ADE-1

The Open Industrial OS

From executable models to operational industrial systems

We don't optimize operations. We generate executable industrial systems.

ADE-1 (Autonomous Decision Engineering)

Developed by Andreas Lechthaler and Jaime de la Fuente.

Today I will introduce a new approach to industrial process optimization, the First Open-Source, Model-Driven Industrial Control Architecture.

The core concepts behind ADE-1 originated more than twenty years ago. Only recently have computing power, software architectures and hardware platforms evolved to the point where the vision can be implemented at scale.
ADE-1 represents the convergence of those ideas with modern technology.

Ready for Ecosystem Expansion.

Now **we are bringing a VISION to LIFE**

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The Innovation: ADE-1 introduces a new industrial execution paradigm

The shift: Instead of connecting multiple software layers through integration, ADE-1 uses a single executable model that defines, simulates and operates the industrial process.

The Result: a unified execution architecture capable of generating control logic, orchestration, traceability and system behavior from the same underlying structure.

This is the First Open-Source, Model-Driven Industrial Control Architecture.

ADE-1 transforms industrial models into executable systems capable of planning, simulating and operating production processes from a unified structure.

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Introduction

A Vision Realized After Two Decades

Not a planning tool: **ADE-1** is not classical APS (Advanced Planning and Scheduling).

The Engine: It is a system engine that models, simulates, and runs industrial production using the exact same underlying structure.

The Metaphor: ADE-1 is an executable industrial reality model. The same model used to describe a production system is used to simulate and operate that system. This removes the traditional separation between design, simulation and execution.

The Outcome: The system continuously evaluates physically valid alternatives and executes the most suitable course of action.

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Automatic System Generation

One Model: Total Reality.

From a single graphical model, the system autonomously generates:

- Production Control System (The Brain)
- Machine Control Logic (Generated from the model)
- Database/State Management (The Memory)
- Visualization & Documentation (The Face)

Using system-wide context, real-time feedback and configurable priorities, the system evaluates physically valid production scenarios and selects the most suitable execution path.

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The Problem: The fragmented Factory

Industrial systems are currently controlled by disconnected layers: ERP, MES, PLC, and Planning Tools. They lose efficiency every day, not because of a lack of data, but because of fragmented decision systems.

Companies rely on **disconnected tools** (ERP, MES, planning, control), each operating on a partial view of reality.

These systems cannot maintain a unified representation of the physical process.

Result:

- Suboptimal decisions
- High variability
- hidden inefficiencies that scale with complexity.
- In complex environments, human-driven planning simply does not scale

This leads to inefficiencies that are widely accepted as unavoidable.

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Why Existing Solutions Fail: The Abstraction Gap

No system today provides a unified, executable model of the full production system

Current industrial software models fragments of reality rather than maintaining a single executable representation of the entire system.
Each system layer amplifies the problem:

- Planning tools ignore execution constraints (they guess).
- Execution systems lack global optimization (they react locally).
- Control systems operate in isolation.

As a result:

- Decisions are made on incomplete models
- Optimization is local, not global
- Systems become unstable under disruption

The core issue: **Decisions are made on incomplete models. Optimization is local, not global. Systems become unstable under disruption because the "Digital Twin" is just an approximation, not the reality itself.**

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The Core Idea: The Model Is The Machine

We take a fundamentally different approach. Current systems require manual programming, integration, and maintenance.

- ✓ ADE-1 minimizes manual programming through model-driven system generation.
- ✓ The model is not a representation: It becomes the executable system itself
- ✓ Materials are tracked as real identities
- ✓ Machines define physical constraints
- ✓ Processes are rule-based transformations

System behavior emerges from physical constraints, process rules and material transformations encoded in the model itself.
The model is a functional representation of the process itself.

The model is not merely descriptive. It defines system behavior, material transformations and execution logic. The same structure used to describe the process is used to operate it.

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How ADE-1 Works: Unified Simulation and Execution

The same model generates both simulation and real-system execution. There is no translation layer between simulation and execution.

Material is never abstracted away; it is tracked continuously through transformations.

Objects are tracked spatially in real-time with millimetric precision.

