Singapore Institute of Manufacturing Technology
A*STAR SIMTech

Advanced Remanufacturing and Technology Centre
A*STAR ARTC

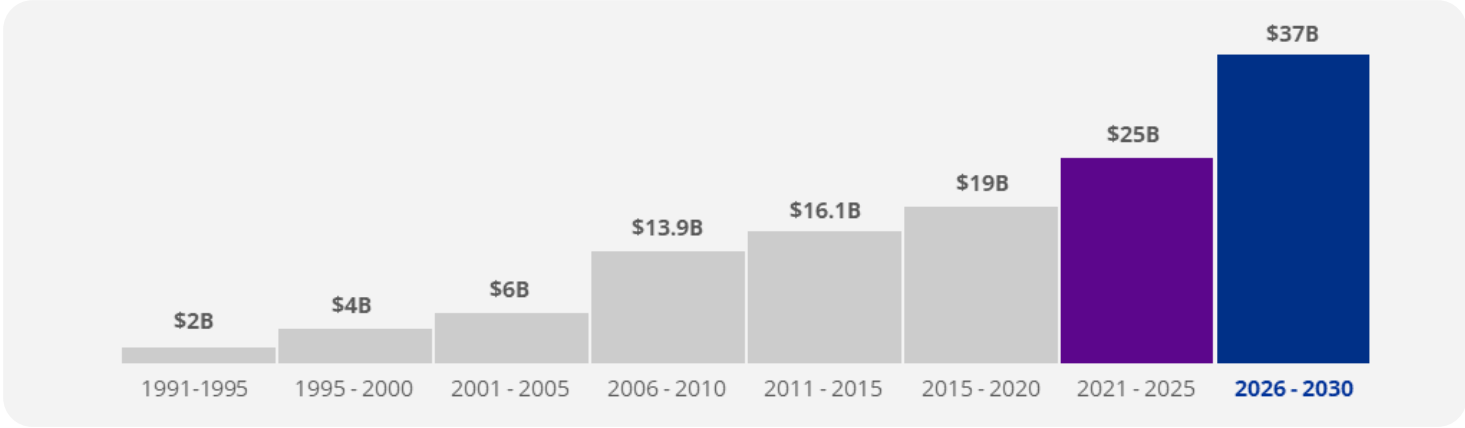
Delivering AI Impact in Manufacturing: From Workforce Transformation to Asset Intelligence

SCIC - "Seminar on Managing Ageing Process Plants in the Artificial Intelligence (AI) Era"

A*STAR in Singapore's RIE Ecosystem

RESEARCH INNOVATION AND ENTERPRISE COUNCIL (RIEC)

Lee Hsien Loong
Chairman, RIEC
Senior Minister of Singapore



FUNDING AGENCIES & MINISTRIES

Ministry of Education SINGAPORE

MINISTRY OF HEALTH SINGAPORE

MTI MINISTRY OF TRADE AND INDUSTRY SINGAPORE

NRF SINGAPORE

NMRC National Medical Research Council Singapore

A*STAR Agency for Science, Technology and Research SINGAPORE

EDB SINGAPORE Enterprise Singapore

RESEARCH PERFORMERS

Polytechnics & Universities

Academic Medical Centres

A*STAR Research Institutes

MNCs & SMEs

How A*STAR is organised

Research

- Research Office (RO)
- Biomedical Research Council (BMRC)
- Science & Engineering Research Council (SERC)
- Research Institutes
- Horizontal Technology Coordinating Offices

Industry Development and Commercialisation

- Innovation & Enterprise (I&E)

Talent Development

- A*STAR Graduate Academy

Headquarters

- Corporate Group

>6,000

>4,700

Researchers,Engineers and Technical, Support Staff

~37% from

>60 countries

A*STAR fosters scientific discovery and innovation through open collaboration with public and private partners

Chairman
Professor Tan Chorh Chuan
and Board of Directors

Mr Beh Kian Teik
Chief Executive Officer

Mr Suresh Sachi
Deputy Chief Executive (Corporate)

Professor Andy Hor
Deputy Chief Executive (Research)

Professor Yeo Yee Chia
Deputy Chief Executive (Innovation & Enterprise)

SCIENCE AND ENGINEERING RESEARCH COUNCIL (SERC)

- Advanced Remanufacturing and Technology Centre (**ARTC**)
- Institute of Advanced Intelligence and Computing (**IAIC**)
- Institute of Microelectronics (**IME**)
- Institute of Materials Research & Engineering (**IMRE**)
- National Metrology Centre (**NMC**)
- Singapore Institute of Manufacturing Technology (SIMTech)
- Institute of Sustainability for Chemicals, Energy and Environment **(ISCE²)**
- ***National-Level Initiatives***
- ***Programmes, Platforms and Scientific Services***

BIOMEDICAL RESEARCH COUNCIL (BMRC)

- Bioinformatics Institute (**BII**)
- Bioprocessing Technology Institute (**BTI**)
- Genome Institute of Singapore (**GIS**)
- Institute of Bioengineering and Bioimaging (**IBB**)
- Institute of Molecular and Cell Biology (**IMCB**)
- Singapore Institute for Clinical Sciences (**SICS**)
- Singapore Immunology Network (**SIgN**)
- A*STAR Skin Research Labs (**A*SRL**)
- Singapore Institute of Food and Biotechnology Innovation (**SIFBI**)
- A*STAR Infectious Diseases Labs
- ***National-Level Initiatives***
- ***Programmes, Platforms and Scientific Services***

MTI MINISTRY OF TRADE AND INDUSTRY SINGAPORE | Enterprise Singapore | EDB SINGAPORE | Agency for Science, Technology and Research SINGAPORE | jtc

A*STAR Graduate Academy Joint Planning Hub Research Office | Grants Policy & Governance | Innovation & Enterprise Division | National Platforms and Coordination Offices Corporate Services

