



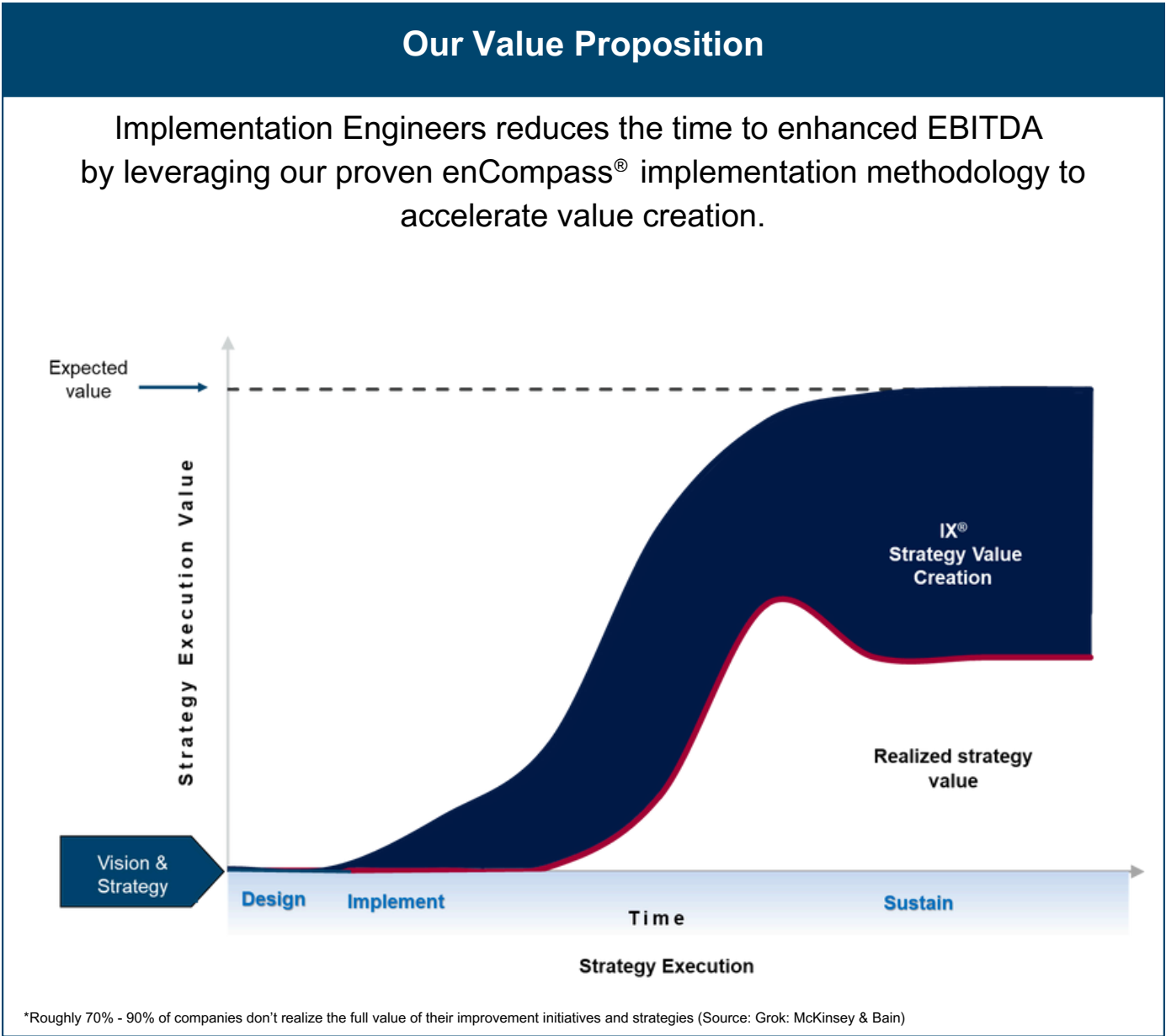
IMPLEMENTATION
ENGINEERS®
BEYOND CONSULTING

IX[®] for Industry 4.0



Introduction to IE

Implementation Engineers is not a consulting or advisory services firm. We are an Implementation Execution (IX[®]) services company dedicated to helping our clients accelerate value creation through the implementation of Vision and Strategy. Research has shown that a significant 90% of strategic initiatives fall short of achieving their intended value. At Implementation Engineers, we are here to assist leaders who recognize gaps in their implementation capabilities that are crucial for realizing the full potential of their business vision and strategy. By streamlining the strategy design process from months or years to mere weeks, we enable faster implementation. Our approach involves leveraging enCompass[®], our structured, disciplined, and sustainable implementation methodology, to ensure successful implementation. Our core value proposition is centered around expediting the realization of Vision and Strategy, resulting in sustainable achievement of expected value.



Implement What?

Industry 4.0, also known as the Fourth Industrial Revolution, has had a profound impact on manufacturing companies across the globe. This paradigm shift towards automation, data exchange, and digital technologies has revolutionized traditional manufacturing processes, leading to increased efficiency, productivity, and competitiveness. Companies that embrace and adapt to these technological advancements are poised to thrive in the digital age of manufacturing and IE is here to implement.

How will Industry 4.0 help your business?



Build Faster

Reduce cycle time and improve production velocity through real-time performance visibility, increased automation, and efficient information transfer



Build Better

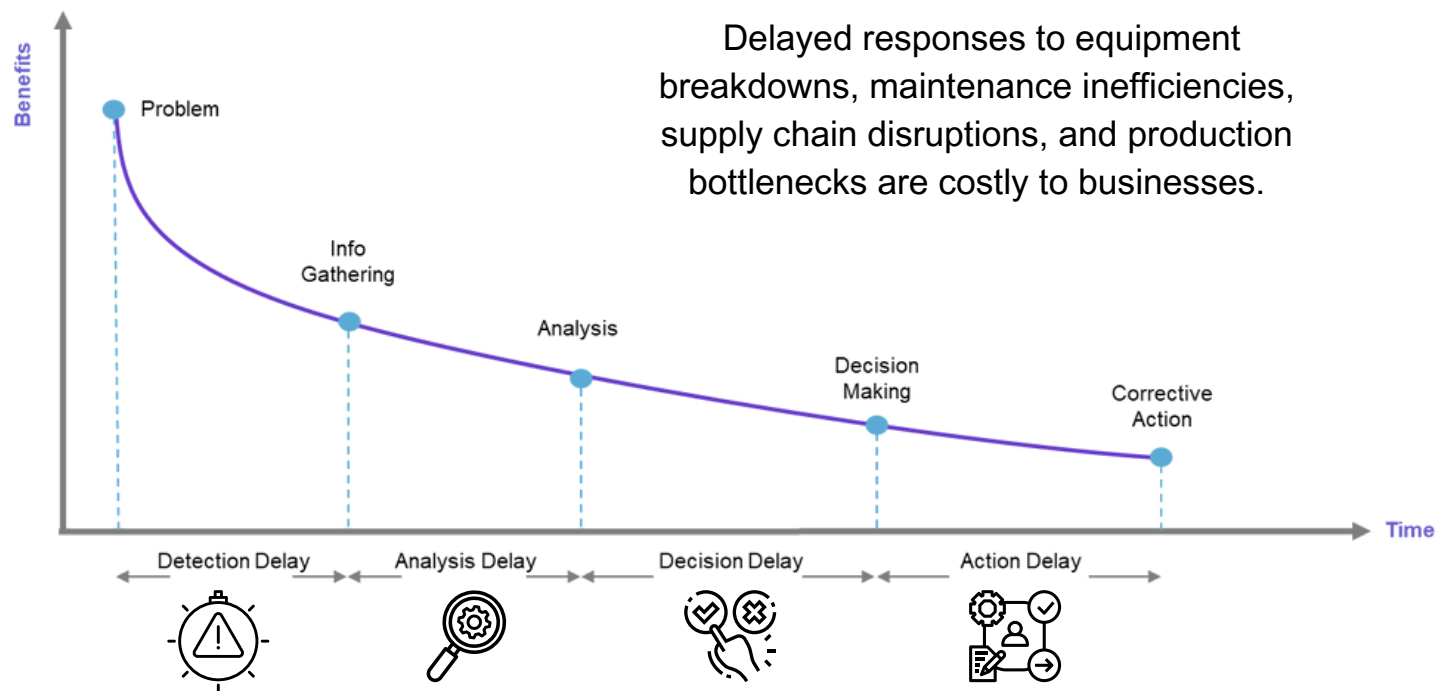
Improve quality with connected worker applications, predictive failure analytics, and reduced reliance on tribal knowledge



Build Cheaper

Decrease bottom line costs with an agile production system, resilient machinery, and an optimized supply chain

Business Challenges Before Industry 4.0



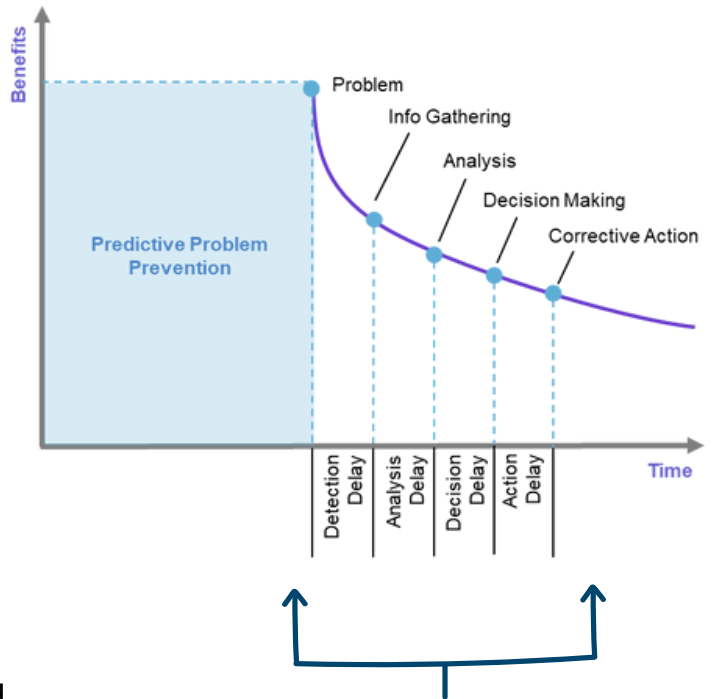
Businesses encounter several delays in addressing challenges

Implement What?