At machine boundaries:

- Objects are consumed
- New objects are created
- Identity and genealogy are preserved

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The Transformation Example

Physical Continuity: A cooling batch is incrementally transformed into a saw batch.

That saw batch transforms into stacker batches and by-products.

Crucial Difference: Source and target objects coexist until the transformation is complete. The system understands the physics of the transition, ensuring no "ghost" materials exist in the logic.

This preserves consistency and traceability throughout the transformation process.

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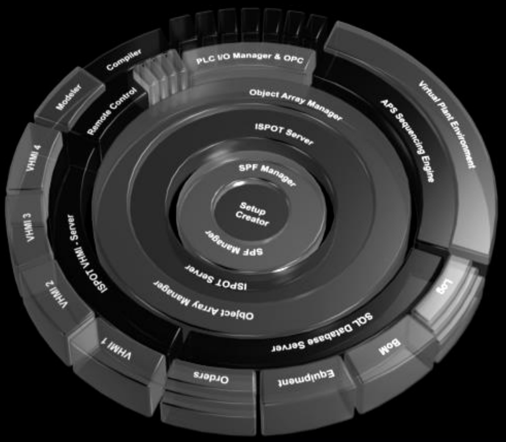
Scenario Engine: Executable Industrial Reality
Industrial systems are governed by constraints, transformations and conservation rules.

Unlike traditional APS systems, ADE-1 evaluates scenarios within the physical constraints encoded in the model.

The system generates thousands of possible sequences.
It varies lot sizes, batch composition, and machine configurations.
Each scenario is simulated over a defined time horizon.

The Outcome:
- ✓ Not estimated—computed.
- ✓ This enables true "rolling production" self-optimization.



The outcome is not estimated: It is computed through the model.

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Key Differentiator: The "Linux Advantage"

- ✓ Unified execution environment
- ✓ Model-driven system generation
- ✓ Constraint-aware orchestration
- ✓ Native traceability
- ✓ Extensible architecture
- ✓ Deterministic execution

ADE-1 does for industrial systems what Linux did for computing: A common execution foundation for heterogeneous industrial environments.

It evaluates thousands of physically valid production scenarios and selects the most suitable outcome according to system objectives and constraints
This leads to:

- ✓ improved consistency
- ✓ stable operations
- ✓ reduced planning effort.

The intelligence is not coded: It emerges from the structure of the system

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Why It Works: The Object-Matrix Architecture

All scenarios are physically valid by design. The Object-matrix architecture replaces traditional database bottlenecks.

Performance: Architecture designed to eliminate many of the bottlenecks associated with traditional database-centric industrial systems.

Constraint Integrity: The system enforces conservation of material, geometric feasibility, and machine capabilities.

The Result: The search space is significantly reduced because the system only explores what can happen, not what might.

This ensures that all simulated scenarios are physically valid.

As a result, the search space is significantly reduced, and large-scale scenario evaluation becomes feasible.