Smarter Manufacturing through Real-Time Planning & Scheduling and Predictive Maintenance

Ian Chan

Principal Scientist, Digital Manufacturing Division (DMD) and AI for Manufacturing (AIMfg)

*A*STAR SIMTech*

SMART Manufacturing & Beyond

Towards SMARTER, GREENER and MORE CONNECTED Manufacturing

Human-centric Autonomous Manufacturing

Robust Shopfloor

- Predictive Maintenance
- Predictive Quality

Resilient Enterprise Value Chain

- Real-time Planning & Scheduling
- Demand Forecasting
- Inventory Management

Operations Management

- Resource Management
- Manpower Planning

Key Competency and Strengths

Motivation

- **Challenges in implementing AI**
  - Varying time horizons
  - Diverse manufacturing
  - Varying needs (enterprise, shop-floor, etc)
  - Poor data quality & lack of data
  - High mix of machines and products
- **Our focus:**
  - Direct R&D on AI for manufacturing
  - Making data and manufacturing AI-ready
  - Deploy AI to enhance resilience and robustness
  - Enable prediction, prescription and perception
  - Capturing manufacturing knowledge
  - Modeling, connectivity, software, systems

Real-Time Planning & Scheduling

Challenges with Manual Planning

Slow response to change

Manual planning struggles to adapt quickly to unexpected disruptions, leading to delays and lost efficiency.

High Risk of Human Error

Spreadsheets and manual data entry are prone to mistakes, causing costly planning and execution issues.

Poor Scalability in Growing Operations

As operations grow, manual processes become too complex and time-consuming to manage effectively.

Lack of Real-Time Visibility

Lack of real-time, connected data makes it hard to get a clear view of what's happening across the business.

Inefficient Resource Allocations

Without a complete picture, it's hard to allocate people, time, and equipment where they're needed most.

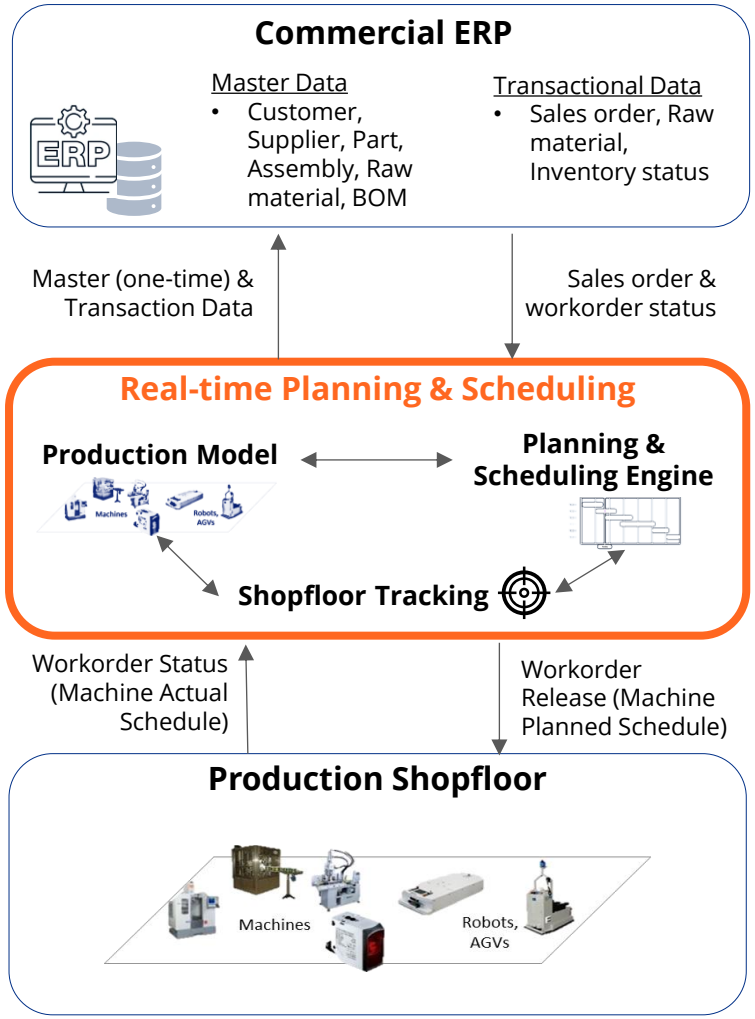
Leading to..

Production Delays

Opportunity Cost

High cost of Inventory

An intelligent, adaptive planning solution with real-time visibility and predictive insights is needed



A*STAR Real-Time Planning and Scheduling (RPS)™

KEY FEATURES & VALUE PROPOSITIONS

Context-Aware Re-Scheduling

Adaptive re-scheduling to manage unexpected shopfloor productions

Shopfloor Tracking

Full integration and visibility across end-to-end system and production shopfloor

Smart Scheduling Engine

Diverse KPI optimisations, accommodating delays, machine breakdown, ad hoc / on-demand requests

Capacity Analysis

Using Constrained-based modelling, considering availabilities and preferences of man, machine, material

Integration Framework

Integration framework to WMS, ERP, CRM, MES to enable end-to-end system integration;

