatment system used in aluminium billet production. It operates in a continuous mode, where billets move through controlled thermal zones — ensuring uniform material properties.

While the process is highly automated, operator intervention remains critical for handling disturbances and process adjustments.

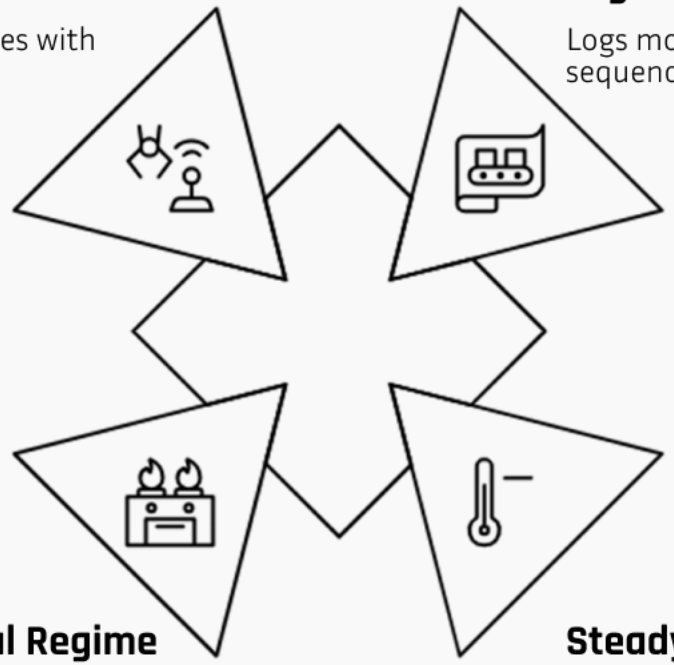
This combination of automation and human influence makes CHL an ideal case for a Human-Centric Digital Twin.

Automation with Human Intervention

Automated processes with human oversight

Continuous Material Flow
Logs move smoothly

Logs move smoothly through a sequence of zones



Precise Thermal Regime

Controlled heating and cooling ensure optimal wood properties

Steady-State Operation

Consistent temperature minimizes equipment stress

Process Modeling Mode: A Digital Laboratory

Configurable Parameters & Study Dimensions

- **Arrival Patterns**

  Billet arrival frequency and variability

- **Furnace Scheduling**

  Heating, holding time

- **Failure & Quality Rates**

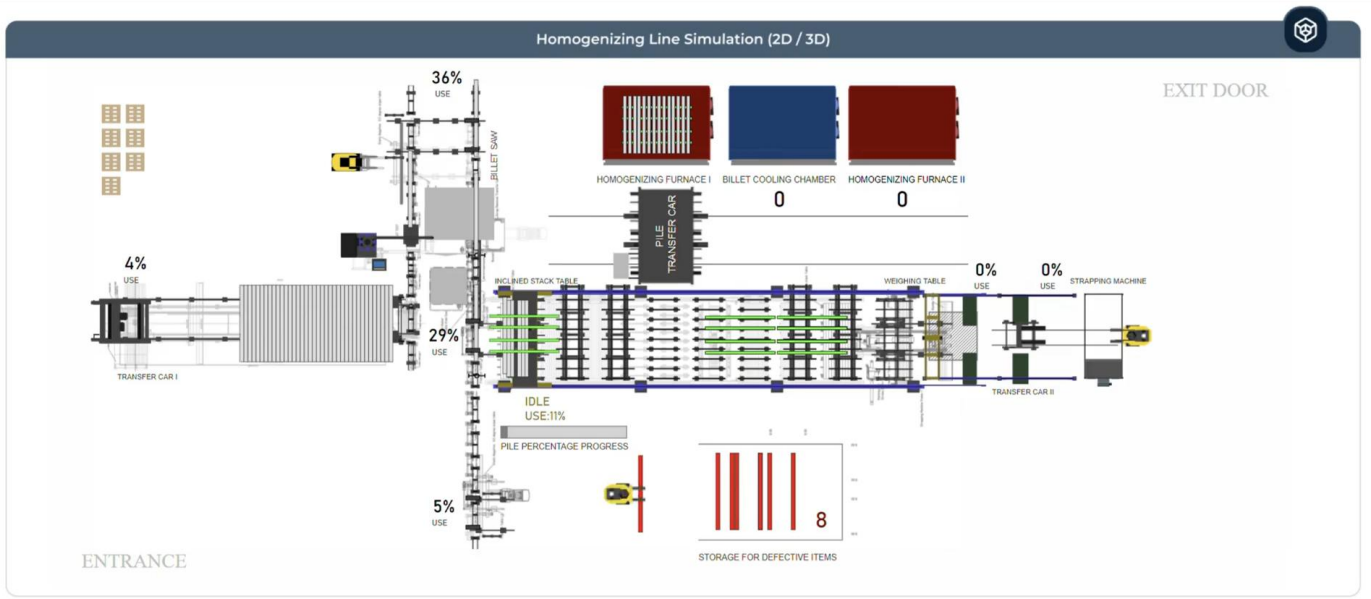
  Generation of defective billets and process variability