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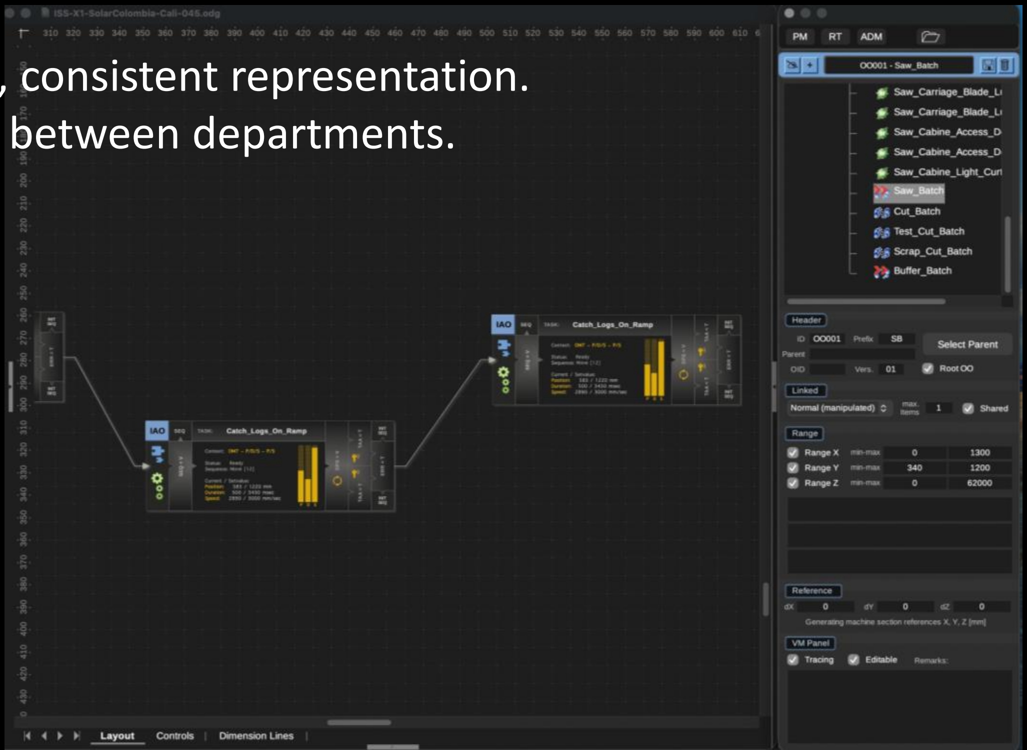
Why ADE-1 is Unique: Unified Execution Architecture

This framework unifies traditionally separate domains:

- ✓ Process Modeling (LibreOffice/FreeCAD)
- ✓ Production Planning (The Sequencer)
- ✓ Execution Logic (C#/Rust/FPGA Runtime)
- ✓ Visualization & Documentation

All operate on a single, consistent representation.
There is no "hand-off" between departments.



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Why ADE-1 is different: ADE-1 vs. Traditional Systems

- ✓ Traditional Systems ADE-1 Framework
- ✓ Fragmented (ERP/MES/PLC) Unified Single Model
- ✓ Manual Integration Automatic Generation
- ✓ Coding Required (PLC/SQL) Model-Driven Configuration/ Visual Modeling
- ✓ Approximation / Heuristics Constraint-Based Execution

Traditional Systems

- fragmented
- manual integration
- coding required
- approximation

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- unified
- automatic generation
- model-driven configuration
- executable industrial model

This level of integration is not available in conventional systems.

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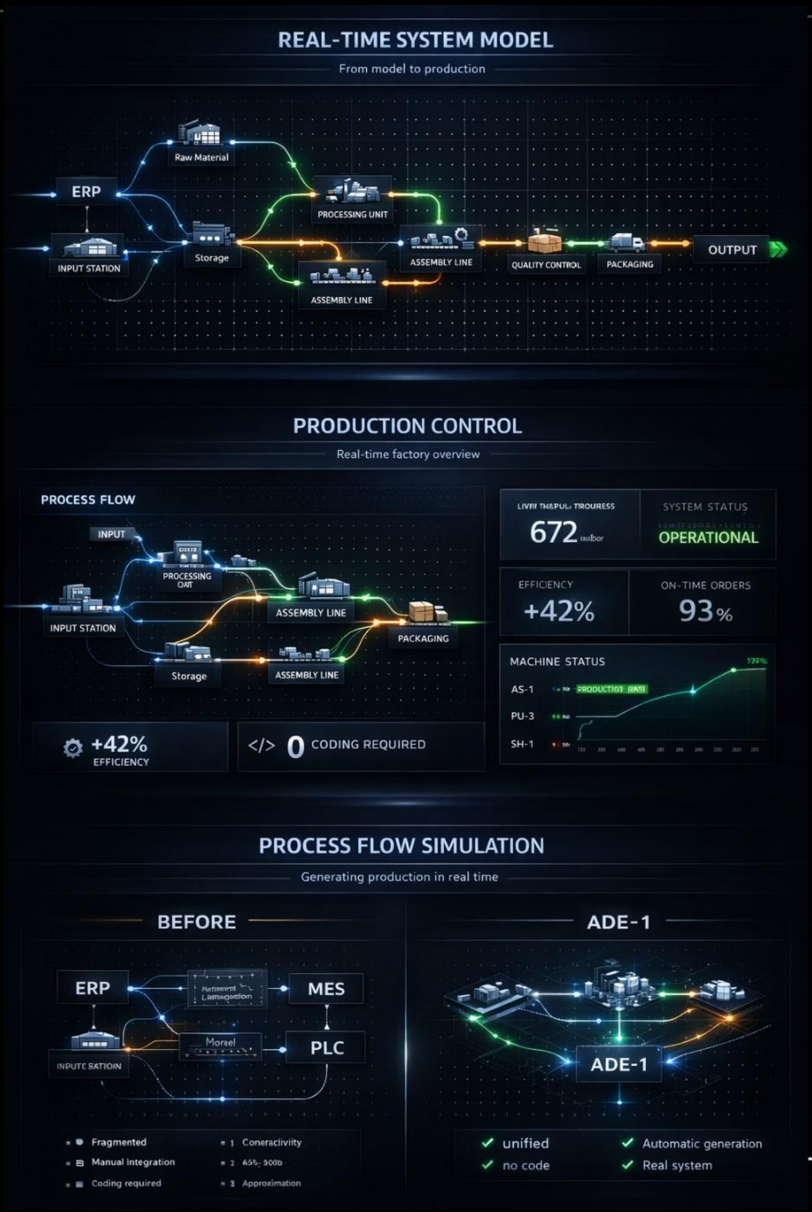
ADE-1 Development Environment
Real system. Real implementation.