Customisable for Cross-Sectorial Applications

Fully applicable for diverse manufacturing industry

Industry Use Case: Real-time Planning & Scheduling

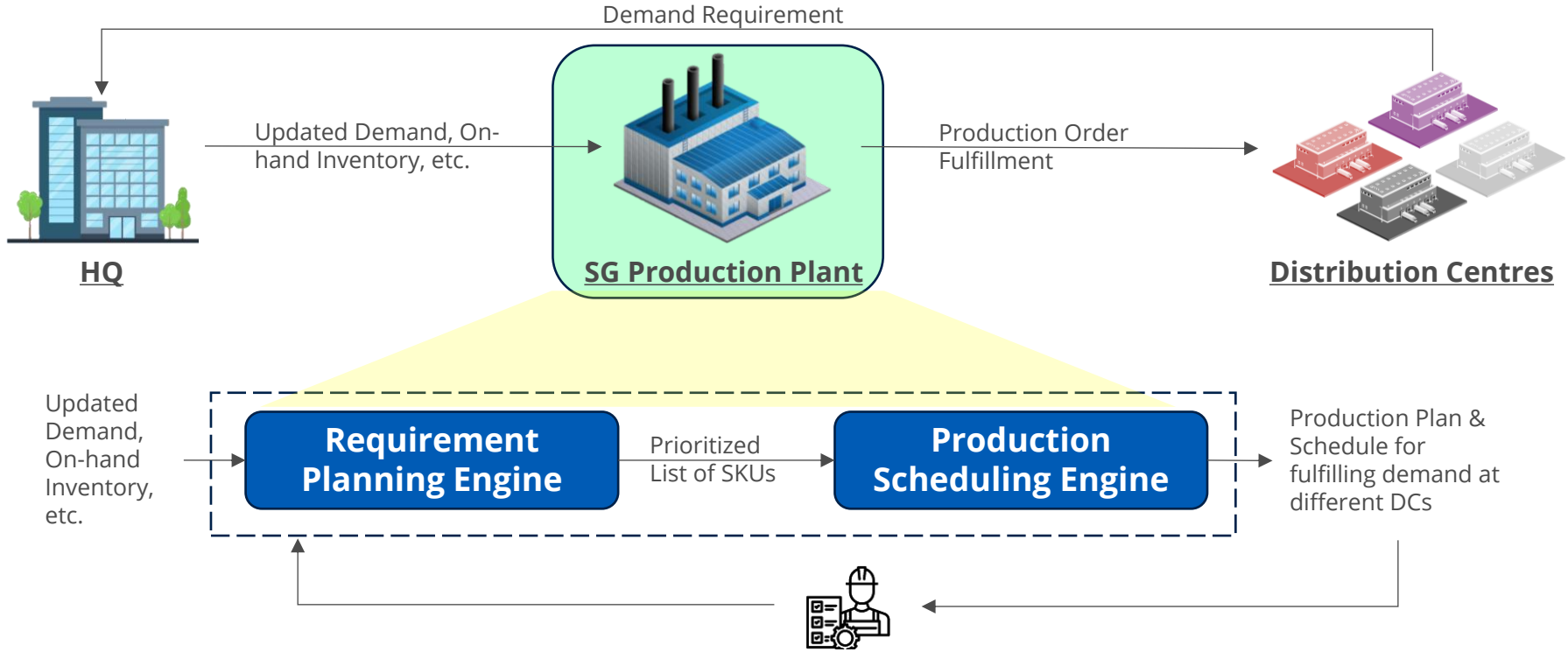
RPS ensures reliable delivery commitments and exceeds customer expectations with integrated planning, scheduling, and tracking.

A decision support system that **optimises production planning and scheduling** for lens manufacturing. The what-if analysis capability ensure high fulfilment for demand arising from various distribution centres

Key Features

1. **Constrained-based modelling**, considers availabilities and preferences of multi-resource

2. **Diverse KPIs (e.g., Machine utilization) optimization** for efficient production schedule



Impacts

1 **80%** Reduction Planning Efforts

2 **30-60%** Increase Machine Utilisation

Industry Adoption: Real-time Planning & Scheduling (RPS)

>50 companies

Riso Seiki (S) Pte. Ltd focusing on design and fabrication of customized cutting tools


Scrapping waste and lost time with a good system

WORKING OUT WELL

"They are incentivised to work fast and efficiently, because now it's very easy for their managers to see if they're taking too long or wasting materials."

CKE Manufacturing Pte. Ltd that provides precision machining services

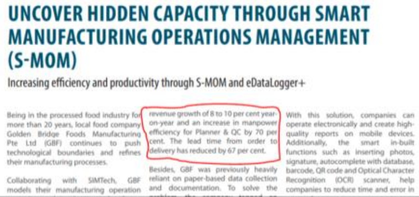

PRODUCTIVITY MATTERS 11

PRECISION ENGINEERING

Keeping tricks of the trade alive

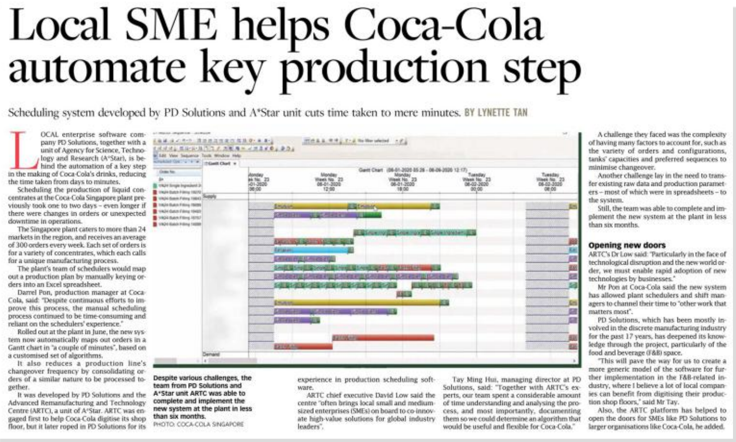
Technology has helped CKE Manufacturing to incorporate the experience of the older generation into its work system, reports VICTORIA HO

Golden Bridge Foods Mfg


UNCOVER HIDDEN CAPACITY THROUGH SMART MANUFACTURING OPERATIONS MANAGEMENT (S-MOM)

Increasing efficiency and productivity through S-MOM and eDataLogger+

The Coca-Cola Company


Local SME helps Coca-Cola automate key production step

Scheduling system developed by PD Solutions and A*Star unit cuts time taken to mere minutes. BY LYNETTE TAN

Opening new doors

Techcom Technology that provides engineering solution

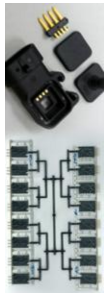

电脑化追踪产品进度

新软件系统有效提高生产力

业界合作项目

SPRING singapore

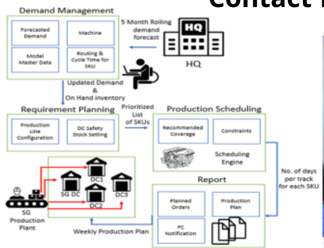
SANWA manufactures PE plastic components



"The software was very user-friendly even for those not familiar with computers and programming. Our older and non-English speaking floor operators picked it up very quickly. It has not only motivated them to work together more efficiently but also offers improved response time to our clients and value-added service."

