

Industry Interaction Session 2021

Applicable Automation & I4.0 Technologies (for the Malaysian Rubber Industry)

by the Automation Expert Panel:

- EP Chairman: Mr. Lee Boon Teck
- EP Member : Mr. Tiong Khe Hock
- EP Member : Assoc Prof Ir Dr Chang Yoong Choon

Outline



- A. Basic Automation technologies
- B. Basic I4.0 technologies
- C. Summary of Applicable Technologies
- D. Case studies



FA – Pick-and-Place by robotic arm



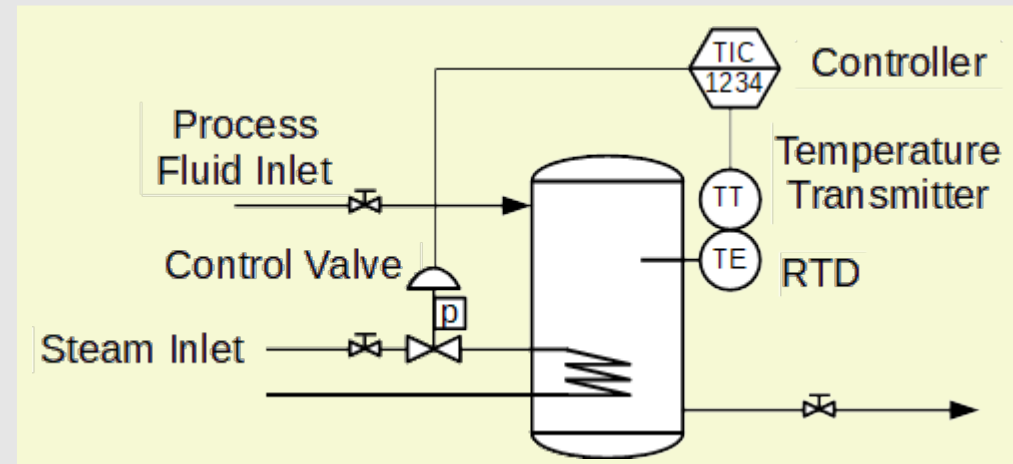
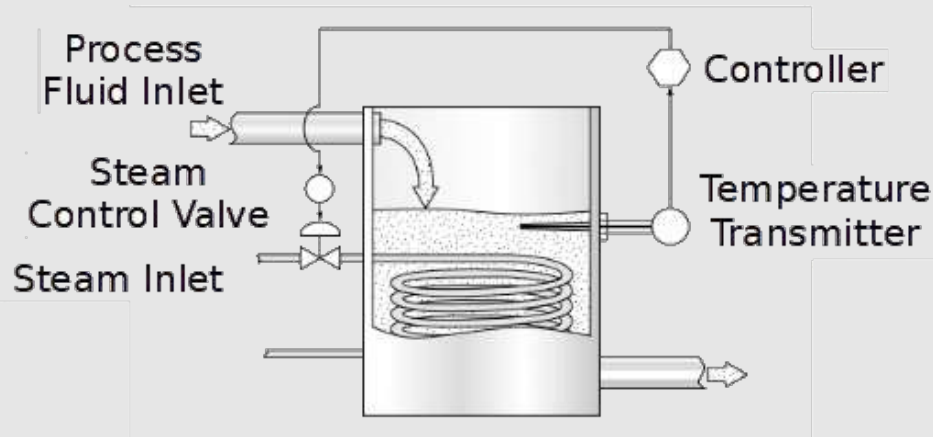
FA - Sequence control of conveying belt system.