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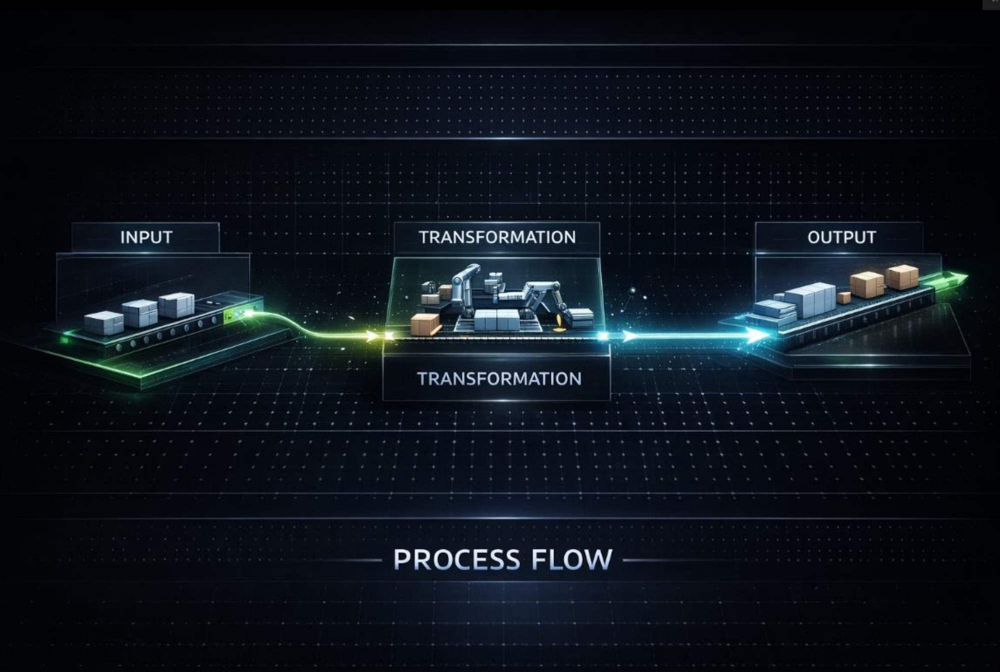
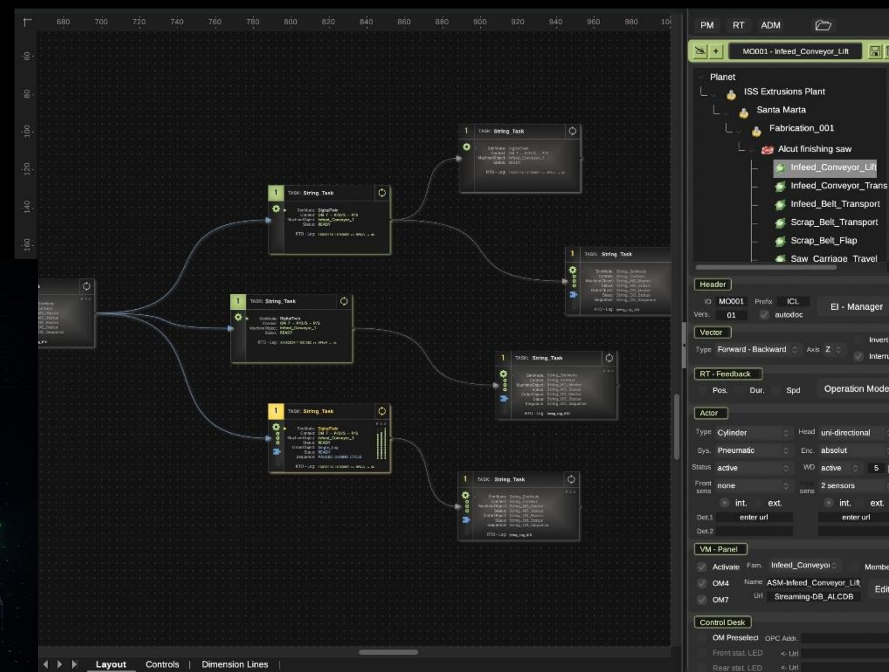
Visual Industrial Modeling
Executable system generation from a unified model.