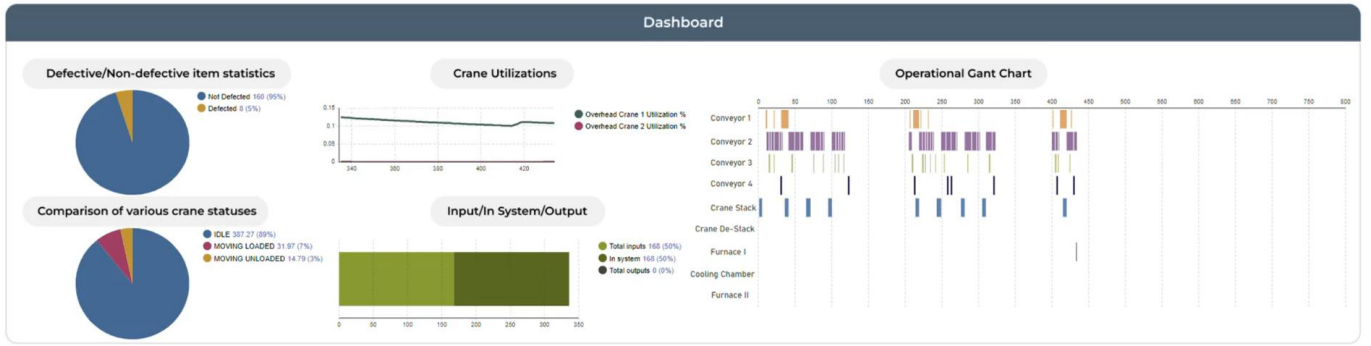
- **Material Handling Systems**

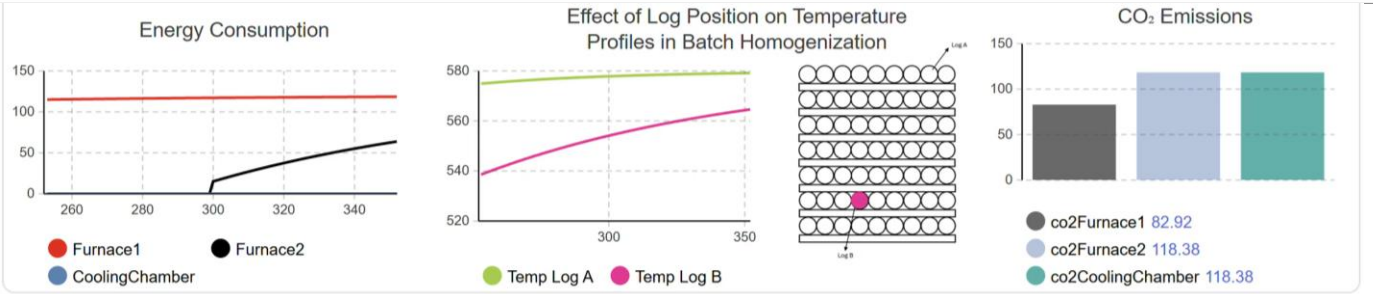
  Conveyor logic, crane operations, and transfer mechanisms

- **Buffering & Flow Control**

  Billet accumulation, stacking and destacking strategies





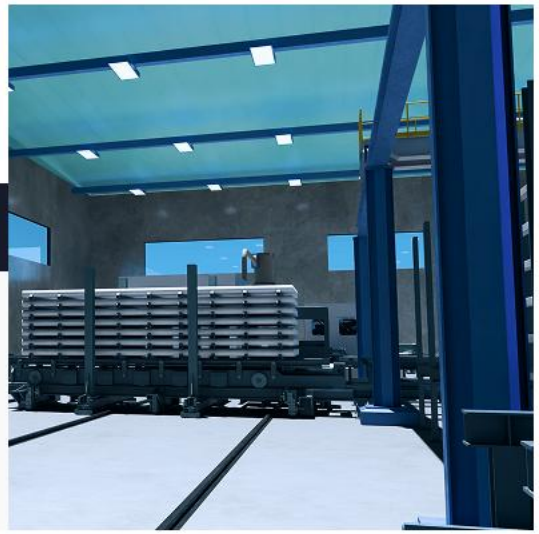


1. Forklift Billet Transport

Challenge	Constraint	Risk
Rapid evacuation of billets identified as defective by the Ultrasonic Testing (UT) station	A physically limited loading zone for forklift operations	If the operator is slower than the line, billets build up on the conveyor, causing back-pressure and possible stoppage.