Industry 4.0 Mitigates Business Challenges

Predictive tools prevent problems from occurring and thus prolonging benefits

- Predictive maintenance anticipates when machine is at risk and alerts staff
- Supply chain risks auto-identified and member notified
- Production capacity bottlenecks known and mitigated prior to release to shop floor

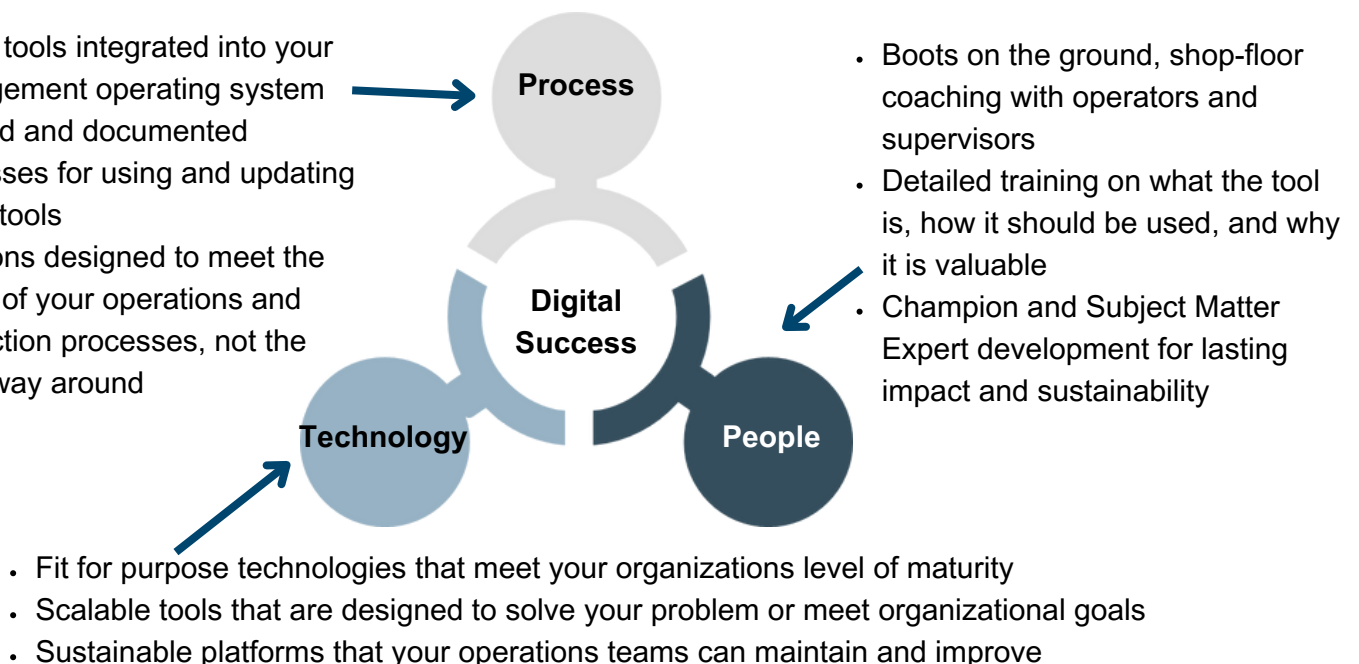


Industry 4.0 reduces the time between business problem and action

- Real-time dashboards provide visibility and alert team to issues
- Connected worker apps improve efficiency and reduce tribal knowledge
- Data-driven culture empowers workforce
- SOP's are delivered to operator at point of use reducing waste
- Management team has easy access to all necessary data to make decisions

People Development & Process Integration is Key to I4.0 Implementation

- Digital tools integrated into your management operating system
- Defined and documented processes for using and updating digital tools
- Solutions designed to meet the needs of your operations and production processes, not the other way around



- Boots on the ground, shop-floor coaching with operators and supervisors
- Detailed training on what the tool is, how it should be used, and why it is valuable
- Champion and Subject Matter Expert development for lasting impact and sustainability

- Fit for purpose technologies that meet your organizations level of maturity
- Scalable tools that are designed to solve your problem or meet organizational goals
- Sustainable platforms that your operations teams can maintain and improve

Implement What?

Implementation Engineers play a crucial role in the successful integration of Industry 4.0 technologies. Our IX® specialists possess the expertise and knowledge required to effectively implement advanced technologies that drive operational efficiency and productivity. By carefully assessing the size and scope of an organization, we can tailor technology solutions to meet specific needs and objectives. Factors such as data maturity and scale are taken into consideration to ensure that the selected technologies align with your organization's capabilities and goals.

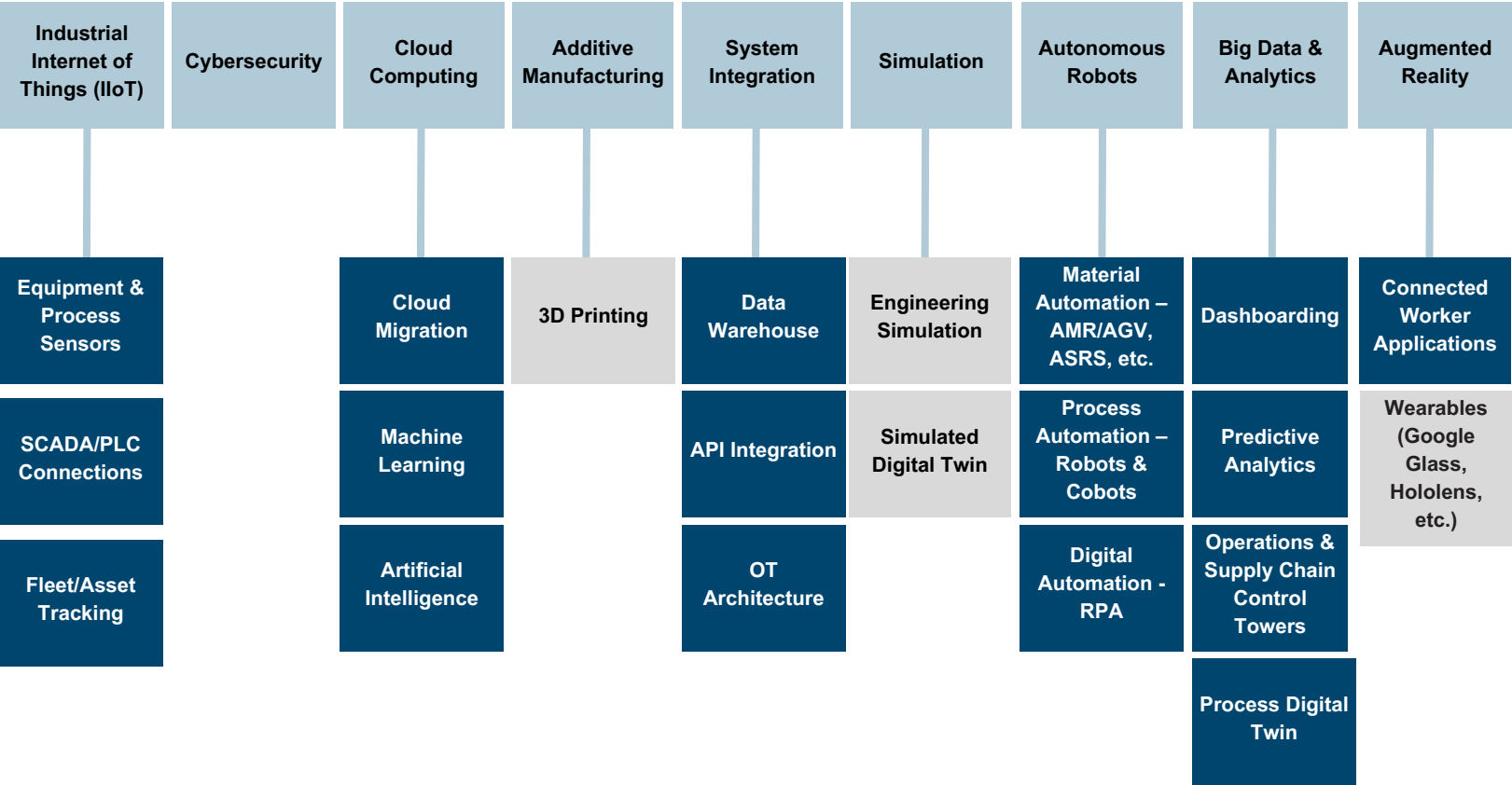
Industry 4.0 Technologies

I4.0 Technology

IE Core Service

IE Non-Core Service

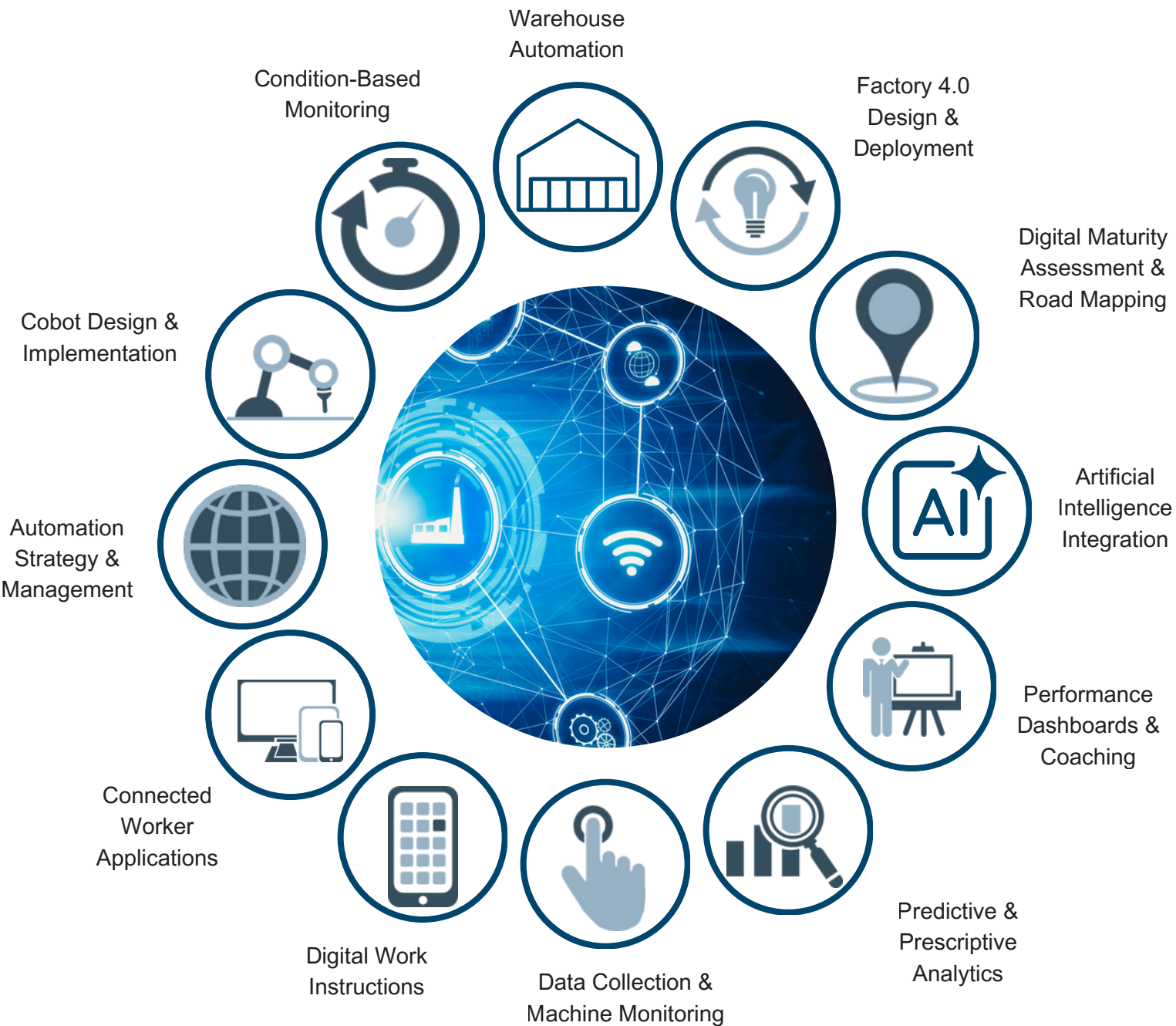
The following technologies are categorized based on their types, with Implementation Engineers specializing in the technologies highlighted in dark blue below.