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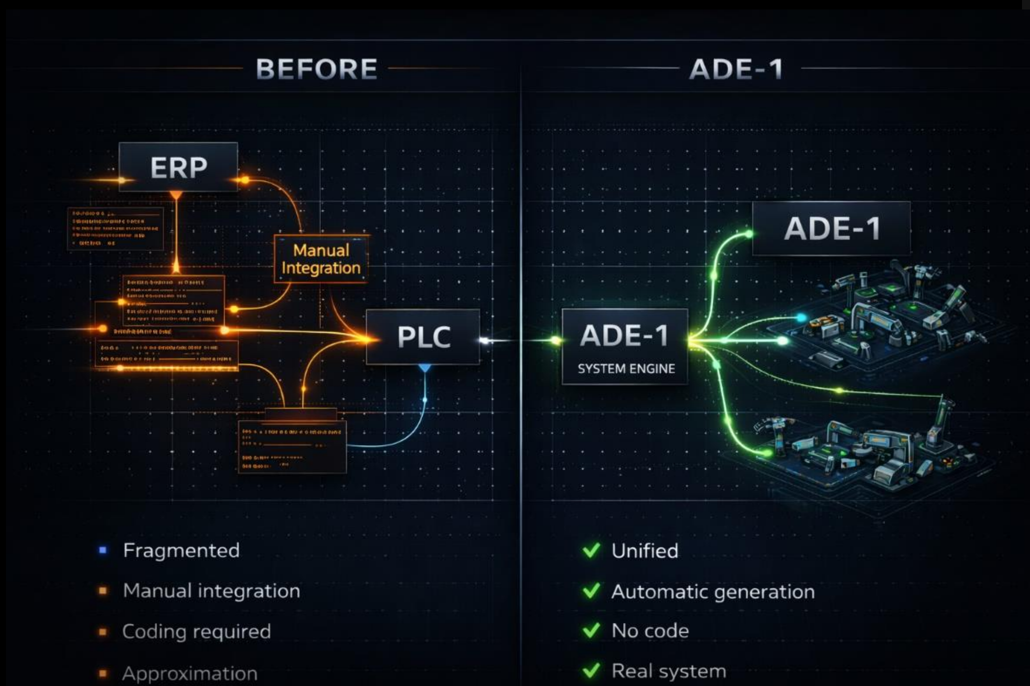
Runtime Components
Industrial entities executing in real time.