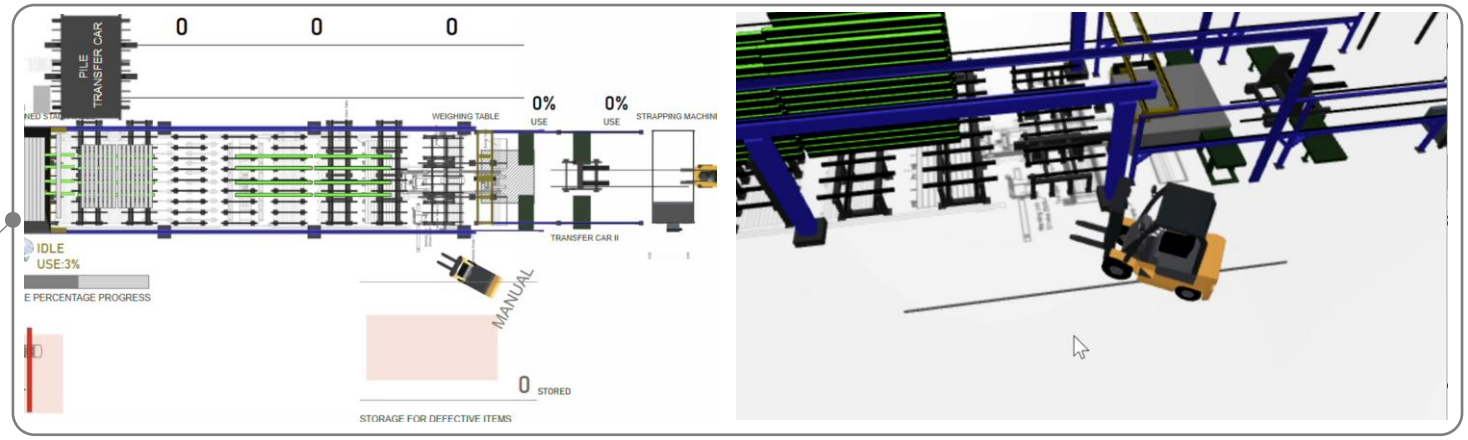
Where Human Agency Shapes Throughput ...

2. Pile Charging Machine



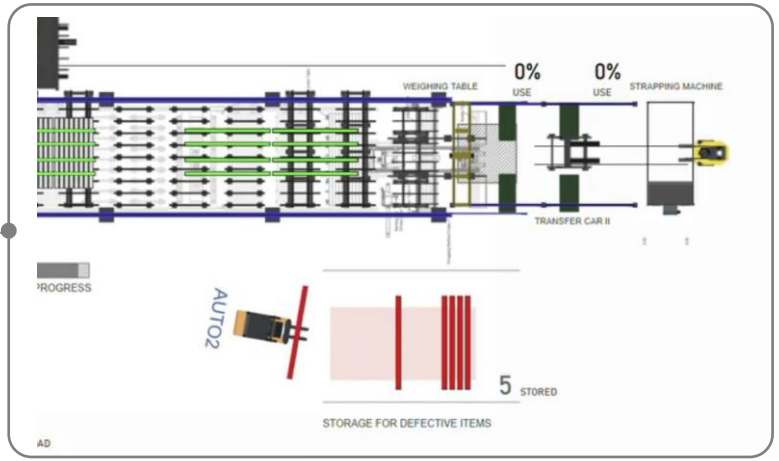
Challenge	Constraint	Risk
The operator handles a tightly synchronized process: furnace entry, inter-zone transfer, and final discharge.	Tight Scheduling	Timing variability disrupts flow, causing bottlenecks at destacking and downstream buildup.

Key Features for Realistic Operator Experience



Physics-Based Simulation

- Realistic physical interactions between all elements
- Collision-aware environment to prevent unrealistic overlaps