Alvin Lee, Production Engineer

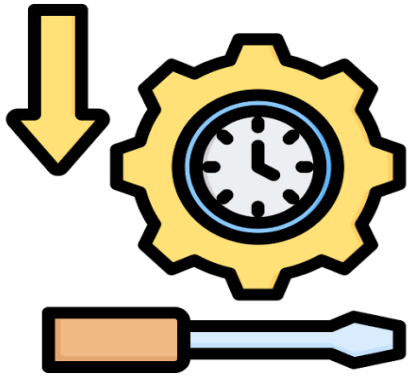
Contact Lens Mfg



This integrated DRPS solution is now operational and has since reduced planning efforts by over 80% from 3 days to 2-3 hours per week.

Asset Integrity

Challenges with Scheduled Maintenance

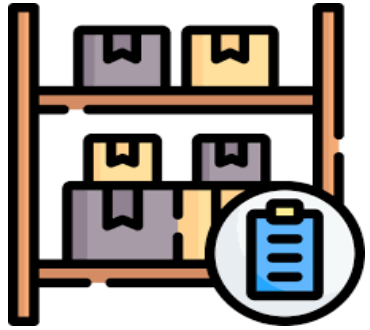


Unexpected Equipment Failures

- unplanned downtime

High Maintenance Costs

- Unnecessary checks



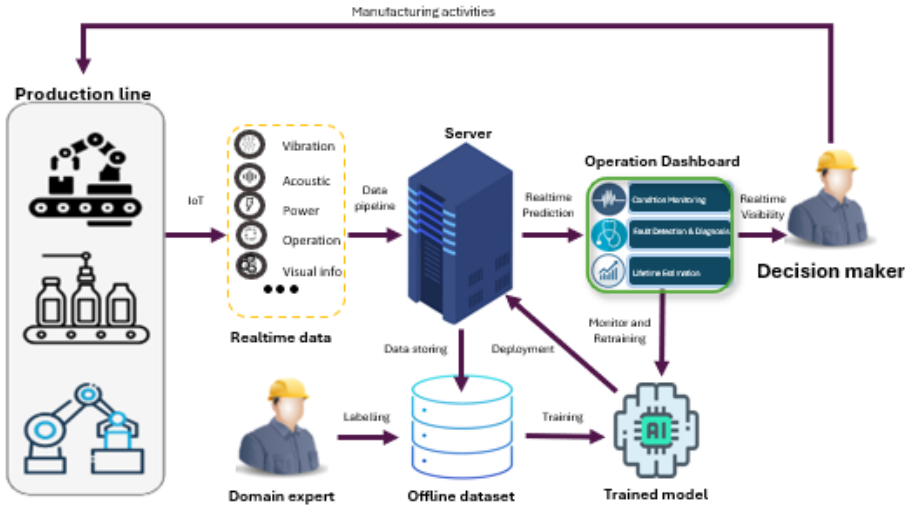
High Inventory Spares

- Unnecessary stock-up

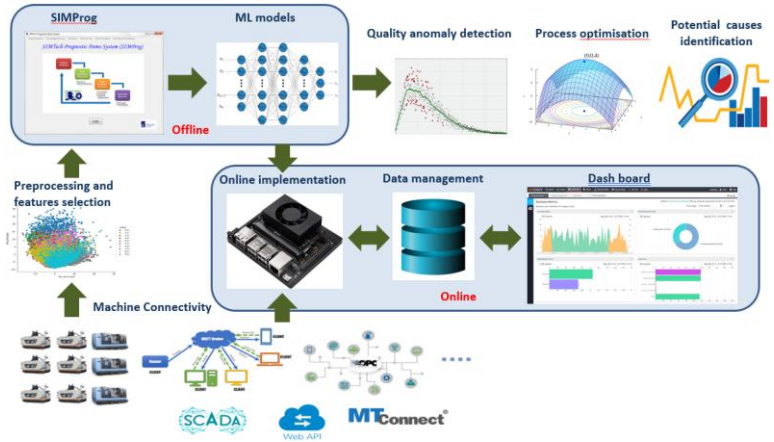
Lower Productivity

- Disrupted production

Predictive Maintenance & Quality



Predictive Maintenance



Predictive Quality

KEY FEATURES & VALUE PROPOSITIONS

Web Application

monitor and predict equipment health condition in real-time and manage maintenance activities

Context-aware Root Cause analysis

for equipment fault diagnosis

Intelligent predictive engine

powered by machine learning/ deep learning engines for asset health prediction and RUL estimation

Asset & maintenance management

with digitalised check lists and maintenance planning

Flexible deployment and integration

with customised IoT solution and on-premise or cloud server

Improve machine performance & optimise processes

Real-time visibility of machine health and prediction of when faults need repair

Use Cases

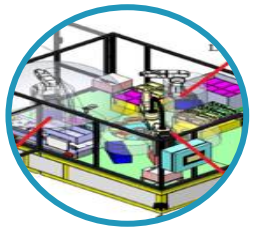
Precision Eng. (OMS, GVT, Tai Sin, DYT, ATC, Sanwa, Racer)

ASRS for logistics (DB Schenker, Softgrid)