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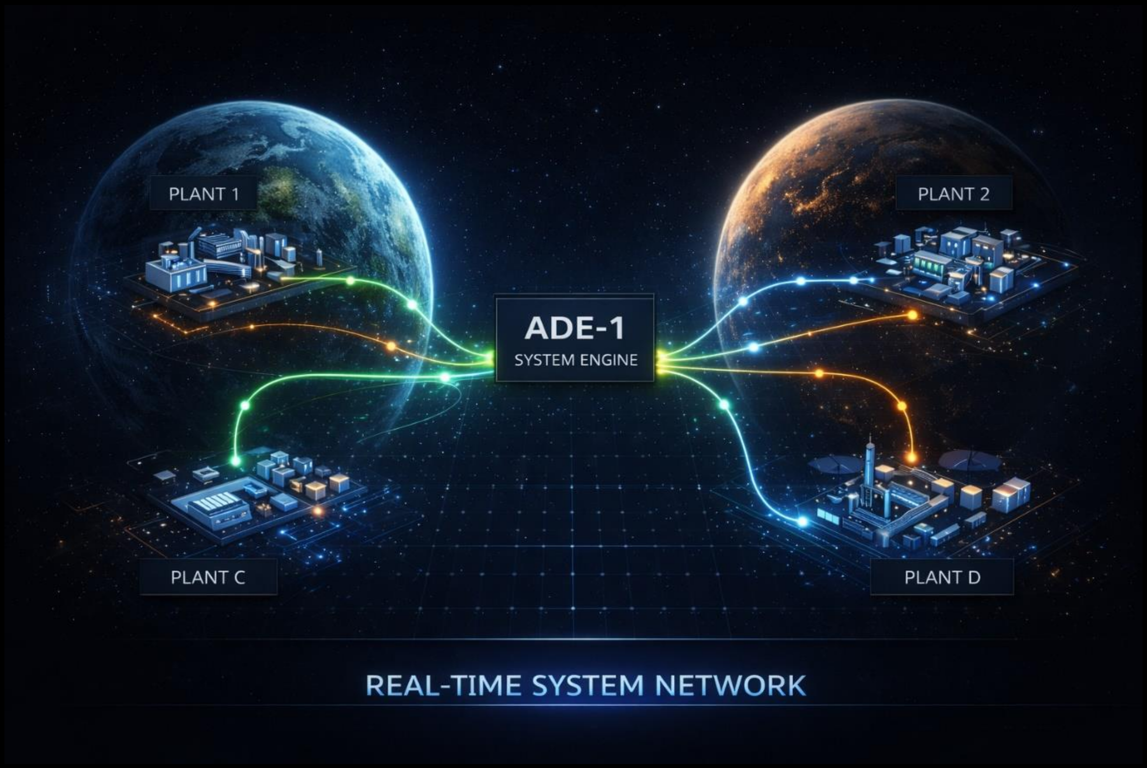
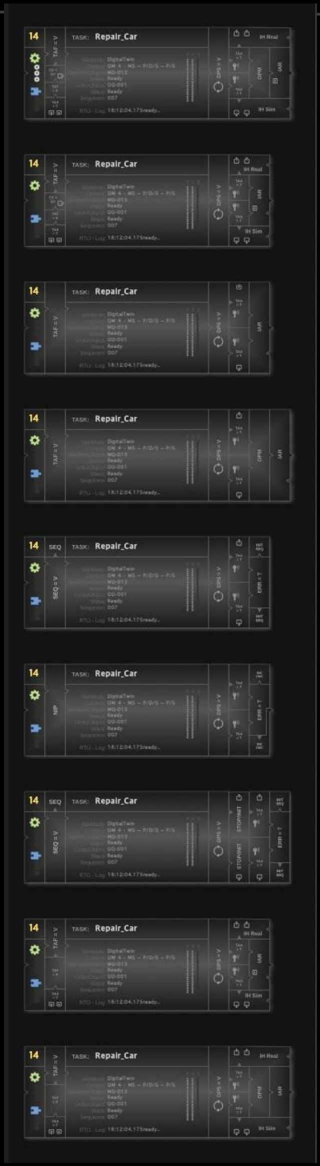
System Architecture
Generated execution structures and operational objects.