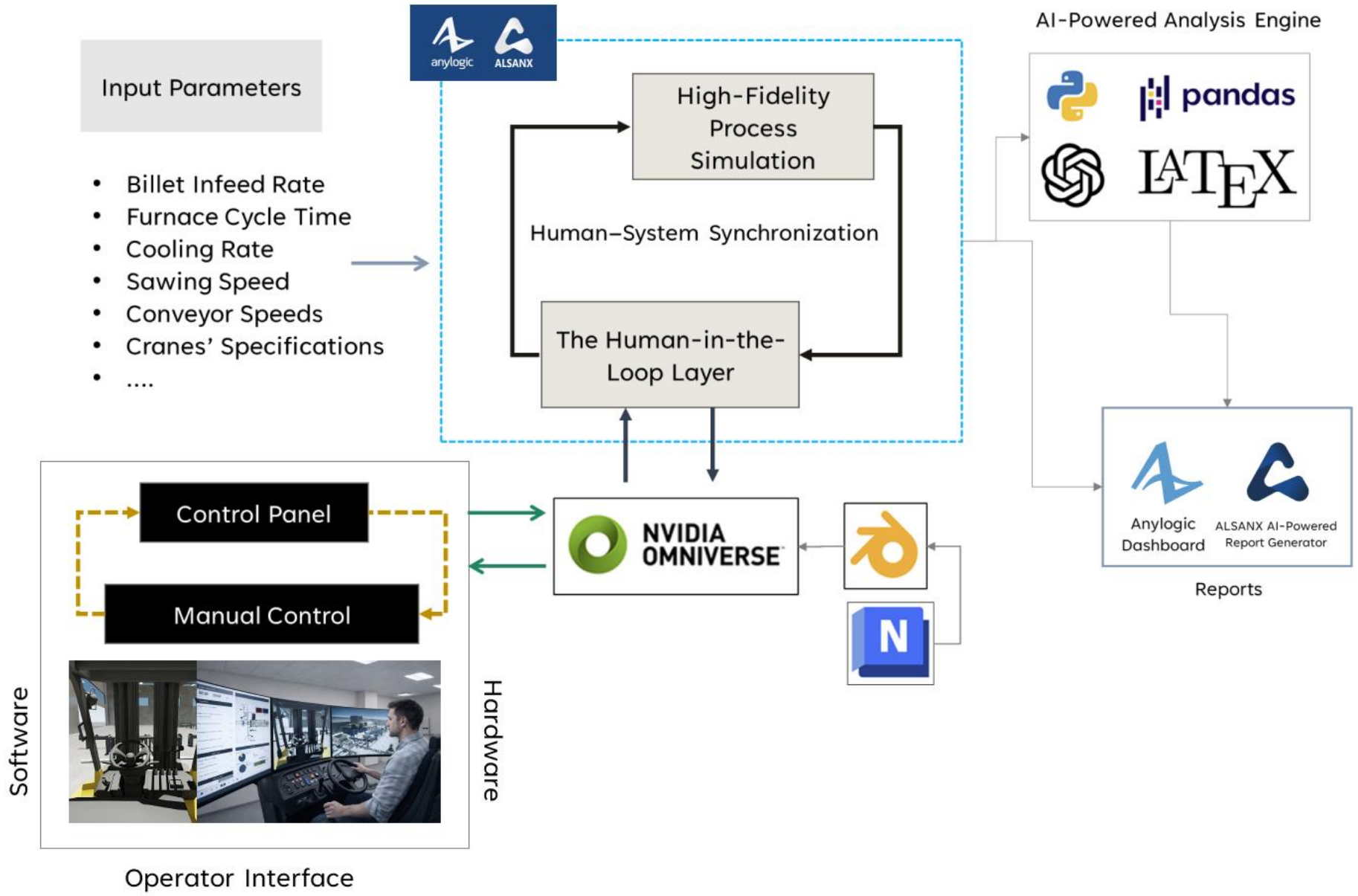


Guided Learning Experience

- Built-in guidance and assistance for operator training
- Scenario-based learning for improved skill development

Fully Configurable Equipment Behavior

- Adjustable motion parameters (speed, acceleration, response)
- Customizable forklift behavior and control settings


Input Parameters
Billet Infeed Rate
Furnace Cycle Time
Cooling Rate
Sawing Speed
Conveyor Speeds
Cranes' Specifications
....
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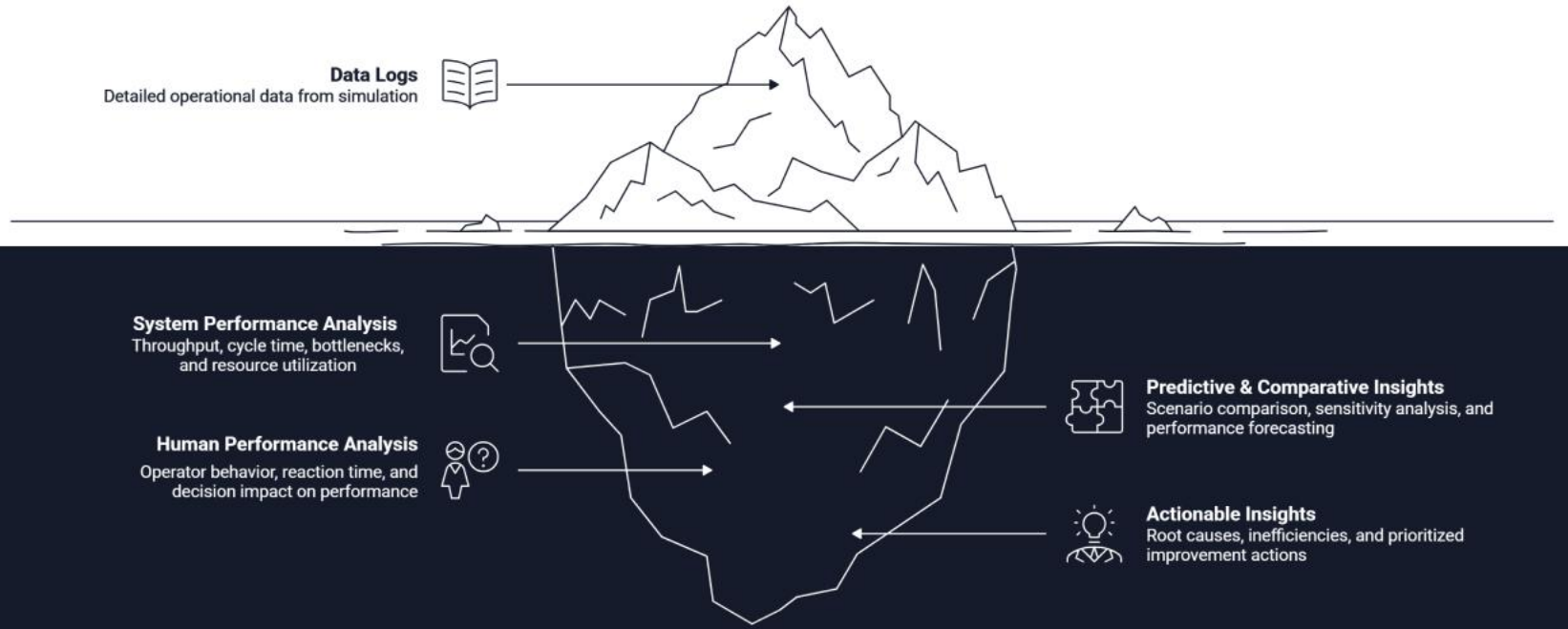
High-Fidelity Process Simulation
Human–System Synchronization
The Human-in-the-Loop Layer
AI-Powered Analysis Engine
pandas
LATEX
Anylogic Dashboard
ALSANX AI-Powered Report Generator
Reports
Control Panel
Manual Control
NVIDIA OMNIVERSE
Software
Hardware
Operator Interface