Implement What?

Implementation Engineers excels at implementing initiatives quickly and effectively to maximize impact. The following outlines the areas in which IE focuses on within the realm of Industry 4.0. Whether taking a holistic approach or targeting specific improvements, we strive to meet the unique needs and objectives of our clients.

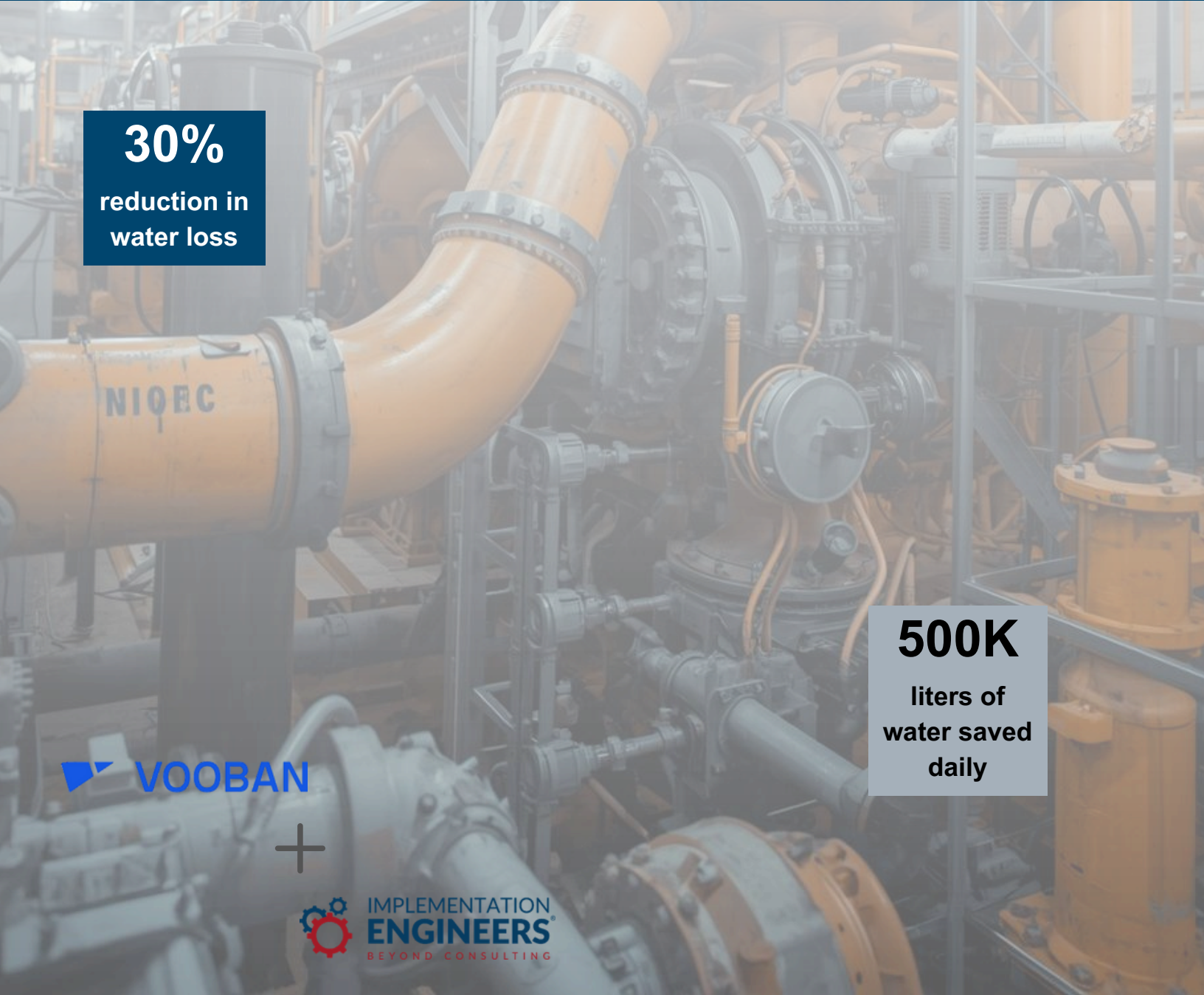
Industry 4.0 Implementation Support



We support the development of an Implementation Design, which includes detailed implementation plans and a business case for your project or initiative, tailored to the complexity of the desired improvements. Implementation Design identifies improvement opportunities across operational processes, any organizational and cultural gaps along with any technology and information gaps. These opportunities are transformed into a detailed project plan designed to accomplish the program’s performance objective. If you already have an implementation design in place, we provide the necessary resources to support your team's implementation needs. Our team members work with you to ensure the realization and sustainability of value while minimizing implementation risks.

Predictive Analytics

IX[®] in Action



30%
reduction in
water loss

500K
liters of
water saved
daily

 **VOOBAN**



 **IMPLEMENTATION
ENGINEERS**
BEYOND CONSULTING

The client is a long-established industrial manufacturer specializing in sealing systems for critical equipment such as pumps, valves, mixers, boilers, and process vessels across heavy industrial sectors including pulp and paper, metals, and resource processing. In these environments, water plays a vital role in cooling and lubrication — especially around rotating equipment where sealing performance directly affects operations, energy consumption, and regulatory exposure.

Over time, gasket performance naturally degrades due to extreme temperatures, pressure differentials, and mechanical wear. However, the condition of these seals was historically difficult to monitor in real time. Maintenance decisions were largely reactive or based on scheduled intervals rather than actual operating conditions. As a result, the company faced excessive water losses, premature part replacements, avoidable downtime, and equipment damage that was costly and difficult to predict.

Leadership engaged Implementation Engineers and Vooban to transform maintenance from a reactive function into a data-driven operating discipline — one capable of predicting failures before they happened and prescribing the right intervention at the right moment.

AI Implementation

The joint team deployed predictive and prescriptive AI models directly into operational environments — embedding intelligence inside industrial equipment rather than leaving it in dashboards.

Predictive Models for Gasket Health

- AI continuously evaluates gasket condition using real-time data on pressure, temperature, and operating profiles.

Prescriptive Maintenance System

- The system not only predicts failure but actively recommends actions — adjusting water pressure, tightening seals, or scheduling targeted inspection.

Real-Time Sensor Network

- Sensors embedded in rotating equipment feed performance data directly into AI models.

Edge-Based Monitoring Stations

- Measurement units deployed in the field deliver real-time insights to both operators and maintenance teams.

Unified Dashboard and Cloud Analytics

- Operational data is visible through dashboards accessible from anywhere via secure remote access.

Continuous Model Improvement

- Each operating cycle improves the system’s ability to detect, predict, and prevent seal failures.

Scalable Architecture for Service Commercialization

- The solution evolved into a product offered to industrial customers as a commercial capability.

Results

The AI deployment delivered material economic, environmental, and operational impact:

Up to 30% Reduction in Water Loss

- Gasket leakage was significantly reduced across customer sites.

Over 500,000 Liters of Water Saved Per Facility Per Day

- Daily resource consumption dropped at scale without capital investment.

Lower Maintenance Costs

- Equipment life was extended by eliminating unnecessary replacements.

Reduced Unplanned Downtime

- Failures were predicted before causing production losses.

Improved Asset Reliability

- Operating conditions became controlled rather than reactive.

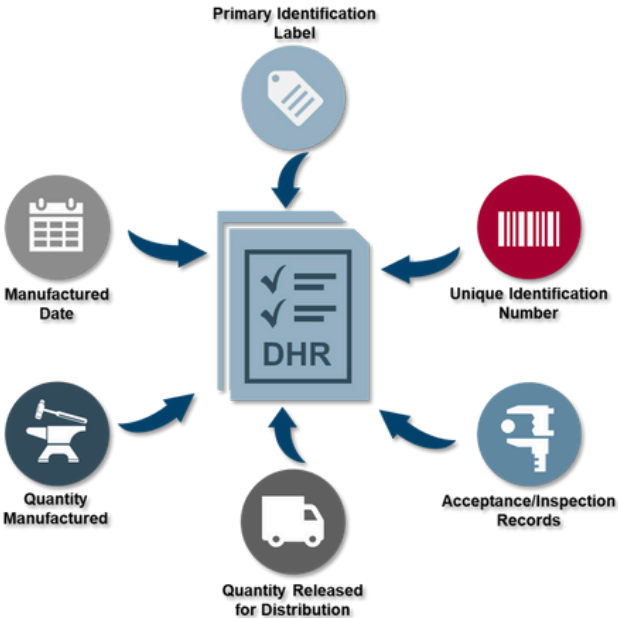
Connected Worker Applications

IX[®] in Action

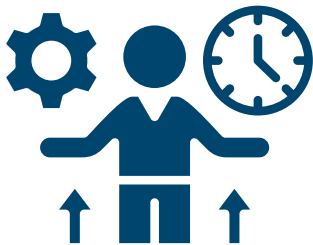
25%
of manual DHR
entries
automated

\$12.4M
annual cost
savings

Implementation Engineers collaborated with a leading medical device manufacturer, specifically focusing on the production of trauma plates. The existing paper-based Device History Records (DHR) process was identified as a source of inefficiencies and quality issues within the manufacturing plant. To address these challenges, our team introduced a solution by implementing an electronic DHR (eDHR) system.



eDHR Benefits



Productivity Savings

- Removal of in-process DHR reviews
- Data recording time reduction



Quality Savings

- Defect lot reduction - Documentation errors on DHRs often require a rework order to re-inspect or correct the issue, each consuming 5 hours of manufacturing production time and labor