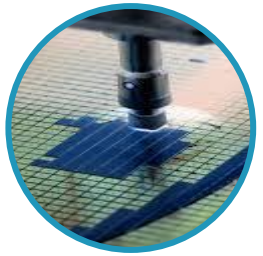
Biopharma & Medtech (Alcon, Novartis, BD)

Aerospace mfg. (R-R, Collins, STE Aerospace)

FMCG mfg. (Coca Cola, P&G, Unilever)



Electronics mfg. (Philips, HP, Panasonic, Murata, Rockwell Automation**)**



Semicon mfg (Infineon, Global Foundries, Component Tech, AEM)

Others (Haiiburton, STE Land)

THE Coca-Cola COMPANY

AI for F&B manufacturing

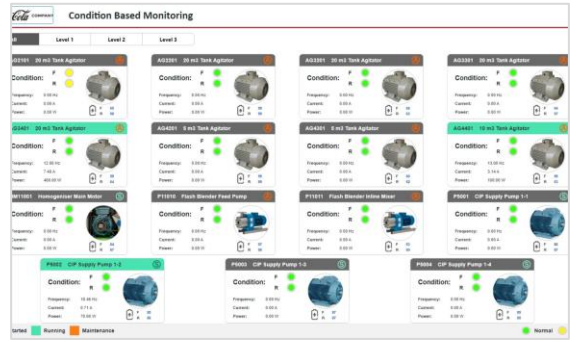
Concentrate Pump Health Prediction (2022)

OUTCOMES

- Less than 1-hour unexpected downtime annually
- 80% less time to check machine health
- Improved reliability of machines/pumps
- Real-time health monitoring for 15 pumps/motors
- ATEX-compliant sensor deployment
- Reduce unnecessary maintenance cost by 10%

OBJECTIVES

- Predict machine health and forecast the next maintenance window to prevent unexpected failures
- Replace threshold-based monitoring with an AI model that minimises false positives on complex data
- Provide decision support for optimal motor servicing across all 15 pumps in the Singapore factory



ABOUT THE INNOVATION

AI-driven condition monitoring solution for factory pumps and motors

- ATEX-compliant sensors deployed for motor data acquisition and **real-time health monitoring**
- AI model trained on sensor data to **predict machine health and next maintenance period**
- Deployed on 15 pumps/motors in Singapore factory; **fault detection and diagnosis algorithms**

"...unexpected downtimes reduced from 32 hours a year to less than an hour. ... The time taken by our maintenance team to check on the health condition ... fell by more than 80%"

Winson Loh,
Engineering Director

TruMarine

AI for Marine

Turbocharger Health Prediction (2023)

OUTCOMES

- Digitalisation through a predictive maintenance app, TruCareTM
- Real-time monitoring of turbocharger's health
- Estimated revenue growth of 51% by 2025
- Enhanced competitiveness in new industries (additive manufacturing)
- Sustainability by Decarbonising shipping
- Launched with German Turbocharger Maker, KBB on 30th June 2023

OBJECTIVES

- Deploy remote cloud-based condition monitoring for marine Turbochargers
- Pioneer IoT innovations to drive digital transformation for operations
- Develop real time monitoring enabled by predictive maintenance technologies for proactive efficiency


THE STRAITS TIMES

Wednesday, December 16, 2020

A*Star sets up joint labs with two SMEs to build new capabilities


Partnering up to solve manufacturing problems

ABOUT THE INNOVATION

TruCare™, a predictive maintenance solution for marine turbochargers

- Transformed business model from **reactive "sick-care" to proactive "health-care"**
- Leveraged technologies related to sensors blockchain data analytics machine learning for **real-time remote monitoring**
- Analyses data to **detect anomalies and alert marine vessels** for servicing

AI for Chemical Process

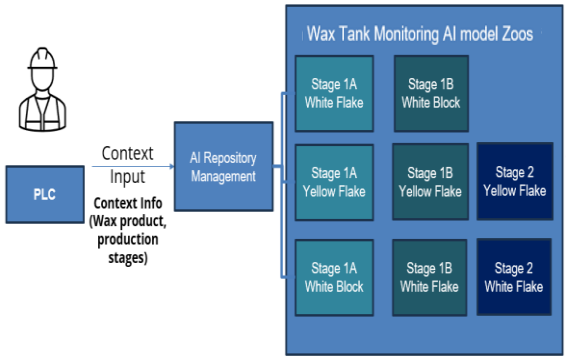
Wax Blending Condition Monitoring (2024)

OUTCOMES

- Manpower cost reduction of 20-40%
- Cycle time reduction of up to 10%
- Detection of 4 distinct melting states of wax
- Web application for real-time alerts via email
- Context-aware AI model with PLC integration

OBJECTIVES

- Replace inaccurate, inefficient manual visual monitoring with automated melting-status detection
- Detect distinct melting states across different wax types reliably in real time
- Let users self-maintain and upgrade models, with timely alerts to act on results



ABOUT THE INNOVATION

Deep-learning Condition Monitoring for Chemical Processes

- Deep-learning visual-analytics model detects **four distinct melting states of three different types of wax**
- Continuous training software lets users **self-maintain and upgrade the AI algorithms**
- Web application displays detection results and **triggers alerts to users via email**

AI for Aeropsace Manufacturing

Vertical Barrel Tub Health Prediction (2025)

OUTCOMES

- 70% reduction of reactive maintenance
- Over 80% cut in manual effort for KPV measurements
- Increased machine availability from optimised scheduling
- Empowered staff with data-driven skills
- Scalable blueprint for other machines

OBJECTIVES

- Develop predictive maintenance for the vertical barrel tub vibrator to prevent unplanned downtime
- Monitor and measure KPVs in the fan blade manufacturing process for continuous improvement

ABOUT THE INNOVATION

Scalable AI/ML fault diagnosis and prognosis system for predictive maintenance

- AI/ML system predicts **machine failures and their root causes**
- Real-time monitoring for **quality assurance and critical process variables**
- Easily **re-train predictive models** on new failure modes for better accuracy