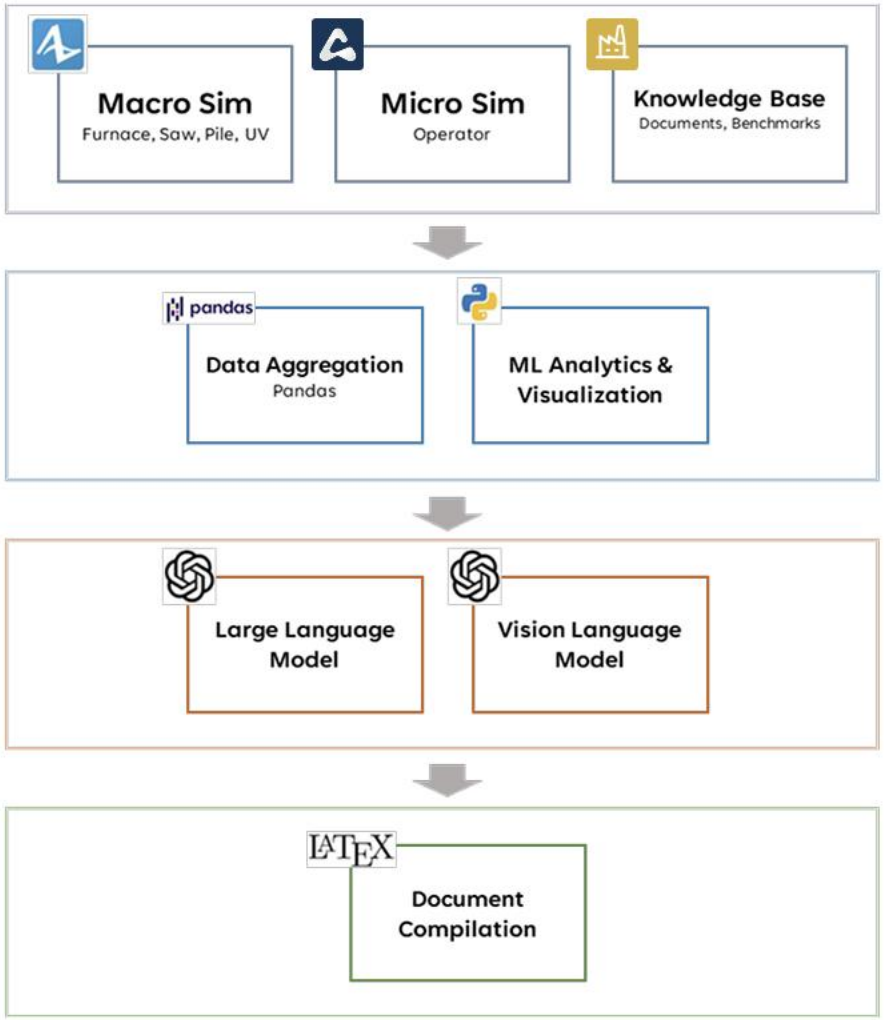
Simulation Generates Data, Not Insight!

What's Needed? An artificial intelligence layer that can:

- Analyze both system and human performance in an integrated way
- Quantify energy consumption and process efficiency
- Detect delays, idle times, anomalies, and hidden inefficiencies
- Translate raw simulation data into clear, actionable insights and recommendations



Automated AI Reporting



- Multi-Scale Data Ingestion
- Dynamic Benchmarking

- High-Speed Data Structuring
- Intelligent Visualization

- Multi-Modal Interpretation
- Autonomous Synthesis

- Automated Typesetting

AI-Driven Coaching & Performance Scoring for Lift Truck Operator Competency

1. Real-time analysis of operator behavior metrics.
2. Standardized scoring against optimal digital twin.
3. Detection of inefficiencies in operational processes.
4. Personalized recommendations for operator improvement.