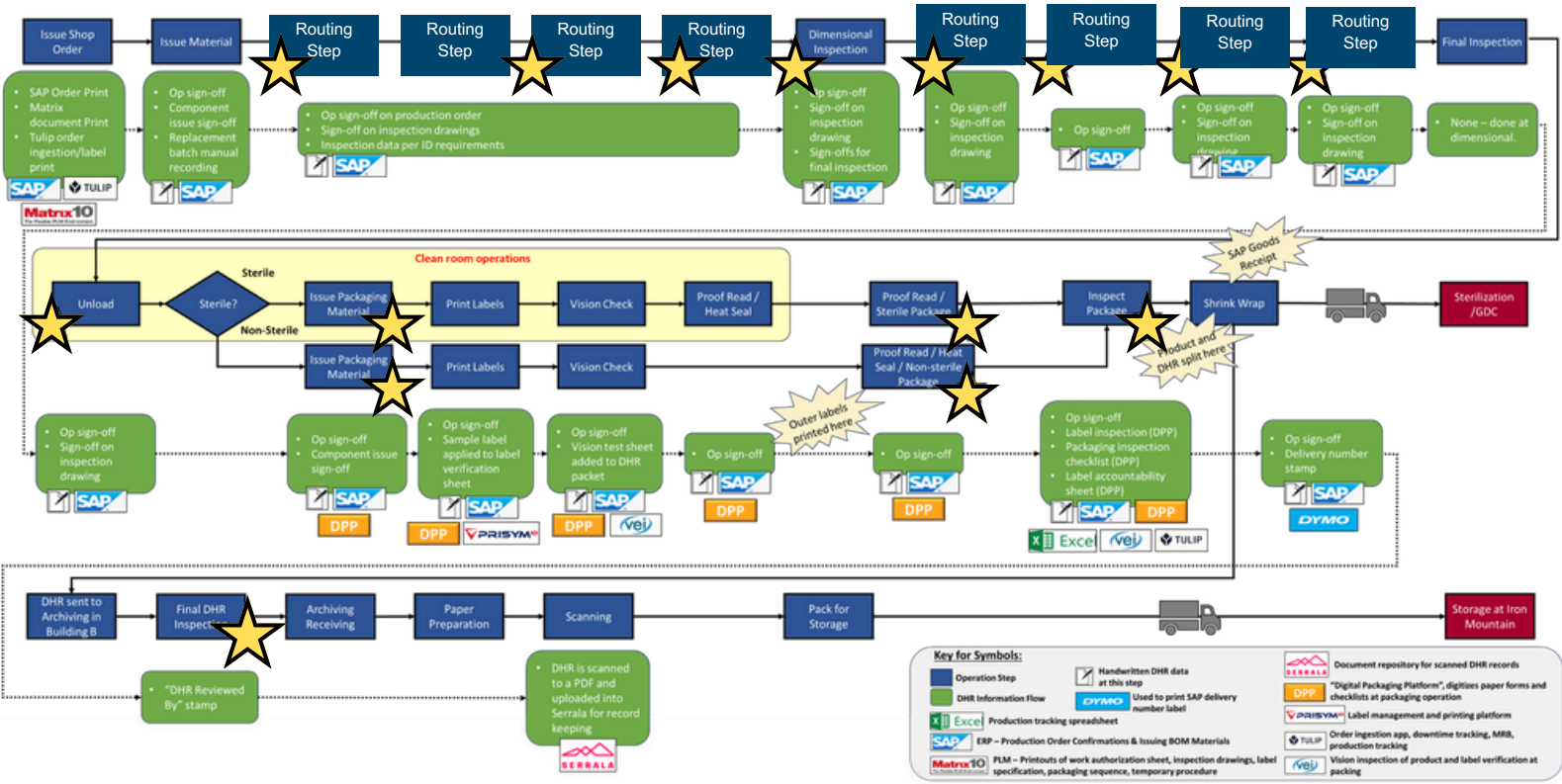
Paper Savings

- Reallocated labor from Archiving
- Eliminated incremental paper storage costs
- Reduced printing costs

Mapping the DHR Information Flow

The eDHR system was designed to streamline operations by reducing manual entries and enhancing error-proofing measures. With traditional DHRs spanning 50-60 pages and containing 400-500 handwritten entries, the transition to eDHR significantly minimized manual data input requirements.

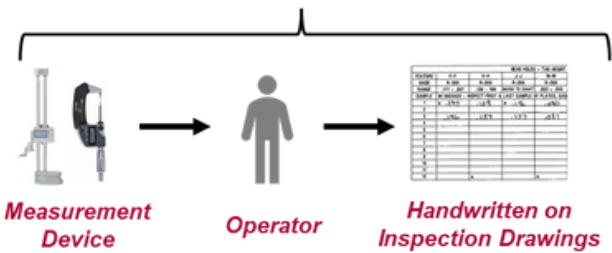
★ Manual DHR review by operators - DHR reviewed 13 times!



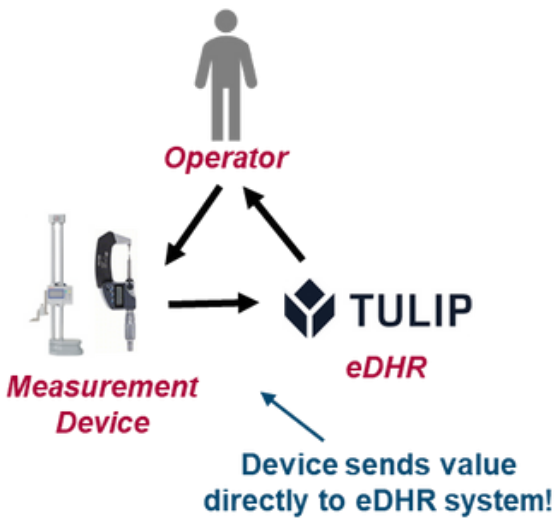
Connected Devices Are An Additional Benefit

By automating key processes such as gage calibration dates and inspection drawing entries, the eDHR system eliminated approximately 25% of manual data entry tasks.

How Measurements Recorded Before eDHR

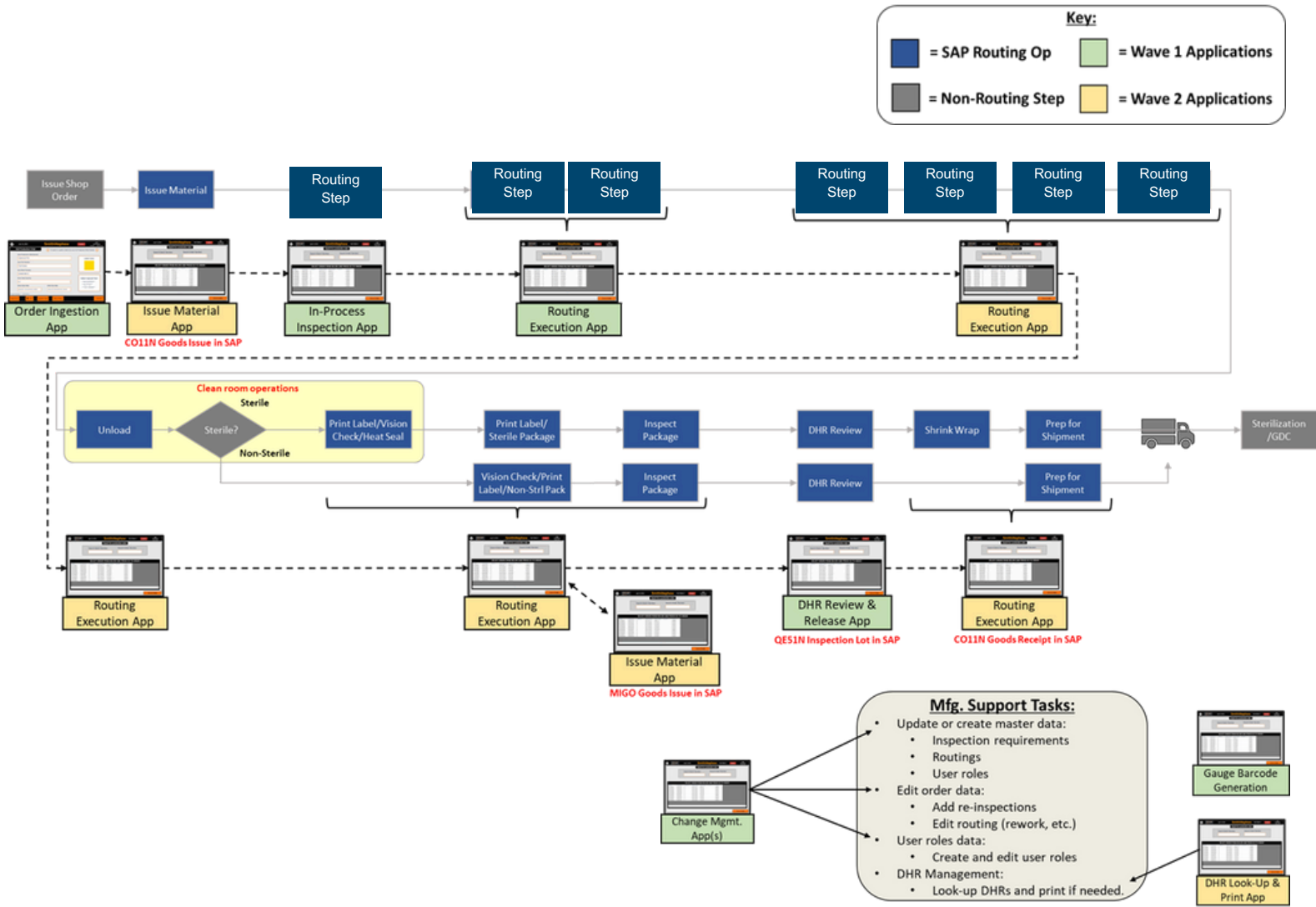


eDHR Enables Connected Devices



eDHR Approach

Leveraging a composable app architecture, we developed a suite of specialized apps tailored to each manufacturing process, all supported by a shared table model for seamless system integration. This approach enabled us to adopt an Agile development methodology, allowing for iterative app prioritization, development sprints, and validation.