A. Basic Automation & Applicable technologies

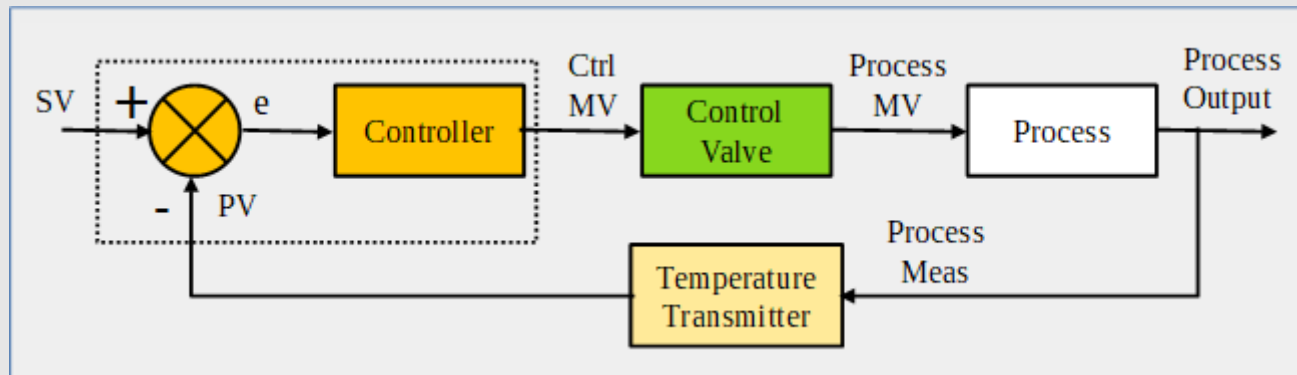


Documentation: Process, P&ID, Loop diagram

- Process: vs Process & Instrument Drawing (P&ID):



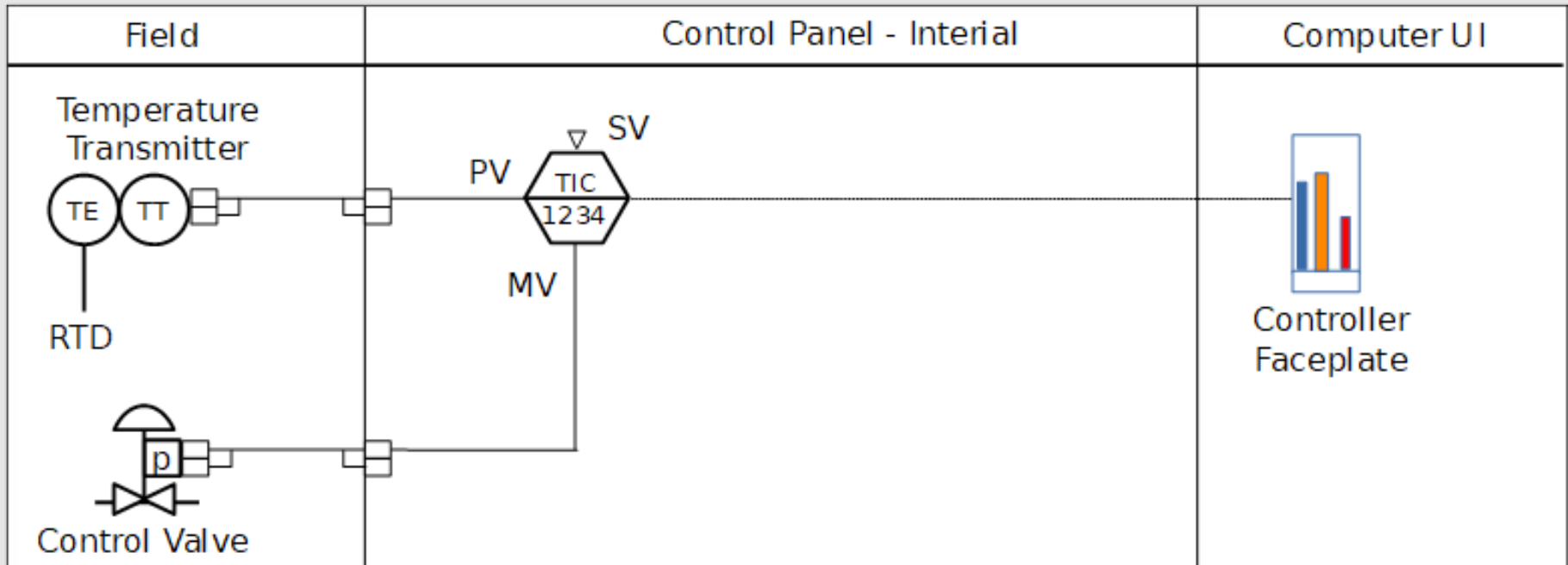
- Control Loop Block Diagram:



A. Basic Automation & Applicable technologies



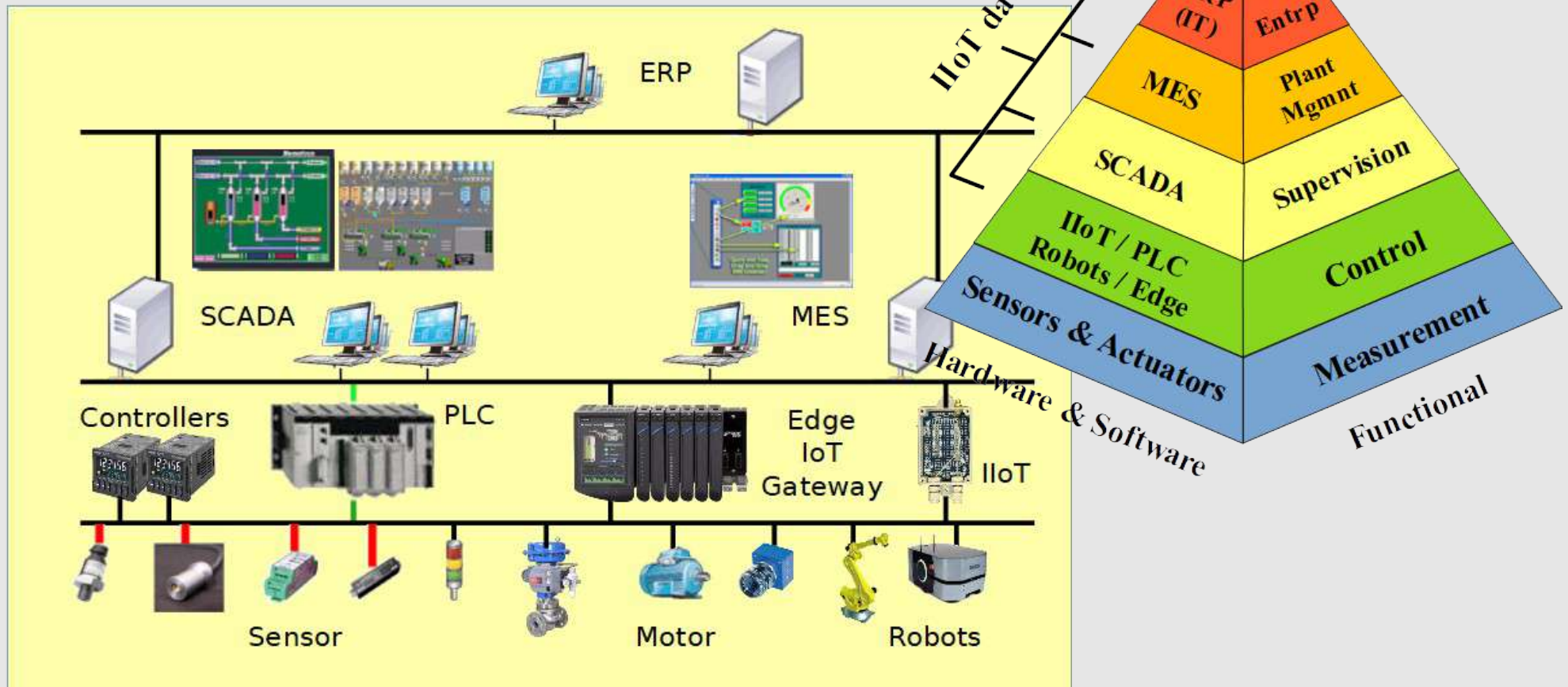
- **Documentation: Process, P&ID, Loop diagram**
 - **Loop Drawing (Wiring diagram)**



A. Basic Automation & Applicable technologies



- Automation Network



A. Basic Automation & Applicable technologies



1. Applicable Measurement & Actuators

Types of Sensors

- **Proximity Sensors (On-Off)**
 - Opto, Inductive, Capacitive
 - Through-beam, Retro-reflective, Difuse-reflective
- **Displacement/Distance/Position/Thickness Sensor**
 - Laser, Ultrasonic, Rotary/Linear encoder
- **Level/Pressure/Temperature/Flow transmitters**
- **Force/Loadcell/Weighing indicator**
- **Vision/RFID/Bar-code**