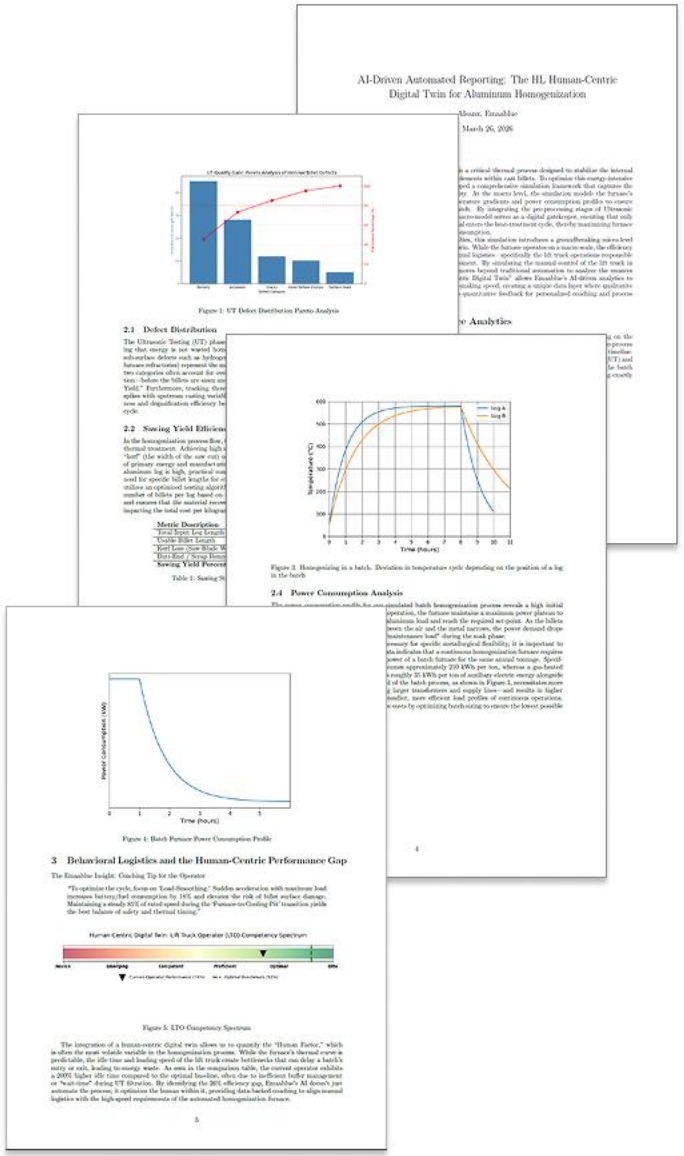
Quantifying Human Performance

Performance Scoring

Identifying Performance Gaps

AI-Generated Coaching Insights

AI-Generated Outputs for a Human-Centric Digital Twin



Photorealistic System Insight

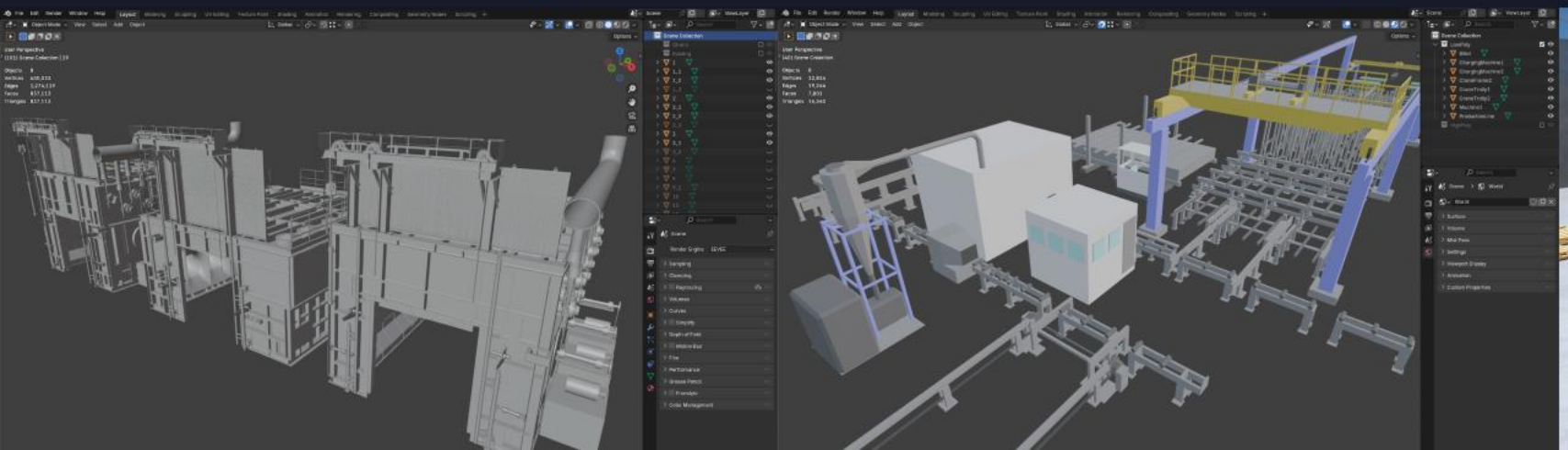
The Power of **NVIDIA Omniverse**

1. High-Quality, Real-Time Visibility

Photorealistic Environments: Applying NVIDIA's lighting and PBR materials to bridge the gap between simulation and reality.

2. Engineering-Driven Optimization of 3D models

Strategic Mesh Optimization: Reduced model complexity from millions of vertices for zero-Lag Simulation (Allowing the digital twin to run complex process logic alongside high-end graphics).