Apps Developed

- 1

Order Ingestion
- 2

Routing Execution
- 3

Issue Material
- 4

In-Process Inspection
- 5

eDHR Review & Release
- 6

Shipment Prep
- 7

Gauge Barcode Creation
- 8

Change Management/Admin



Digital Work Instructions

IX® in Action

100%

of processes
documented

30

custom apps
developed

The Challenge: Ensuring Continuity in a Complex Production Relocation

A leading multinational manufacturer of electrical enclosures faced a pivotal decision: relocate production from its U.S. facility to a new plant in Mexico to optimize costs and operational efficiency. The U.S. plant fabricated custom electrical cabinets, starting with sheet metal and progressing through forming, welding, finishing, assembling, and painting enclosures ranging from less than 1 foot to over 8 feet in size. However, a significant hurdle emerged—no formal work instructions existed to document these intricate processes. Without clear guidance, the transition risked production delays, quality inconsistencies, and operational setbacks at the new facility.

Our client recognized that a seamless relocation required more than just moving equipment; it demanded a robust strategy to capture and transfer institutional knowledge across borders. That’s where Implementation Engineers stepped in.

Digitizing Operations for Seamless Cross-Border Success

Implementation Engineers partnered with the manufacturer to bridge the gap between facilities using our expertise in digital manufacturing and technology implementation. Leveraging the composable MES platform Tulip, we deployed a tailored solution to document, digitize, and translate the production processes into operator-friendly tools. Our team observed operations firsthand at the U.S. plant, identifying 30 unique processes tied to specific equipment and product families - covering the full scope of production moving to Mexico.

We then transformed these observations into multilingual digital work instruction apps, complete with pictures and videos, designed to simplify complex workflows for operators. Each app was developed in both English and Spanish, ensuring accessibility for the Mexican plant’s workforce. Beyond the apps themselves, we created detailed usage instructions to empower engineers and operators with the training needed to adopt the technology swiftly and effectively. Every app underwent rigorous approval by the Mexican plant’s engineering team, guaranteeing alignment with operational standards.

Delivering Continuity and Efficiency in Relocation

Our project metric was clear: build, translate, and secure approval for 30 digital work instruction apps. We delivered on time and exceeded expectations, enabling the manufacturer to:

- **Preserve Production Quality:** Comprehensive documentation eliminated guesswork, maintaining consistency across facilities
- **Accelerate Ramp-Up:** Operators in Mexico adopted the apps quickly, minimizing downtime during the transition
- **Enhance Scalability:** The digital framework provided a foundation for future process improvements and technology integrations

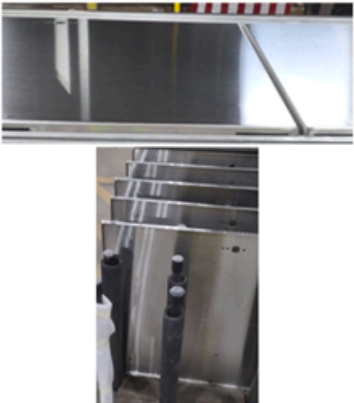
By combining our deep operational expertise with innovative digital tools, Implementation Engineers turned a high-stakes relocation into a strategic advantage. The manufacturer achieved a smooth production handoff, safeguarding efficiency and customer satisfaction while positioning their new facility for long-term success.

Precautions

Safety

Quality

EPP

Important step	Key points	Reasons
Remove the lids and place them on the cart. 	1. Visually inspect the caps to make sure they have a smooth, polished finish. 2. Place the finished caps carefully on a cart to avoid scratching the surface.	1. Caps with visual defects will need to be reworked. 2. This allows the caps to be safely transported to the next work cell.

If there are defects, follow the rework instructions.

← Previous

1

Precauciones

Seguridad

Calidad

EPP

Paso importante	Puntos clave	Razones
Retirar las tapas y colocarlas en el carrito. 	1. Inspecciona visualmente las tapas para asegurarte de que tengan un acabado liso y pulido. 2. Coloca las tapas terminadas cuidadosamente en un carrito para evitar rayar la superficie.	1. Las tapas con defectos visuales necesitarán ser retrabajadas. 2. Esto permite que las tapas se transporten de manera segura a la siguiente celda de trabajo.

Si hay defectos, siga las instrucciones de retrabajo.

← Anterior

🏠

🔔 Reiniciar alarmas

🔄 Retrabajo

✚

✓ Completo

Digital Work Instructions in English and Spanish

Artificial Intelligence



Our client was a leading North American manufacturer of engineered steel components for mission-critical infrastructure and large-scale construction projects. Operating multiple high-volume plants and employing thousands, the company produces hundreds of thousands of structural assemblies each year — every one defective weld can jeopardize safety, delay multi-million-dollar projects, and trigger costly rework.

The Challenge

Weld inspection had become the single largest constraint on growth:

- 100% manual visual inspection by certified technicians
- Severe shortage of qualified inspectors in a tightening labor market
- Rising production volumes outpacing inspection capacity
- Inherent human variability, fatigue, and shift-to-shift inconsistency
- Quality risk escalating as throughput demands increased

The Solution: AI Embedded AI Inspection System

Implementation Engineers and Vooban partnered to design, validate, and deploy an AI system that operates as a core element of the production line — not alongside it.

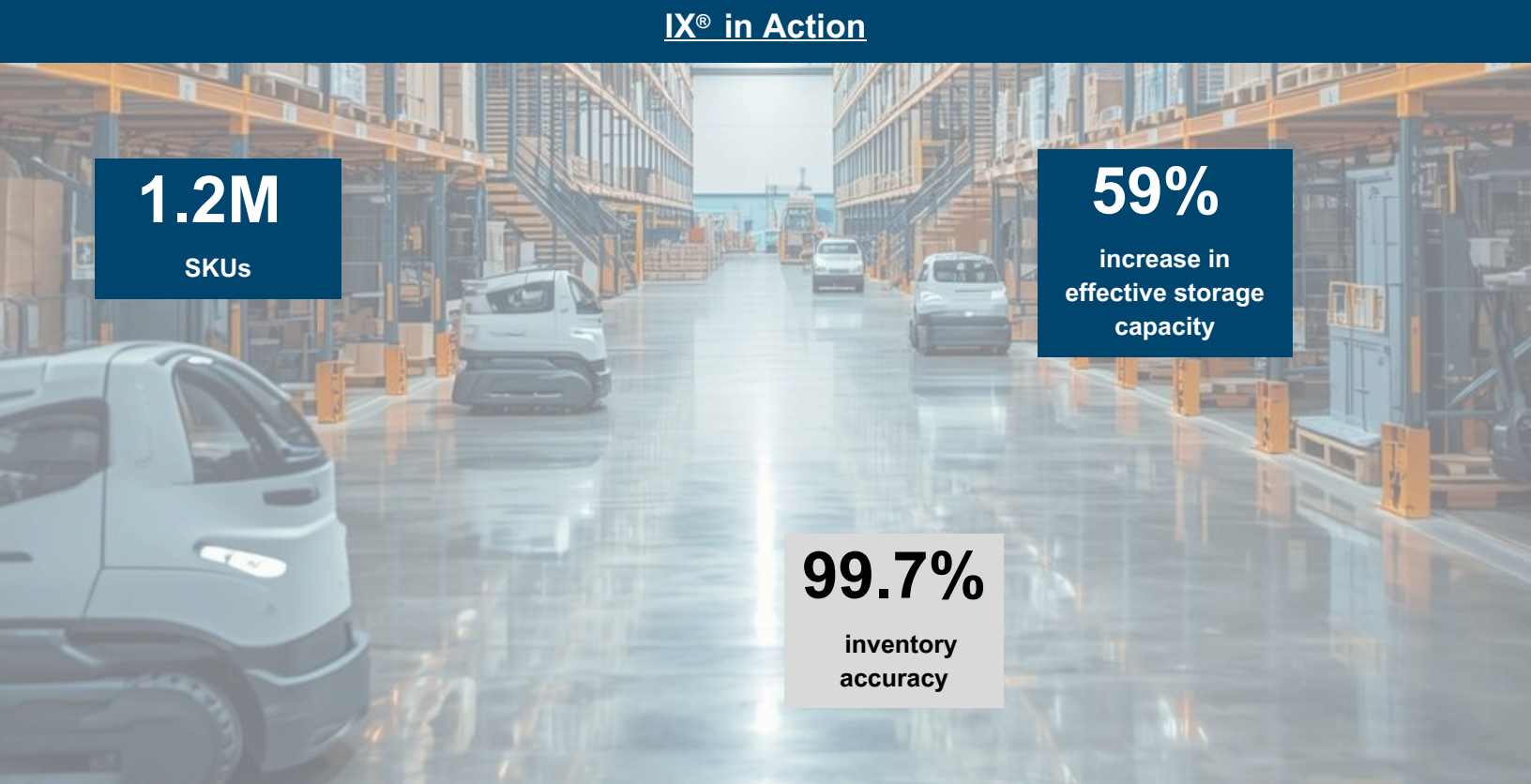
Key Capabilities

- Real-time computer vision analyzing live overhead and side-camera feeds
- Simultaneous multi-object detection across stacked, complex steel assemblies
- Classification of 15+ weld defect types (missing welds, undercuts, porosity, misalignment, etc.) with enterprise-grade precision and recall
- Edge-based inference delivering sub-second decisioning with zero cloud latency
- Intuitive operator HMI that highlights defects instantly with bounding boxes and confidence scores
- Automated continuous-learning loop: low-confidence images are routed for human review and automatically re-ingested to improve the model
- Fully scalable architecture already replicating across additional lines and facilities

Results: \$6.5M+ Annual Impact and a New Competitive Edge in Weld Quality

The production-grade AI weld inspection system eliminated routine manual checks with near-perfect accuracy, removed the inspection bottleneck, and unlocked 24/7 throughput. It now delivers >\$6.5M in annual value through higher volume, better yield, and labor optimization while standardizing quality across plants and freeing scarce inspectors for higher-value work—transforming a major constraint into a competitive advantage.

Warehouse & Material Automation



The Challenge

A large **agricultural and industrial equipment manufacturer** faced a growing operational constraint within its **300,000 sq. ft. electrical components manufacturing and distribution facility**.

The operation supported:

- A **1.2 million SKU total line card**
- Approximately **250,000 SKUs on hand at any given time**
- Direct support to manufacturing, assembly, and outbound distribution

As demand increased and SKU proliferation accelerated, the warehouse could no longer scale through traditional means. Storage density, material flow, and legacy processes forced reliance on a **separate external storage facility** to maintain service levels.

Each retrieval from this off-site location required a **9-minute roundtrip** — before any picking or handling even began.

At scale, this created:

- Built-in latency for production and outbound orders
- Chronic expediting and firefighting
- Excess labor and transportation cost
- Increased risk of shortages and line interruptions
- A hard ceiling on productivity and service performance

IX[®] in Action (continued)

This was not a problem solvable through incremental layout changes or isolated automation pilots. Success required a **multi-year Industry 4.0 transformation** grounded in a deep understanding of:

- Warehouse operations and labor models
- Supply network dynamics and material velocity
- Digital systems, inventory accuracy, and IT infrastructure

All while the operation continued to run.