AI for Electronics Manufacturing

Intra-logistics Vertical Lifter Health Prediction (2026)

OUTCOMES

- 87% reduction in unnecessary maintenance checks
- $42k savings per incident requiring urgent recovery
- 100% lifter uptime guaranteed during production
- WEF Global Lighthouse use case
- Increased throughput from guaranteed uptime

OBJECTIVES

- Predict each lifter's health within one second of completing a trip using a digital-twin predictive model
- Detect early degradation trends without labelled fault data, overcoming noisy signals and slow degradation
- Replace scheduled manual checks with predictive maintenance to protect lifter uptime and production capacity

ABOUT THE INNOVATION

Digital-twin predictive maintenance system for shop-floor vertical lifters

- Digital twin of lifter motion with a predictive model **assesses lifter health within one second of each completed trip**
- Novel degradation-centric autoencoder reduces high-dimensional data to a monotonic health indicator, **flagging early degradation without labelled faults**
- Shop-floor PdM deployment adopted as a key use case for **WEF Global Lighthouse status (June 2026)**

Across Industry

Precision Engineering

CNCs, injection molding, cutters, pumps, motors, robotic arms

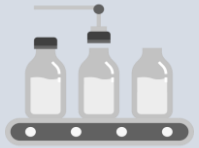
Energy & Chemicals

Boilers, chillers, scrubbers, pumps, motors, pipes, valves

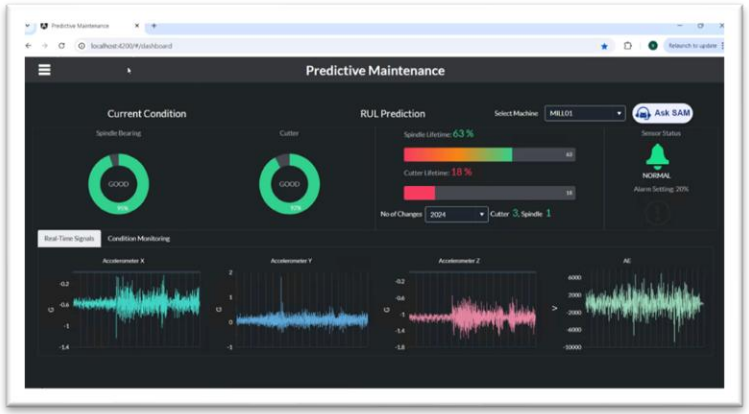
Bio-Manufacturing

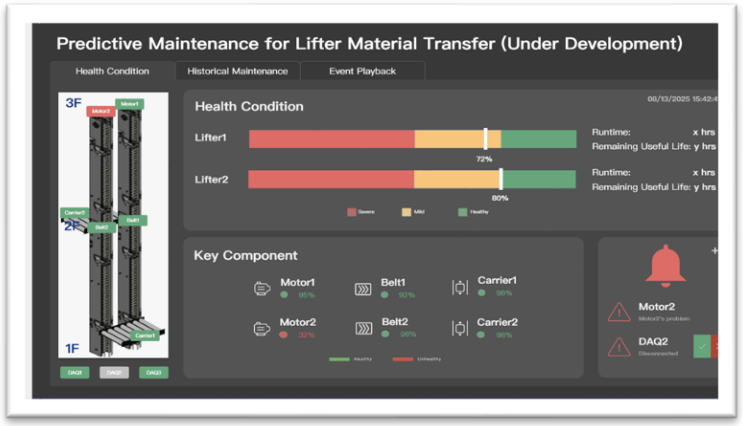
Capsule fillers, granulators, bio-reactors, pumps, motors, valves

FMCG



Pumps, motors, valves, compressors, chillers



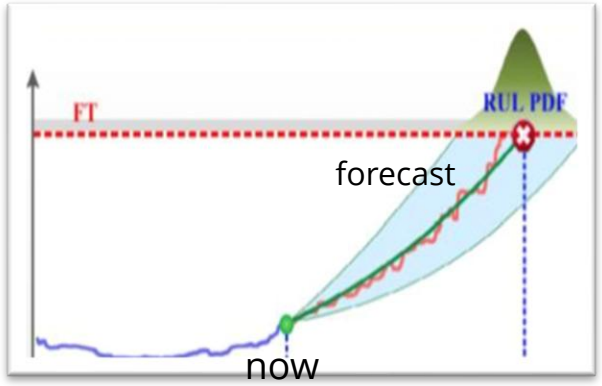


1 **95%** **Reduction** Unplanned Downtime

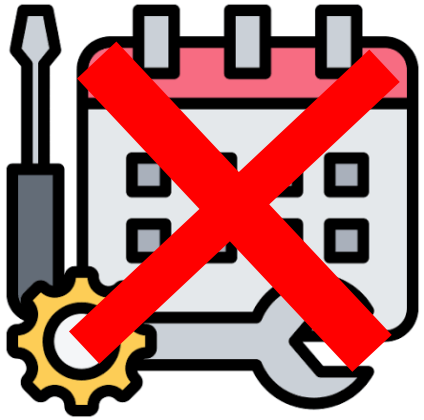
2 **50%** **Reduction** Preventive Maintenance Time

3 **10%** **Increase** Maintenance Efficiency

With Deployed PdM



- Predict Failures
- Alert ahead
- Downtime avoided



- Reduce Scheduled Checks
- Full Visibility
- Time and labor saved

- Increased availability
- Production plans not disrupted

Data Needed for AI Solution

1) **Sensor Data** with date time stamps
    1) Time-series data on vibration , acoustic, current transducers, temperature, etc
    2) Data on images, NDI measurements, NDT measurements with date-time stamps

2) **Manufacturing process data** with date time stamps
    1) Machine start-stop timing
    2) Actual time-stamped values from machine controller/PLC key parameters (such as fluid pressures, flow rates, actual material feed rates, actual robot/guide x-y-z positions with date-time stamps)