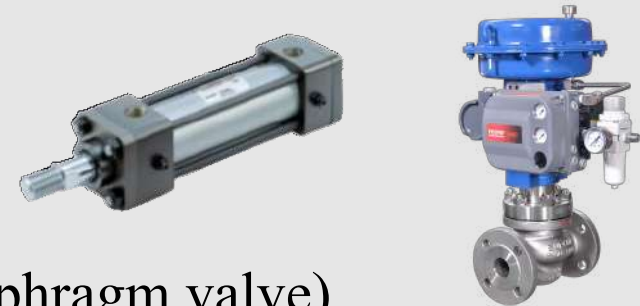
A. Basic Automation & Applicable technologies



2. Applicable Measurement & Actuators

Types of Actuators & Drives

- Linear On-off Cylinder Actuator
- Linear Positioning Cylinder Actuator
- Damper Actuator
- On-Off motorized Valves (Ball-valve, Diaphragm valve)
- Modulating Control Valves (globe, Ball-valve, needle valve, Butterfly valve)
- Fan (motors)
- Stepper motors
- Servo-drives
- Robots/Co-bots/AMR



A. Basic Automation & Applicable technologies



2. Applicable Automatic Control

Types of Control Devices

- Dedicated On-Off Controller
- Dedicated PID Controller
- DCS (Distributed Control System)
- PLC (On-Off, Interlock logic, Sequence, PID, Recipe Batch)
- IIoT (On-Off, Interlock logic, Sequence, PID, Recipe Batch)
- Edge Controller/Gateway
- Edge Computers

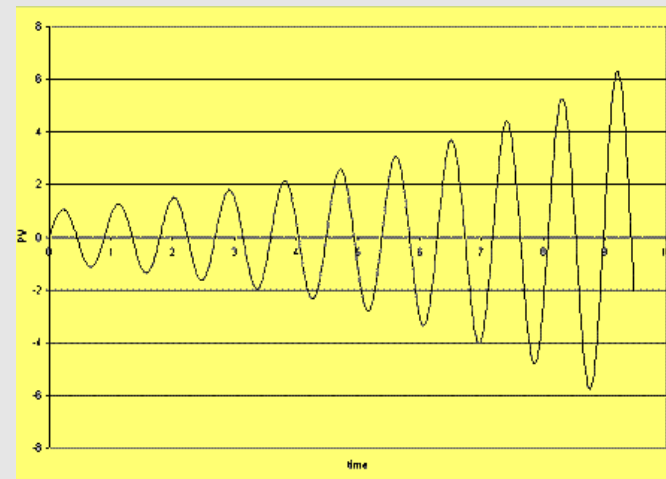
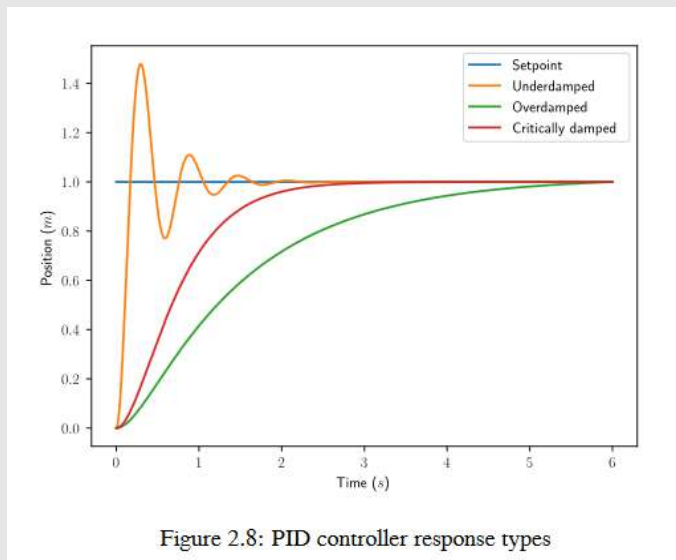


2. Applicable Automatic Control

Types of Control Functions

- **On-off Control/Gap Control/Interlock Logic Control**
- **Proportional Control**
 - PID Control (feedback control) / Self-tuning control
 - Time-Proportional control/Fuzzy logic
- **Recipe Batch Sequence Control**

Watch out for oscillation response (with increasing amplitude)