Implementation Engineers’ Role

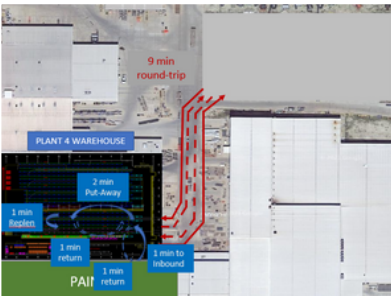
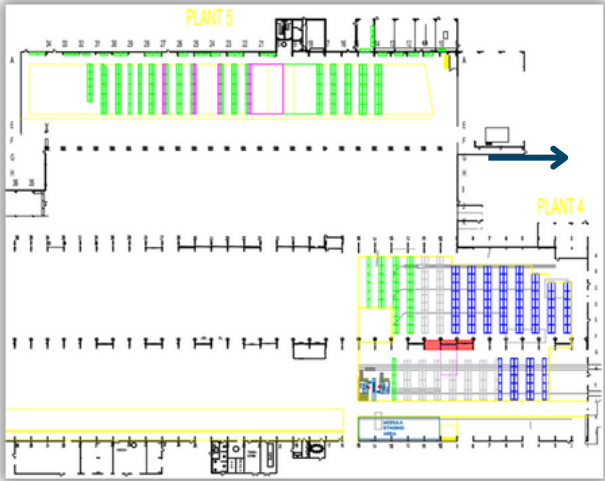
Implementation Engineers did not act as advisors. **IE owned the outcome.**

Over a **five-year period**, IE:

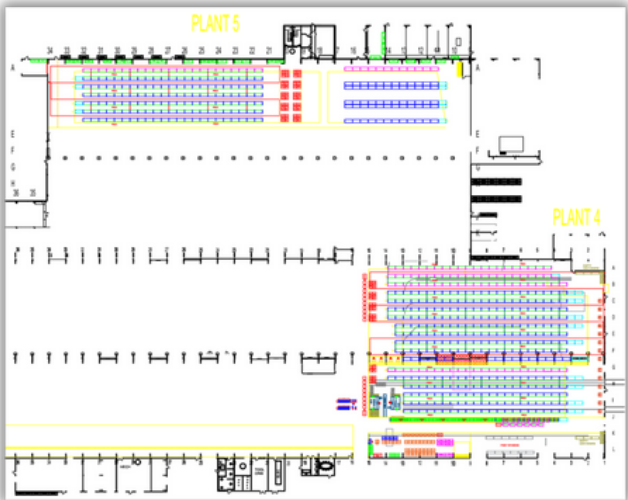
- Designed the warehouse layout, storage strategy, and material flow
- Implemented racking, automation, and digital picking technologies
- Defined labor standards, productivity targets, and performance management
- Built inventory accuracy, location control, and IT integration
- **Ran day-to-day warehouse operations while transforming them**

This engagement represented true **Industry 4.0 execution** — aligning people, process, technology, and data through disciplined, phased implementation.

Original Warehouses



Outside storage facility eliminated



Optimized Warehouses

The Transformation — Executed in Phases

Phase 1: Facility Design & Industry 4.0 Operating Model Foundation

IE began by designing a future-state warehouse capable of handling extreme SKU complexity **without sacrificing speed, accuracy, or scalability.**

This foundation created the structural and digital conditions required to unlock automation and eliminate external storage.

Design principles included:

- High-density storage aligned to SKU velocity
- Clear separation of picking, replenishment, and vehicle traffic
- Storage and slotting strategies matched to form factor and demand
- Scalable material flow supporting both manufacturing and distribution
- Digital visibility designed into the physical operation

Phase 2: Eliminating the External Storage Facility

Eliminating reliance on the external storage facility was established as a non-negotiable requirement.

Examples of these systems are on page 5

Rather than expanding footprint, IE:

Results

- | | |
|---|---|
| ➤ Redesigned storage density and slotting strategy | ➤ 100% elimination of the external storage facility |
| ➤ Increased vertical utilization and reduced aisle widths | ➤ Full repatriation of inventory into the 300,000 sq. ft. warehouse |
| ➤ Re-engineered material flow to support higher on-site velocity | ➤ Removal of a 9-minute roundtrip delay from every material retrieval |
| ➤ Implemented automation to reclaim floor space without reducing access | ➤ Immediate reduction in handling time, labor, and logistics cost |

Phase 3: Inventory Accuracy, Digital Control & IT Integration

With inventory centralized, IE focused on building **digital reliability at scale.**

Through disciplined processes and tight integration between physical execution and IT systems, IE achieved:

- 99.7% inventory accuracy by quantity and location
- Real-time visibility across hundreds of thousands of active SKUs
- Reduced shortages, expedites, and production disruptions

IX® in Action (continued)

Phase 4: Productivity, Labor Standards & Execution

IE established aggressive but achievable labor standards supported by digital execution systems.

Floor Picking Performance

- Target rate: 30 picks per hour
- 50% of the workforce consistently achieved 40+ picks per hour

Full-Pallet & VNA Operations

- Very Narrow Aisle (VNA) turret trucks operating in 200-foot aisles
- Sustained pick rates of 15 pallet picks per hour

These results were driven by:

- Optimized, system-directed pick paths
- Velocity-based slotting
- Clear work standards
- Strong frontline leadership and execution discipline

Phase 5: Industry 4.0 Automation & Long-Term Scalability

Over time, IE implemented fit-for-purpose Industry 4.0 technologies as part of a long-term roadmap — not isolated pilots:



Selected and installed a Modula Vertical Lift Module (VLM) to store small and medium parts



Implemented Pick to Light for floor picking, replenishment and empty container



Implemented Autonomous Mobile Robots (AMRs) for receiving delivery, kit cart movement and assembly transport



Implemented Very Narrow Aisle (VNA) trucks for put-away and replenishment

Why This Case Matters

This engagement demonstrates Implementation Engineers’ ability to:

- Lead **long-duration, high-complexity Industry 4.0 transformations**
- Integrate **operations, supply chain, automation, and IT**
- Deliver sustained results at enterprise scale
- **Run live operations while transforming them**

Cumulative Results (Five-Year Impact)

Over five years, the transformation delivered:

- **300,000 sq. ft. facility designed, implemented, and operated**
- **1.2M SKU line card managed with ~250K SKUs on hand**
- **99.7% inventory accuracy** by quantity and location
- **100% elimination of an external storage facility**
- Removal of a **9-minute roundtrip delay** per material retrieval
- **80% reduction in internal travel distance**
- **59% increase in effective storage capacity**
- **94% reduction in small-parts storage footprint**
- Industry-leading picking and pallet handling productivity
- A scalable, future-ready Industry 4.0 warehouse operation

Cobot Design & Implementation

The implementation of collaborative robots, or cobots, in manufacturing processes offers a range of benefits for companies. Cobots are beneficial for manufacturing companies in several ways, including increasing productivity, reducing production costs, improving product quality, and enhancing workplace safety. By streamlining operations and optimizing workflows, cobots can contribute to higher profitability for manufacturing companies in the long run. IE successfully integrates cobots with your processes and people.

IX® in Action

Labor demand
reduction

10%
output
improvement

Our client operated a glass processing facility. The Glass deburr & chamfer process required one to two operators per shift. Our client partnered with IE implement cobot in its glass debur and chamfer process. These operations were manual and very repetitive, which made it difficult to retain employees on this station.

- Confirmed the business case for automating
- Developed automation requirements and designed automated process using cobots
- Used two cobot systems to meet cycle time requirements
- Deployed two cobots and accompanying fixtures.
- Designed and fabricated part handling fixtures for optimal flow
- Utilized 3rd party vendor to develop auto-rotate gripper to alleviate eight (8) cobot manual rotations.
- Built new automated cell and integrated the cell into the production process
- Documented system details and created standard work for operating the automated cell
- Trained direct labor force on how to operate new equipment/cell and trained client SME to maintain cell moving forward

Data Collection & Machine Monitoring

We deploy advanced data collection technologies, such as sensors, IoT devices, and real-time monitoring systems, to capture and analyze critical operational data. By implementing these systems, our clients benefit from enhanced visibility into their processes, enabling them to make data-driven decisions, identify bottlenecks, and optimize their operations. Real-time machine monitoring allows for proactive maintenance, reducing downtime and increasing overall equipment effectiveness. Additionally, the collected data provides valuable insights for continuous improvement initiatives, enabling our clients to drive efficiency, reduce costs, and improve overall productivity.

IX[®] in Action



Our client, a food manufacturing company, was unable to measure Overall Equipment Effectiveness (OEE) due to gaps in data for machine availability, performance and quality. Leadership did not know if they won the day or where problems existed. Our client partnered with IE to use a machine monitoring system to track OEE. Activities during IX[®] included:

- Identified and captured all data needed to accurately calculate Availability, Performance and Quality of production facility
- Tracked machine downtime by machine data and operator input depending on machine capability
- Integrated all data into centralized warehouse and began measuring OEE
- Built custom dashboards to visualize OEE performance metrics in real-time
- Created views empowering all users from executive to shop floor level
- Trained members across organization to understand and use OEE dashboard
- Leveraged OEE data to identify highest priority production issues
- Improved production through root cause and corrective action and waste elimination

Performance Dashboards & Coaching

Implementing performance dashboards on the manufacturing floor provides numerous benefits for optimizing operations and decision-making. These dashboards offer real-time visibility into key performance indicators (KPIs) such as production output, machine efficiency, and quality metrics, enabling operators and managers to quickly identify bottlenecks, inefficiencies, or deviations from targets.

IX® in Action

**Data Dictionary
& KPI Catalog
developed**

**Real time
dashboards
implemented on
assembly lines**

Our client, one of the world's largest suppliers of aerospace and defense products, had a data and analytics foundation that was lacking in maturity as information was not being adequately managed and utilized as a strategic asset. There was limited visibility into program and business performance and an absence of standardized metrics and KPIs established by the business. Our client partnered with IE to deploy a data & analytics foundation and high-mix OEE dashboard with a central source of truth, drill through capability, and real-time insights to operational effectiveness. Activities during IX® included:

- Enabled self-service capable Data Warehouse environment
- Configured dashboarding platform with functional documentation
- Developed System Application Protocol Interface for systems relevant to dashboards
- Established dashboards for OEE by line (availability, utilization and yield), WIP Tracking, turn-backs by line/device, and Supply Chain
- Developed and aligned on value stream line OEE calculations that took into account performance, availability, and quality along the critical path
- Implemented drill through hierarchical capability from top level to line to cell to asset
- Conducted small group and 1-on-1 coaching of shop floor
- Established sustainability and governance structure around two working teams: 1) Steering Committee - Data & Analytics Working Group (DAWG), and 2) User Community - Data Citizens (DC)

Automation Strategy & Management

An automation strategy allows a manufacturing company to stay ahead of the curve, adapt to changing market demands, and remain competitive in an increasingly technology-driven industry.