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Performance & Scalability: Designed for the Edge and Cloud

Designed for the Edge and Cloud: The system is designed for high computational throughput. Performance advantages:

- ✓ Speed: Architecture optimized for high-throughput industrial execution.
- ✓ Latency: Designed for low-latency control and orchestration workloads.
- ✓ Scalability: Execution capacity scales with available computing resources.
- ✓ Future Architecture: Deployable across cloud, edge and FPGA-based execution environments.

This opens the possibility for near real-time global optimization that was previously computationally impractical using traditional industrial architectures.

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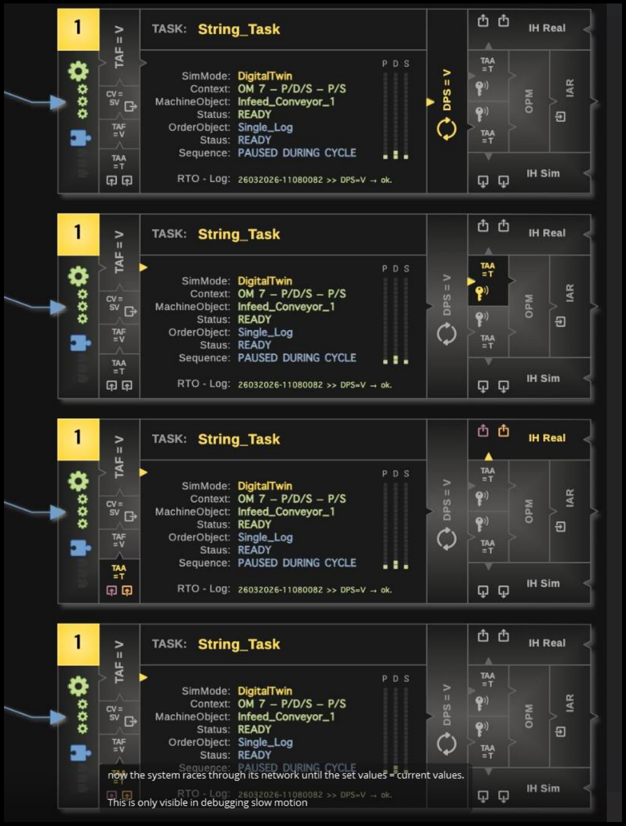
Business Impact: Validated Results

Results observed in validated industrial environments:

- **Efficiency: 20–40% improvement in throughput.**
- **Waste: Significant reduction in material and energy waste.**
- **Complexity: Ability to evaluate operational complexity at scales impractical for manual planning.**



Most importantly:
Ability to evaluate operational complexity beyond practical manual planning limits.

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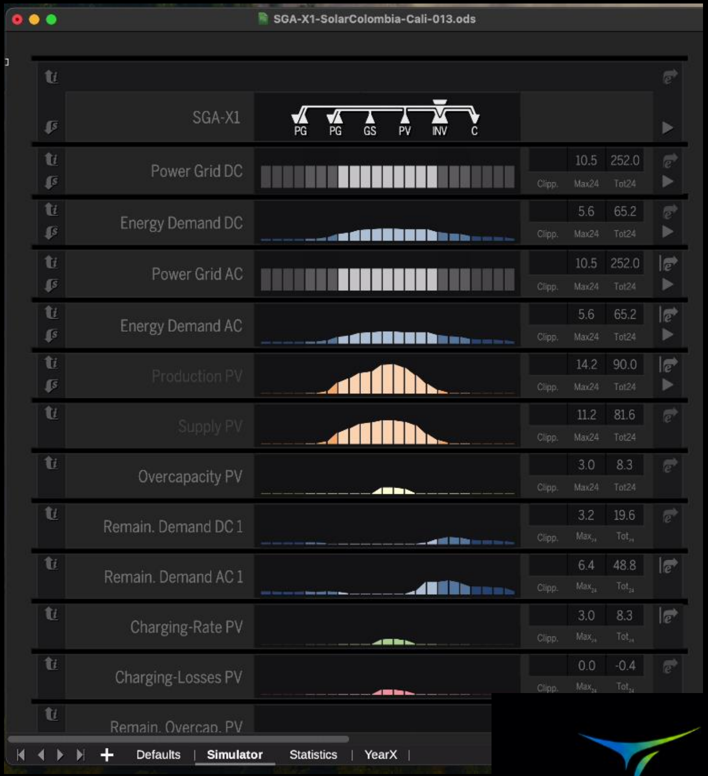
Use Cases: Universal Application