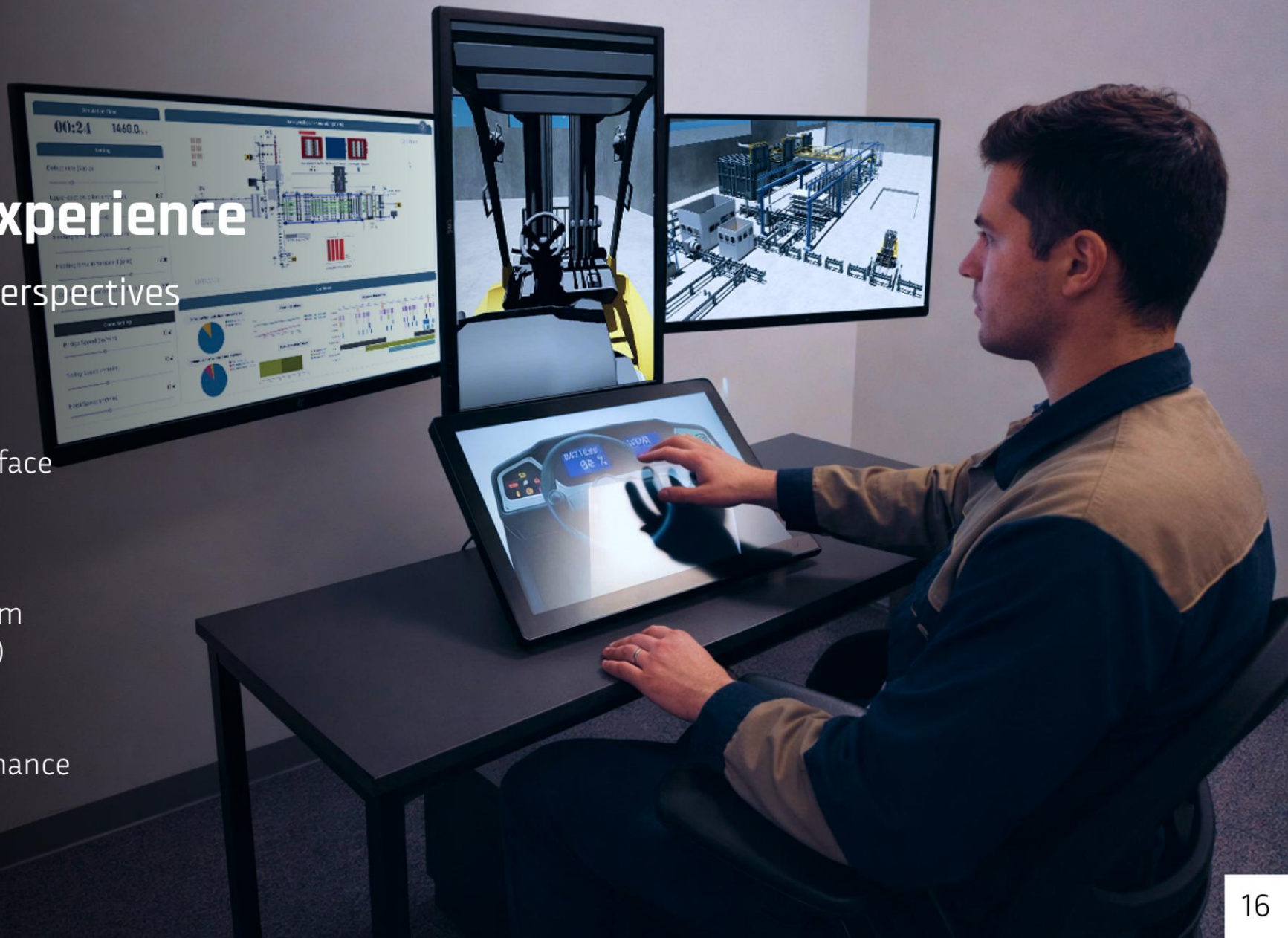


▶ VR Experience: Inside the Digital Twin

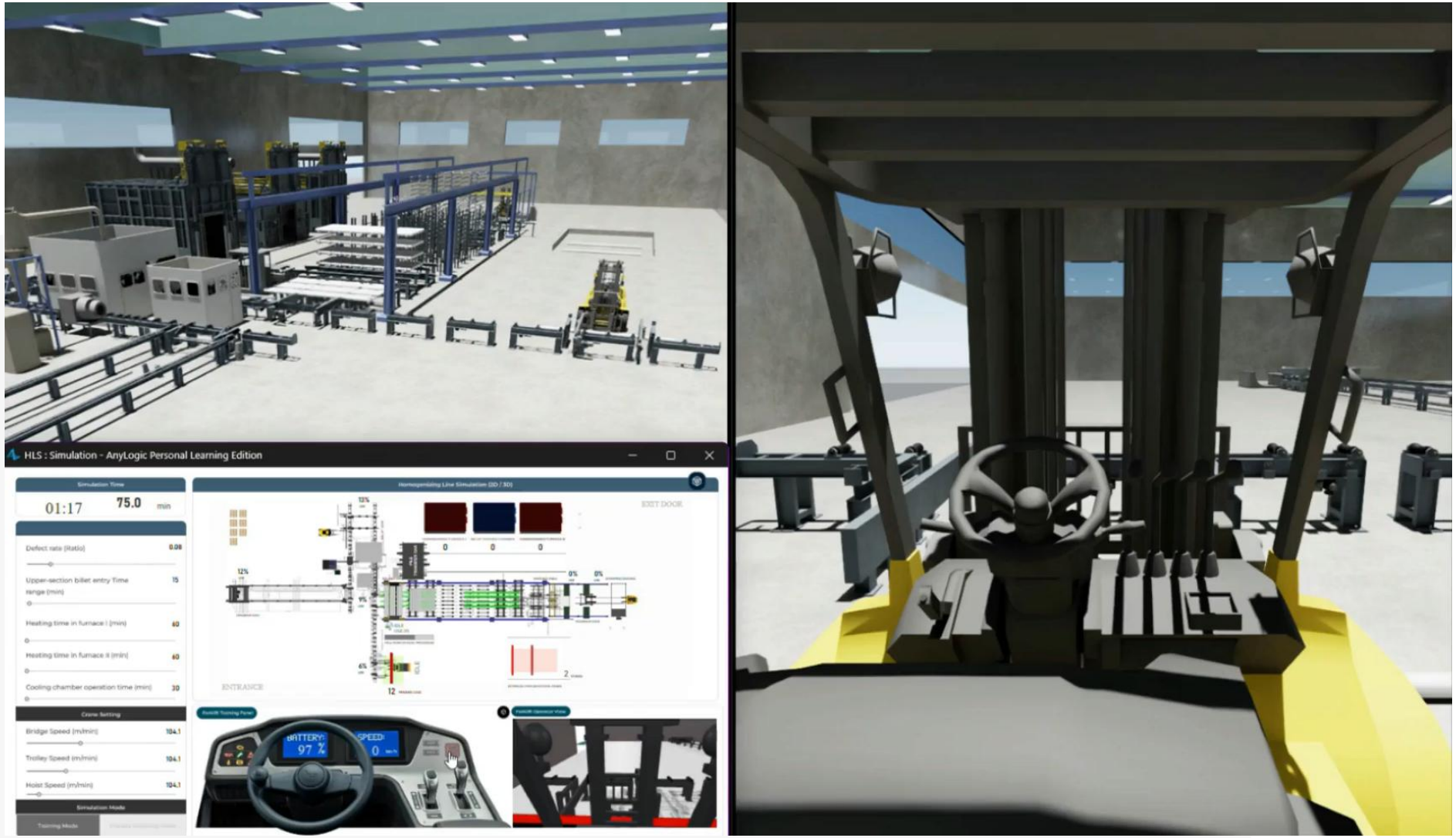
The Multi-View Experience

One Digital Twin, Multiple Perspectives

- **Operator View**
  First-person operational interface (Operator Cockpit)
- **Monitoring View**
  Plant-wide visibility and system monitoring (CCTV perspective)
- **Analytical View**
  Top-view analysis and performance dashboards (AnyLogic Core)



The Multi-View Experience: One Digital Twin, Multiple Perspectives



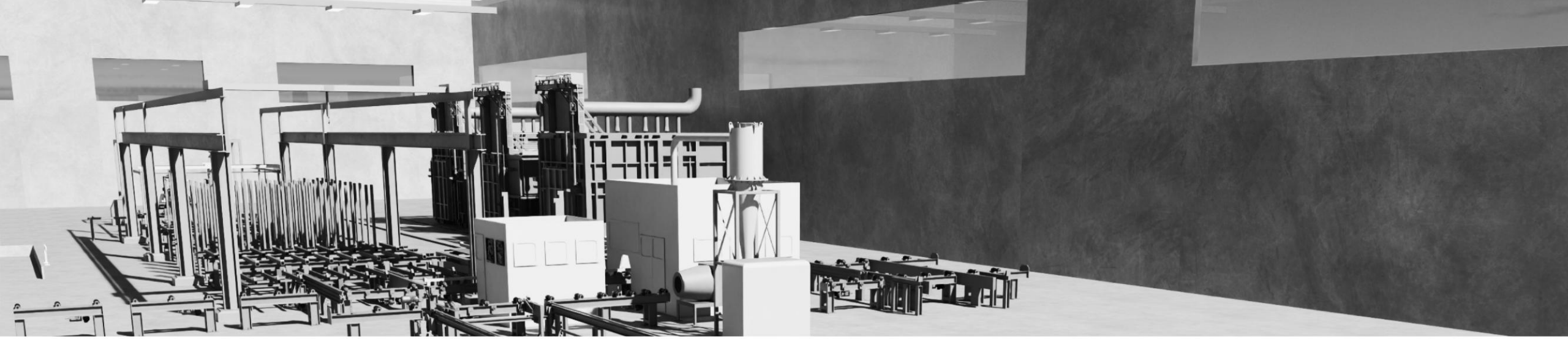
The Value & Vision of Remote Operations

Why it matters

- **Safety** – Remove operators from hazardous environments
- **Cost Efficiency** – Centralized expertise, reduced on-site dependency
- **Global Talent** – Access skilled operators regardless of location
- **Resilience** – Central monitoring & faster intervention

What it looks like

- **Digital Twin** → Live Control System (bi-directional interface)
- **Real-Time** Integration – PLC, SCADA, IoT into one environment
- **Remote Operator** – VR/AR-based control of physical assets
- **Tele-Operation** – Low-latency control of automated & manual processes



Summary

- **Beyond Isolated Simulation**
  From static process models to human-centric, interactive digital twins
- **Human-in-the-Loop Intelligence**
  Integrating operator behavior into system performance and decision-making
- **AI-Driven Insights & Coaching**
  Transforming raw simulation data into actionable insights and performance improvement
- **Multi-Equipment Operation**
  Seamless operation of multiple machines through one integrated control system
- **A Path Toward Remote Operation**
  Enabling the future of connected, intelligent, and remotely operated industrial systems

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BRINGING TALENTS BACK TO INDUSTRY

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Thank You

Thank you for your attention

We're now open for any questions.

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