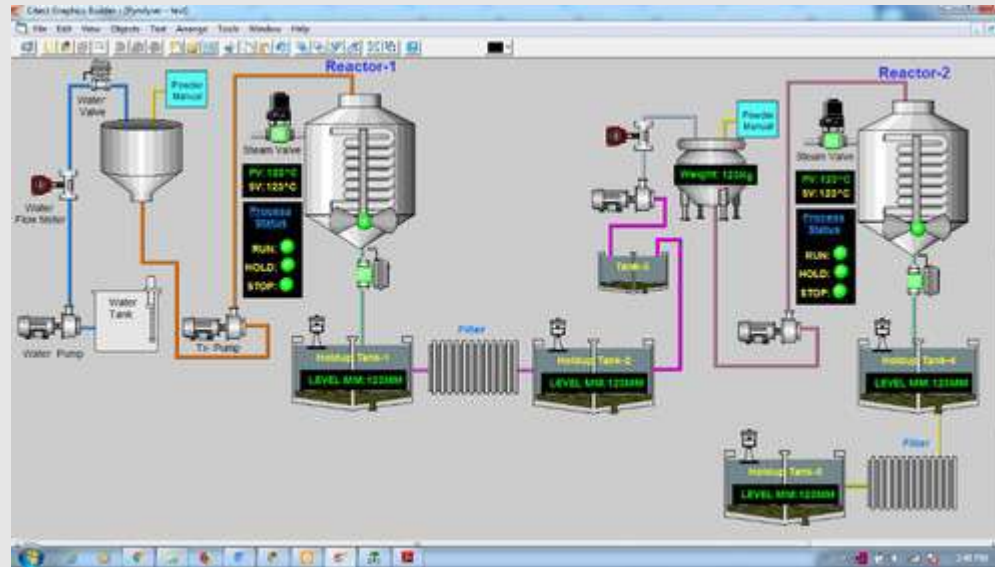


A. Basic Automation & Applicable technologies



3. SCADA (Supervisory Control And Data Acquisition)

Analytics, Visualization, AI & I4.0



4. MES (Manufacturing Execution System)

Production Planning, Analytics, Visualization, AI & I4.0

(SCADA & MES offerings are merging)

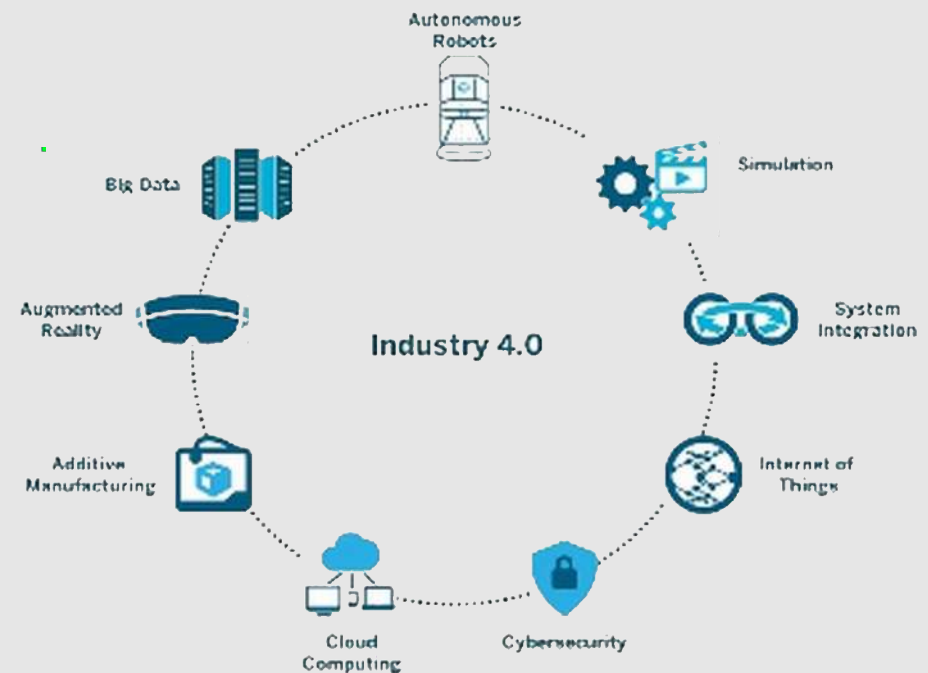
B. Basic I4.0 & Applicable technologies



What is Industry 4.0

- German initiative in 2011 (10 years has passed by)
 - Seamlessly combine Hardware, Software & Cyber Space (Internet) as a whole
- **Digitalization / Digital Transformation** of manufacturing/production