Initially developed for metal processing (Aluminum Extrusion), the underlying model is domain-agnostic. It applies to any system involving material flow and transformation:

- Fluids & Gases (Chemical/Petrochemical),
- Logistics Networks,
- Energy Distribution,
- Recycling Systems,

It applies to any domain involving:

- material flow,
- transformation processes,
- constrained systems,
- Additional industrial domains involving transformation and constrained execution systems.



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Vision: The Discrete Physics Layer
A common execution layer capable of representing materials, transformations, constraints and industrial interactions within a single executable framework.

Our long-term vision is to establish a **universal execution layer for industrial systems**

A system capable of describing:

- Material
- Energy
- Process Interactions
- in a unified, executable form. Effectively creating the "Linux of Automation“: an open standard for industrial reality.

Effectively, a discrete physics layer for industrial systems.

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Strategic Position: ADE-1 is designed as a foundational technology.

It can be deployed as:

- ✓ An industrial execution platform
- ✓ A planning and orchestration engine
- ✓ A digital twin runtime
- ✓ An embedded automation framework
- ✓ A national industrial technology stack

The architecture is independent of any specific hardware vendor, industrial sector or deployment model.

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Competitive Position: Structural Advantage

ADE-1 replaces multiple systems instead of improving one. Existing solutions typically rely on multiple disconnected models, integrations and domain-specific optimization approaches.

Our Approach: Model-driven, physically consistent, and scenario-based.

The Result: We don't just beat the competition on features; We change the underlying execution paradigm.

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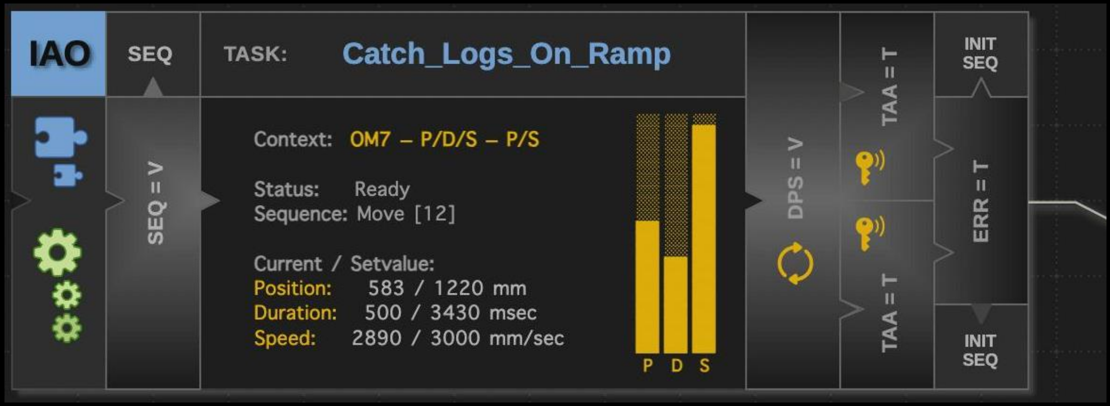
Closing

The Future is Model-Driven

- ✓ We are not adding intelligence on top of industrial systems.
- ✓ We are embedding execution logic directly into the model itself.
- ✓ Planning, simulation and execution share the same foundation.
- ✓ This represents a shift from decision optimization to system-level intelligence.



This represents a shift from decision optimization to system-level intelligence.

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FOUNDERS

Andreas Lechthaler

Electronic Engineer and creator of the ADE-1 architecture.

Developed the original concepts that evolved into ADE-1 and led the design of its executable industrial modeling framework, compiler architecture and automation principles.

Jaime de la Fuente Ramos

Industrial Engineer and business strategist.

Responsible for commercialization, investor relations, strategic partnerships and positioning ADE-1 as a licensable industrial technology platform.

Let's Build the Future of Industrial System

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