3) **Maintenance data logs** including corrective, preventive
    1) Logs with date-time stamps on repair , overhaul or service actions,
    2) Info on fault identified, and fixed/corrected, when was this done

AI Short Courses

Course Title	Who It's For	What You'll Gain
Industrial Artificial Intelligence in Manufacturing (24 hrs)	Operations/Production Managers, Process/Maintenance Engineers, Automation Engineers, Data Engineers	Key AI concepts including predictive analytics, agentic AI, data mining workflows, and AI applications across shopfloor and enterprise systems. For companies looking to explore building AI solutions from the ground up
Generative AI for Manufacturing (24 hrs)	Technical professionals (engineers, developers, data and automation experts) and non-technical stakeholders (leaders and process owners) in manufacturing looking to implement agentic AI solutions	Hands-on skills to design and implement agentic AI solutions for manufacturing — covering generative AI fundamentals, LLM application building, Retrieval-Augmented Generation (RAG) workflows, and multi-agent systems using LangGraph for diagnostics, root cause analysis, and recommended actions. For companies looking to move from concepts to working gen AI and agentic prototypes.

https://www.a-star.edu.sg/simtech/kto/ai-curated_courses

Transformation Journey through AI in Manufacturing Leadership Training

Mark Chua

Principal Research Engineer

*A*STAR SIMTech*

Singapore Institute of Manufacturing Technology
A*STAR SIMTech

Advanced Remanufacturing and Technology Centre
A*STAR ARTC

IMPACT™

Empower Innovation.
Sustain Transformation.

A*STAR SIMTech and ARTC: CoPilot of Your Journey to AI-ready Operations

The World Your Plants Operate in is Changing Faster Than the Plants Themselves

VUCA

Volatile · Uncertain · Complex · Ambiguous

Unstable Environment

- Volatile
- Uncertain
- Complex
- Ambiguous

Strategic Agility

BANI

Brittle · Anxious · Nonlinear · Incomprehensible

Fragile Systems & Stress

- Brittle
- Anxious
- Nonlinear
- Incomprehensible

Resilience and Sense-Making

PUMO

Polarized · Unthinkable · Metamorphic · Overheated

Radical Transformation

- Polarized
- Unthinkable
- Metamorphic
- Overheated

Proactive Strategy and Systemic Transformation

How can Ageing Process Plants Stay Ahead?

A*STAR SIMTech has been helping companies **TRANSFORM**

Best-In-Class Company

2026 & Beyond	Holistic AI-First Transformation	IMPACT™
2018 – 2025	Digital Transformation	DTI™
Before 2018	Operational Excellence	OMNI™

For over **15** years

Plants often invest in many AI pilots, but without the Right Approach, they run into 3 Major Roadblocks

1

Misaligned Goals

- Technology Investments do NOT sync with **BIG PICTURE** Strategy

2

Prioritisation Paralysis

- With so many options, it's easy to get stuck figuring out what to implement first

3

Patchwork Improvements

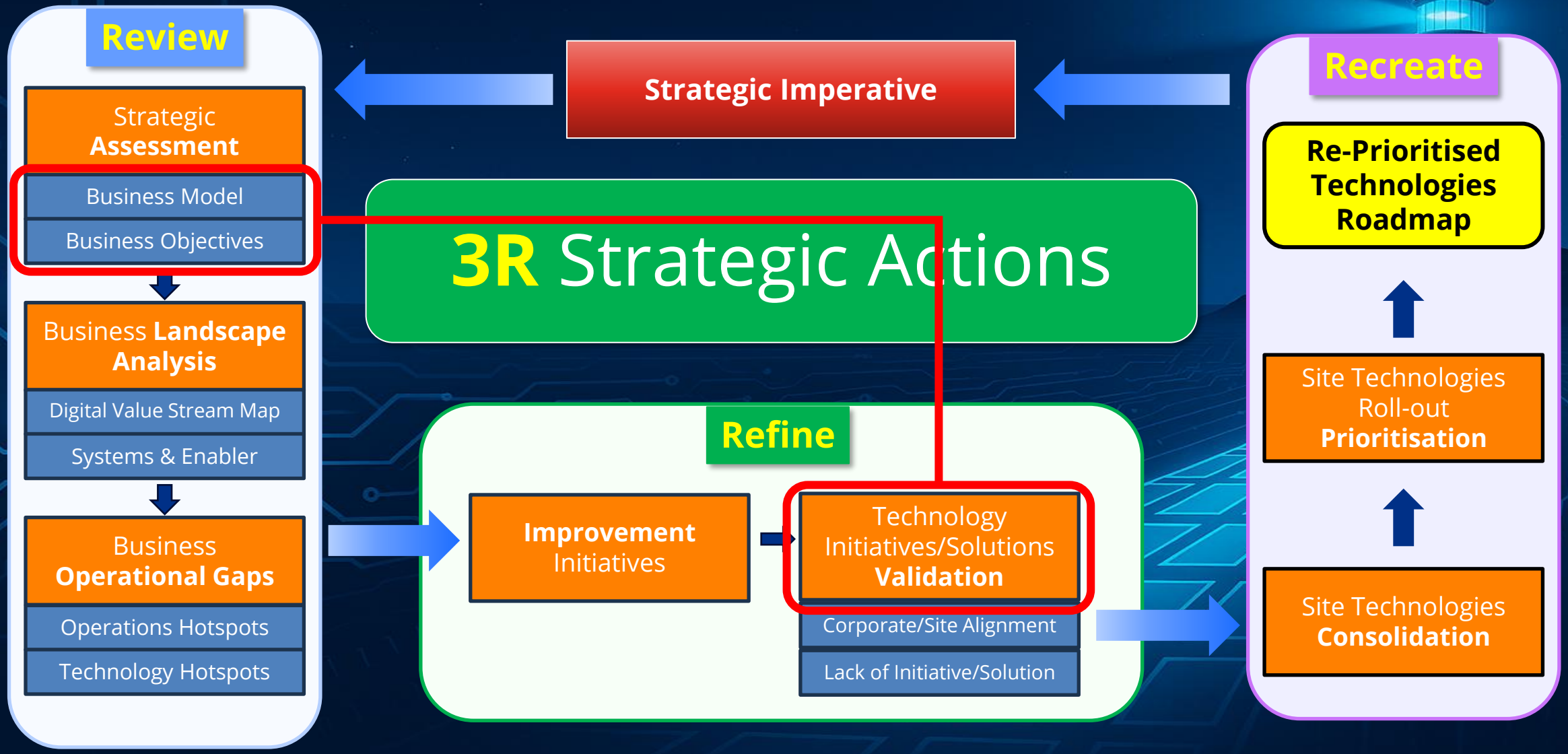
- Implementing isolated solutions without a cohesive plan leads to inefficiencies