The 9 Pillars of I4.0	
1.	IoT
2.	Cloud/Edge Computing
3.	Universal System Integration
4.	Autonomous Systems
5.	Big Data
6.	Cyber Security
7.	Additive Manufacturing
8.	Augmented Reality
9.	Digital Twin/Advanced Simulation



B. Basic I4.0 & Applicable technologies



I4.0: Industrial Internet of Things (IIoT)

- Industrial IoT is an essential part of an I4.0 implementation

What is an IoT / IIoT

- A device that contains **embedded controllers**

Includes:

- I/O connection to Sensors & Actuators
- Local Data Collection & Data Analysis
- (may include Sensors, Local Control and/or AI)
- **Standard and Open communication protocol (eg. MQTT)**
 - data exchange with other devices/systems over the Internet
- **Usually supports wireless communication**



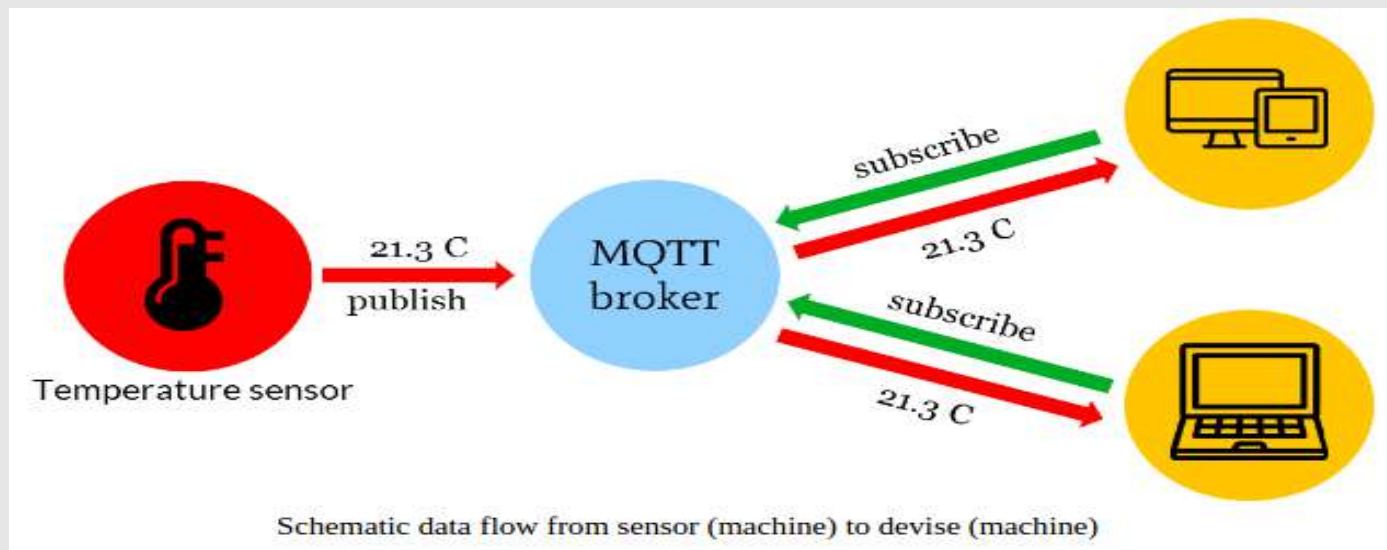
B. Basic I4.0 & Applicable technologies



I4.0: Industrial Internet of Things (IIoT)

The MQTT communication protocol

- MQTT stands for **M**essage **Q**ueuing **T**elemetry **T**ransport.
- Open Standard (OASIS standard and **ISO recommendation**).
- Protocol usually runs over TCP/IP
- Protocol is **Lightweight**
- Based on **Publish-Subscribe** network model (**efficient**)
 - data is **Pushed** by Publisher (instead of **Polling** by clients, such as OPC)