IX[®] in Action

\$4M

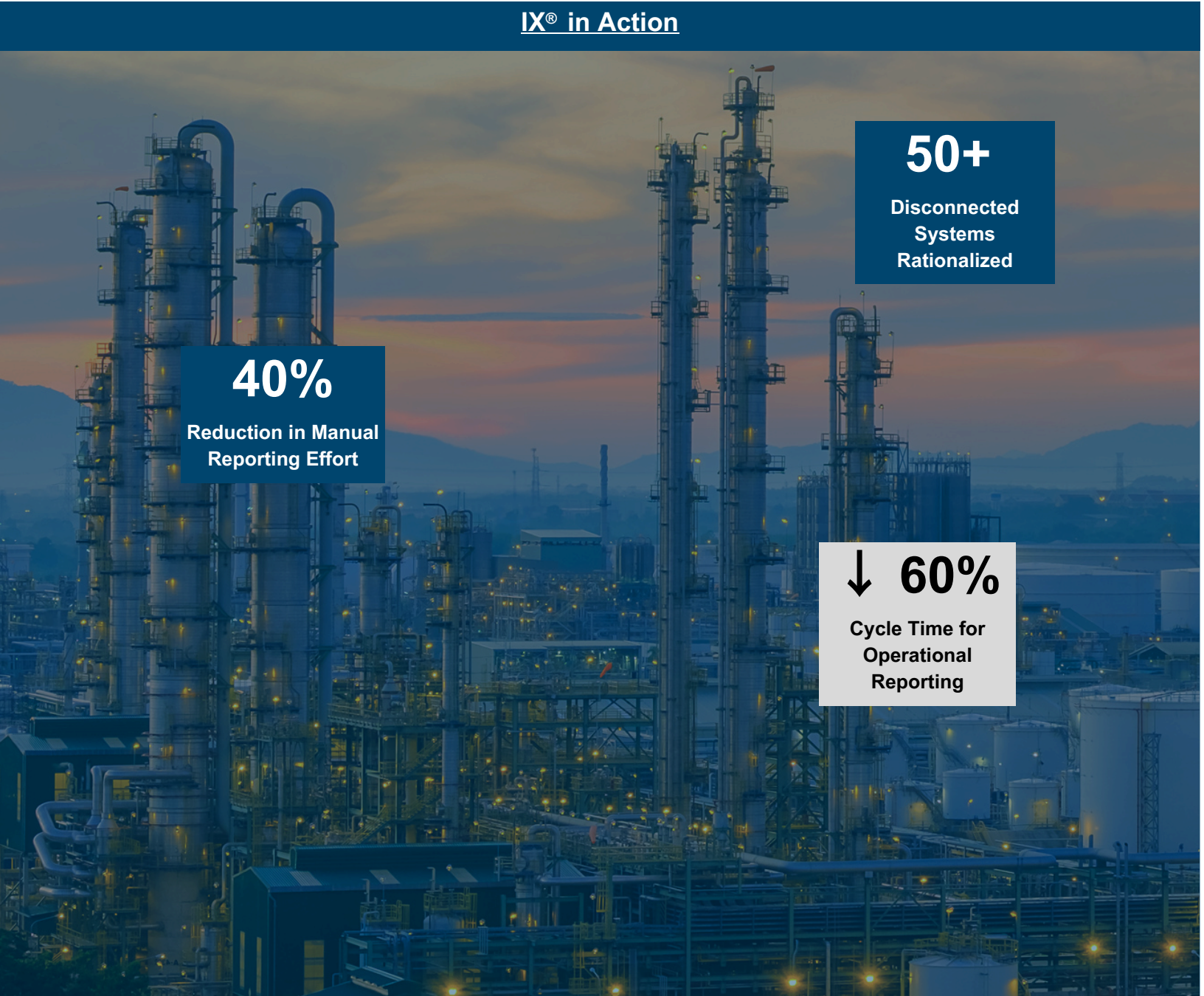
projected
annualized
throughput
improvement

Automation
roadmap

Our client, a leading aircraft equipment manufacturer, had manual operations at one of its facilities involving jig-based drilling and manual assembly of units using rivets and threaded fasteners. In collaboration with IE, the client sought to fully automate the assembly process to increase throughput while reducing reliance on manual labor. Activities during IX[®] included:

- Mapped the current process to identify/confirm all process steps and respective labor content
- Developed a future state map to incorporate automation options that address labor and throughput requirements
- Identified general operational improvements along with the automation roadmap to achieve the future state
- Identified key automation steps to enhance throughput objectives in tandem with initial process enhancements
- Proposed Smart Workstations and basic Collaborative Drilling as starting point with the potential for multiple automation paths at varying levels
- Recommended expansion to larger and more intricate assemblies as the site progresses in operations and maintenance of initial systems
- Automation strategy included upgraded riveting processes using collaborative robot tools and programming and the consideration of fully automated systems for riser, tread, and beam drilling and assembly
- Automation strategy determined that with increased capacity and sustained performance, there was potential for in-house production of currently outsourced components and assemblies

Digital Maturity Assessment & Road Mapping



Executive Summary

A leading North American petrochemical manufacturer engaged Implementation Engineers to conduct a comprehensive **Digital Maturity Assessment** and develop a **three-year digital roadmap** to advance its Industry 4.0 strategy.

While the organization had already invested in advanced technologies—including historians, quality systems, simulation tools, and predictive maintenance—the digital ecosystem had evolved organically. Systems were fragmented, data was underutilized, and frontline execution relied heavily on manual workarounds.

Implementation Engineers conducted an on-site, end-to-end assessment of the site’s **technology stack, operational processes, and digital maturity**, translating findings into a **practical, phased roadmap** focused on foundations first—then culture, analytics, and automation.

The result was a clear, actionable path to move from **reactive, disconnected data usage** to **integrated, scalable digital execution** aligned to operational and business priorities.

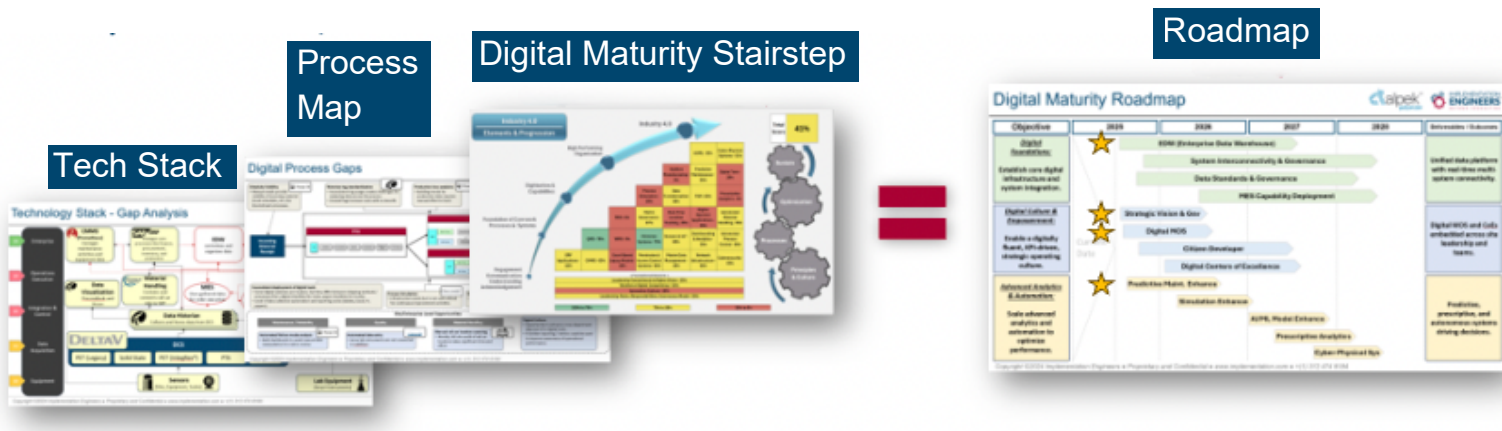
The Challenge

The client’s site operated complex petrochemical processes across multiple production units and Distributed Control Systems (DCS). Over time, digital tools were added to solve individual problems—but without an overarching digital architecture or governance model.

Key challenges identified included:

- ◆ **Fragmented IT/OT ecosystem** across enterprise, operations, integration, and equipment layers
- ◆ **Over 50 digital platforms** in use, including Excel, paper logs, email workflows, custom web apps, and niche point solutions
- ◆ **Manual data handling** for production reporting, scheduling visibility, quality tracking, and logistics coordination
- ◆ **Limited integration** between production systems, quality systems, CMMS, and ERP
- ◆ **Inconsistent deployment of digital tools** across departments and shipping methods
- ◆ **High effort, low-value activities**, such as weekly manual railcar audits and redundant data entry

Despite these challenges, the organization had a **digitally capable workforce** and pockets of advanced capability—indicating strong potential if foundational gaps were addressed.



The Approach

Implementation Engineers executed a **two-week, on-site Digital Maturity Assessment**, examining the operation through three integrated lenses:

1

Technology Stack & IT/OT Architecture

- Documented the full **L0–L4 architecture**, from equipment to enterprise systems
- Mapped five distinct DCS environments supporting different process technologies
- Identified system disconnects, custom solutions, and data handoffs
- Assessed gaps between current state and a scalable Industry 4.0 architecture

2

End-to-End Process Mapping

- Mapped physical and digital workflows across manufacturing, maintenance, quality, logistics, and material handling
- Identified where decisions relied on **manual emails, spreadsheets, or paper logs**
- Highlighted broken feedback loops between operations, maintenance, and planning

3

Digital Maturity Scoring Model

- Evaluated digital maturity across **foundational, operational, and advanced elements**
- Scored each dimension on a **1–5 scale**, based on consistency, adoption, and value realization
- Distinguished between **low-priority gaps** and **high-value enablers** required to avoid future digital debt

This structured assessment ensured recommendations were **fit-for-purpose**, grounded in operational reality—not technology for technology’s sake.