Here is How to Build a Holistic AI Roadmap for an Ageing Plant, and Turn it into Scalable Operational Impact

3R Strategic Actions

IMPACT™ Methodology

Holistic AI-First Transformation through IMPACT™



Structured Transformation Approach - IMPACT™

Empower Innovation. Sustain Transformation.

1

I - Intend

Establish Business Strategy & Key Objectives

2

M - Map

Understand Activity Landscape and Key Enablers

3

P - Prioritise

Identify & Prioritise Transformation Hotspots

4

A - Act

Generate & Develop Initiatives

5

C&T – Change & Transform

Develop Change Story with Transformation Roadmap

Review

Business Model; Transformation Objectives
AS-IS Value Stream Map
AS-IS Infrastructure Enabler
AS-IS Operational Maturity
Hotspots & Transformation Areas
Hotspot Clustering → Corporate/A*STAR Solution

Refine

Initiatives
Initiatives Description
TO-BE Operational Maturity

Recreate

DX Roadmap
Change Story

Our Track Record in Helping Manufacturers Transform

- Helped **>300 companies** from 21 industry sectors since 2010
- **150** batches completed
- Mentored **>1700 transformation leaders**

Transformation CoPilot

Outcomes aligned to Business Case

- Identify **Hotspots**
- Develop **Initiatives** to address the Hotspots
- Train Key Leaders to be **Digital Transformers** and drive Initiatives
- Create company-wide **Digital Transformation Roadmap**

Research Collaboration

- **Establish multi-year R&D collaborations with A*STAR and Institutes of Higher Learning**, e.g., under the Industry Alignment Fund (IAF)
- **Develop Critical Solutions**, e.g, customised AI solutions under **AI Centre of Excellence for Mfg (AIMfg)**
- **De-risk innovation of manufacturing technology proof-of-concepts**

Tech Adoption

Examples of Impact from Technologies Adopted:

- 40 - 70% **Response Time** to quality issues — Predictive Quality Monitoring & Management
- 50 - 90% **Time Taken** to plan, schedule and track — Real-Time Planning & Scheduling
- Up to 90% **Time Taken** on equipment inspection — Predictive Maintenance

Beyond

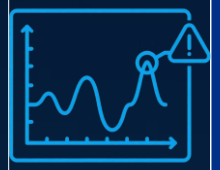
Typical Potential Impacts:

- **Long-term Partnership** (e.g., joint lab)
- **Increase Mfg Value Add** (Revenue ↑, Costs ↓)
- **Multi-year Roadmap with Workforce Upskilling**
- **Ecosystem Building** – qualify SMEs to supply MNC

Where AI Pays Back Fastest in an Ageing Plant

Predictive Maintenance

Vibration, temperature and process data flag degradation on critical rotating equipment weeks before failure - turning unplanned trips into planned work.



Anomaly Detection

Models learn normal operating envelopes from historian data and surface drift, fouling and leaks that fixed alarm limits miss.

Inspection & Integrity

AI-assisted image and NDT analysis focuses inspection effort on the equipment most likely to be degraded, cutting time in the field.

Asset Intelligence in Practice - Illustrative Outcomes

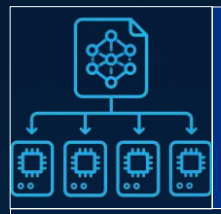
30%	6-8 wks	90%
Reduction in unplanned downtime on critical rotating equipment	Typical early warning ahead of functional failure	Less time on manual equipment inspection and condition reporting

Illustrative ranges based on A*STAR SIMTech industry deployments - actuals depend on asset criticality and data readiness.

Scaling from One Pilot to the Whole Asset Fleet

Data Foundation

Contextualise historian, maintenance and inspection data once, so every new asset connects in days rather than months.



Reusable Models

Build a model for an asset class, not a single machine, then replicate across pumps, compressors and exchangers site by site.

Governance & Trust

Monitor model drift, keep engineers in the loop and align to process safety and regulatory expectations from day one.

Where to Start: A Practical Path for a Brownfield Plant

1

Align Leadership

Agree the business outcome and the two or three assets where failure hurts most.

2

Assess Readiness

Map data, systems and skills against the hotspots, not against a technology wish list.

3

Prove on One Asset Class

Deliver a predictive use case in a single quarter with a measurable business case.

4

Scale Deliberately

Replicate the proven model across the fleet with governance and upskilled engineers.

5

Sustain

Build the roadmap and the change story so capability outlives the pilot.

From AI-ready leadership to Asset Intelligence at Scale:
What This Means for Your Plant

The **Right** **Objectives**	The **Right** **Technologies**	The **Right** **Timing**
Aligning strategy with measurable success	**Leveraging innovation for competitive advantage**	**Seizing opportunities for maximum impact**

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Lee Cherng En
Manager, Tech-Biz Development, A*STAR ARTC
lee_cherng_en@a-star.edu.sg