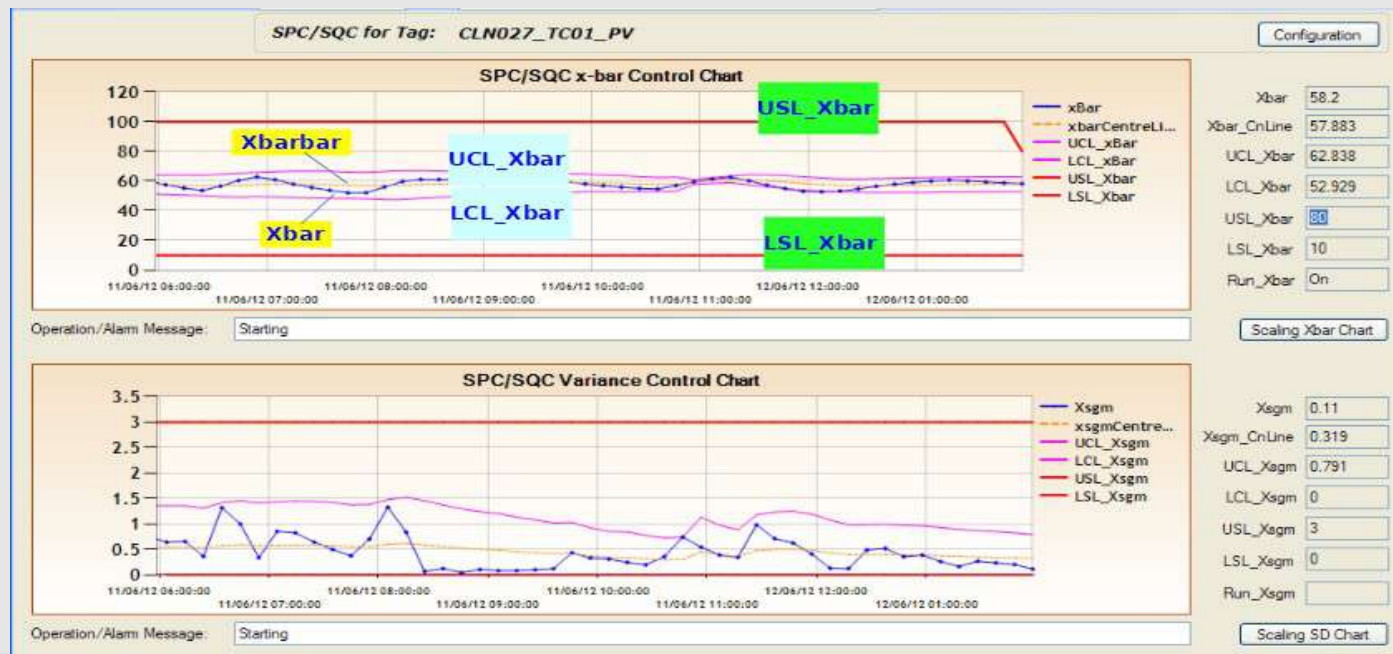


B. Basic I4.0 & Applicable technologies



I4.0: Applicable Analytics:

- **Real-time SPC/SQC**
 - Generate statistical point based on a group of SAMPLE POINTS
 - x-bar Chart: Plots of sample AVERAGE
 - s-Chart: Plots of sample Std. Dev. (SD)
- **Benefits of SPC/SQC**
 - Notify on: Process RUN & OFF-SPEC conditions
 - Generate: Process Control Limits & Process Capability C_{pk}



B. Basic I4.0 & Applicable technologies



I4.0: Applicable Analytics: Real-time OEE

OEE = Availability x Performance x Quality

- Single machine OEE plus Line OEE
- **Benefits of real-time OEE**
 - **Insight** into line **Bottle-neck** and **Spare capacity**
 - **Notify on: Low OEE, Availability, Performance & Quality**



B. Basic I4.0 & Applicable technologies



I4.0: Applicable Analytics

Real-time OEE – Challenges:

- Availability = (Real Run Time) / (Available Time)
- Performance = (Real Cycle Time) / (Ideal Cycle Time)
- Quality = (1st. time Good Products) / (Total Good Products)

Available Time = (Total Time) – (Planned Downtime)

Run Time = (Available Time) – (Unplanned Downtime)

- **Challenge 1:** How & When to incorporate Planned Downtime?
- **Challenge 2:** What is the time period of measurement
- **Challenge 3:** How to plot a trend of real-time OEE