Key Insights from the Assessment

Strengths Identified

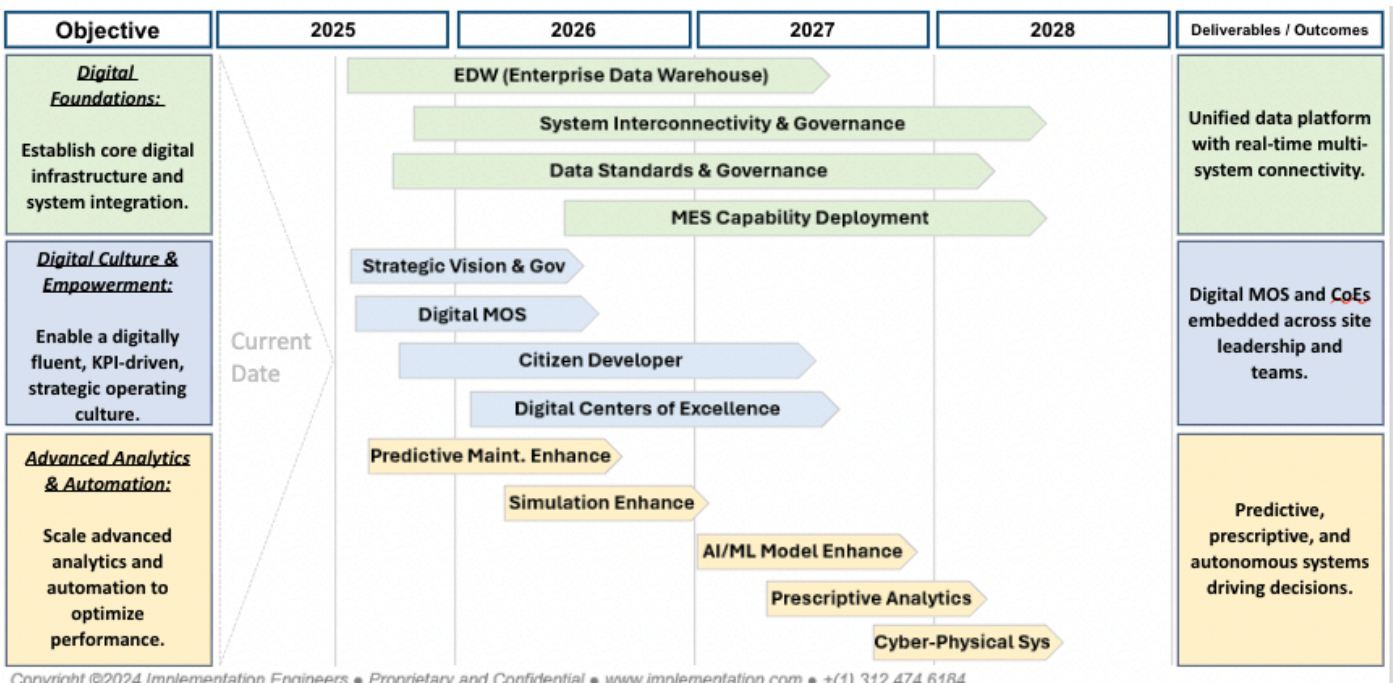
- Workforce Digital Competency: Operators and engineers were comfortable using data and digital tools
- Data Historian (PI): Widely used across functions with reliable, high-quality data
- Quality Management System: Strong reporting discipline and consistent usage

Gaps & Risks Identified

- Disconnected systems limiting enterprise-level insight
- Over-reliance on Excel, paper, and email for execution-critical workflows
- Manual reporting and reconciliation consuming significant engineering and supervisory time
- Inconsistent data standards across assets, tags, and hierarchies
- Risk of accumulating “digital transformation debt” that would limit future AI, analytics, and automation initiatives

The Solution: A 3-Year, Overlapping Digital Roadmap

Rather than a linear transformation, Implementation Engineers designed a **three-year, overlapping roadmap** that allowed the organization to **build digital foundations, enable people and governance, and scale advanced analytics in parallel**.



This approach reduced time-to-value, avoided digital rework, and ensured early initiatives did not become future constraints.

Foundation Layer (Runs Across All 3 Years)

Enabling scalable, connected digital execution

Foundational initiatives were intentionally **front-loaded and sustained** throughout the roadmap to support all downstream capabilities.

Key focus areas:

- ◆ Enterprise data architecture and integration across IT/OT layers
- ◆ Standardized asset hierarchies, naming conventions, and master data
- ◆ Governance for data quality, cybersecurity, and system ownership
- ◆ Evaluation and alignment of MES and execution-layer capabilities

Why it mattered:

Without continuous attention to foundations, advanced analytics and automation would remain isolated pilots rather than scalable capabilities.

Enablement & Digital Culture (Begins Early, Expands Over Time)

Embedding digital into how the site is managed

Digital enablement and cultural adoption began in **parallel with foundational work** and expanded as data availability and system integration improved.

Key focus areas:

- ◆ Digital Management Operating System (MOS) powered by integrated data
- ◆ Tiered daily management, visual KPIs, and escalation routines
- ◆ Leadership governance models for digital decision-making
- ◆ Citizen-developer enablement using governed Power BI environments

Why it mattered:

Digital tools only create value when ownership, routines, and accountability are embedded into daily execution—not bolted on after the fact.

Advanced Analytics & Automation (Pilots Early, Scales Later)

Moving from insight to prediction and action

Advanced analytics and automation were **piloted early** in targeted use cases while foundational and cultural elements matured in parallel.

Key focus areas:

-  Predictive maintenance integrated with CMMS workflows
-  Process simulation for planning, scheduling, and continuous improvement
-  Expansion of AI/ML use cases beyond pilots
-  Prescriptive analytics embedded directly into MOS routines
-  Cyber-physical system readiness integrating SCADA, MES, and analytics

Why it mattered:

Early pilots built momentum and capability, while disciplined scaling avoided technical debt and adoption risk.

The Impact

The Digital Maturity Assessment delivered:

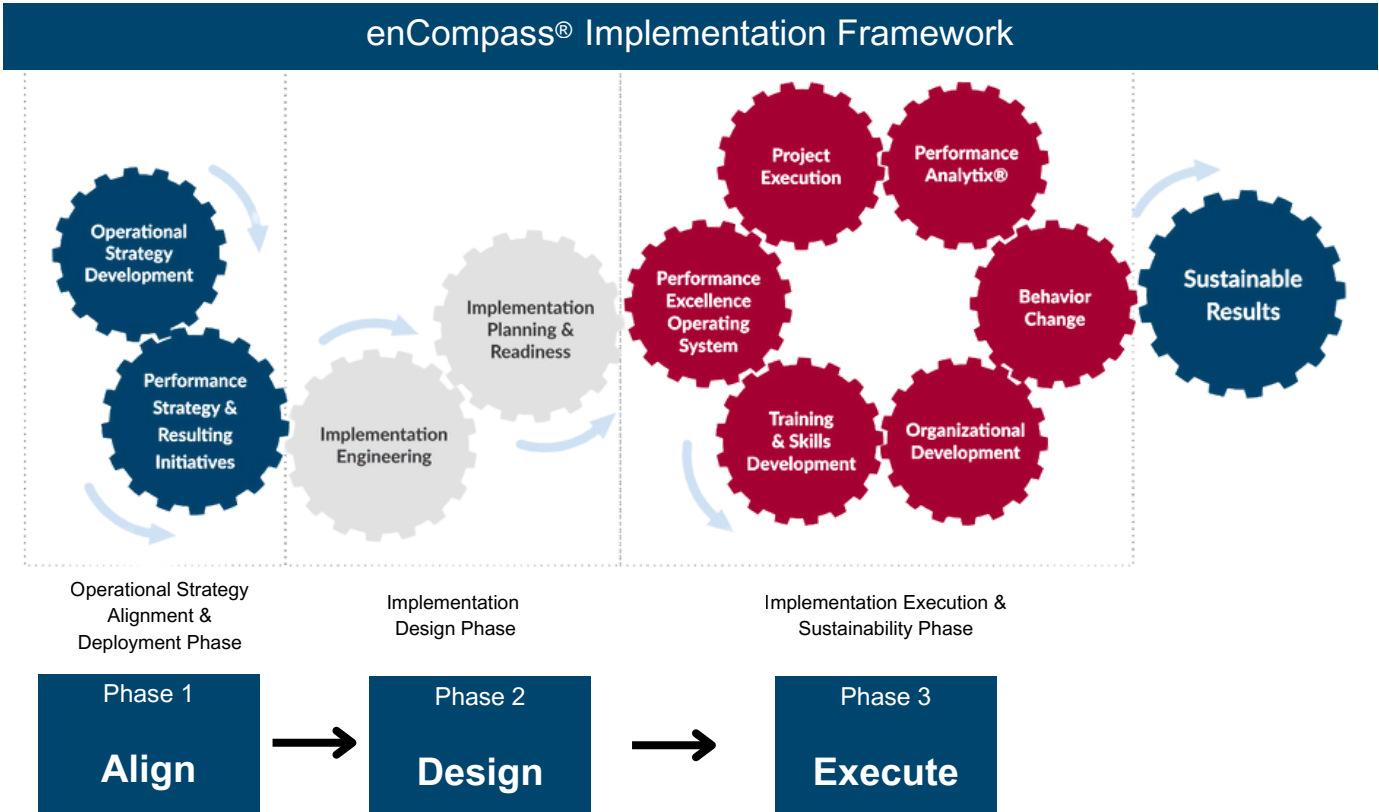
-  A **clear, shared understanding** of the current digital state
-  Alignment between technology investments and operational priorities
-  A **realistic, execution-ready roadmap** grounded in how the plant actually runs
-  Reduced risk of stalled or fragmented digital initiatives

A foundation for sustainable Industry 4.0, AI, and automation deployment

Most importantly, the roadmap balanced **technology, process, and people**—ensuring adoption, not shelfware.

Our Implementation Approach

While Implementation Engineers is not a strategy firm, we collaborate with leaders to enhance strategic thinking and assess the feasibility of implementing various strategies to achieve expected value. Our enCompass® framework offers a comprehensive Align-Design-Execute model to drive value realization. In contrast to traditional approaches, we advocate for a bottoms-up value creation process where each improvement is valued, and the collective impact of these solutions forms the expected value. Leveraging cutting-edge i4.0 principles throughout the value stream, we implement improvements and evaluate the necessary skills and behaviors essential for sustained value realization.



Our People

People make the difference. With record growth over the last many years, we are attracting the best talent to meet our customers' needs. Our IX® experts have been in industry most of their careers and know how to work with your teams to get things done. With over 20 years experience on average, our people bring the experience, skills and capabilities needed to complement your organization to deliver sustainable results.



Let's Turn Your Vision Into Results

At Implementation Engineers, we don't just execute projects - we transform your vision into operational reality. Our proven 3-phase approach - **Align, Design, Execute** - delivers lasting value, from aligning your team on strategic goals to optimizing operations and driving measurable outcomes. Whether you're aiming to lead your market, boost efficiency, or maximize shareholder value, we're here to make it happen, step-by-step, side-by-side.

Ready to Get Started?

Let's explore how we can bring your vision to life. Contact us today to schedule a conversation. Together, we'll chart the path to your success.

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