C. Summary of Applicable Technologies



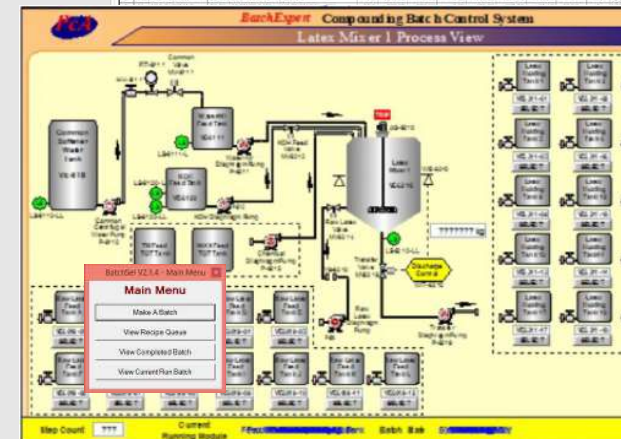
Rubber Glove Manufacturing:

Compounding

Recipe Batch Control

- **Unlimited Master Recipe available**
- **Improves Throughput & Quality**
- **Reduce Manpower**
 - Weighing/Temperature control
- **Recipe Security**
 - Automatic recipe Encrypt/Decrypt
- **Batch Traceability**
- **Real-time Management Reports**
 - Raw Material consumption report
 - OEE & Trending:
 - Run time
 - Production throughput
 - Quality analysis

Item No.	Name	Weight	Time	Chemical Code	Chemical Name	Qty	Unit	Temp	Speed	Notes	Start Time	End Time
1	Latex	100.00	00:00	MS-001	MS-001	100.00	kg	100.00	100.00		10:00	10:05
2	Raw	100.00	00:00			100.00	kg	100.00	100.00		10:05	10:10
3	MS-001	100.00	00:00	MS-001	MS-001	100.00	kg	100.00	100.00		10:10	10:15
4	MS-001	100.00	00:00	MS-001	MS-001	100.00	kg	100.00	100.00		10:15	10:20



C. Summary of Applicable Technologies



Rubber Glove Manufacturing:

Production Line Monitoring & Control

Production Counting

- Chain Speed control (Geared Motor, Servo-drive, VSD-drive)
- Motor Running Hr & performance monitoring
- Production throughput with Glove Size analysis & monitoring
- Former Analysis
- Former Bypass Synchronization
- Trending & SPC/SQC::
 - Process measurement
 - OEE



C. Summary of Applicable Technologies



Rubber Glove Manufacturing:

Production Line Monitoring & Control

Former Preparation, Dipping Tank Control & Drying

- Former Brushing (Brush, Motor, Servo-drive, VSD-drive) control
- automatic Level / Temperature / flow control
- pH / TDS measurement

Beading

- Brush, Geared Motor, Servo-drive, VSD-drive) control

Vulcanization

- Temperature control / Air flow control

Glove Stripping (Removal)

- Automatic Air Purching control
- Automatic Glove Stripping
- Automatic Glove Pulling & Stacking



C. Summary of Applicable Technologies



Rubber Glove Manufacturing:

Production Line Monitoring & Control

QA/QC

- Automatic QA check on Water-leak test

End-of-line packing

- Automatic Glove Packing
- Inner box packing
- Carton box packing

Utilities

- Water, Gas, Energy Consumption Monitoring
- Energy generation
- Boiler Control
- Solar Energy

C. Summary of Applicable Technologies



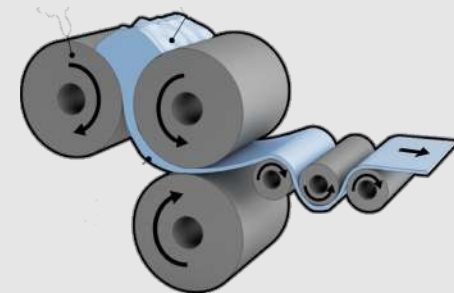
Dry Rubber Manufacturing:

Compounding

- Automatic Small Chemical Compounding - Recipe Batch Control
- Computer guided semi-auto weighing & feeding control

Production Monitoring & Control

- **Production throughput analysis & monitoring**
 - OEE / Temperature / Pressure
 - Trending & SPC/SQC
- **Conveyor belt control (Geared Motor)**
- **Calendering Roller Gap Monitoring & Control**
- **Molding & Vulcanization**
 - compression molding, transfer molding, injection molding
 - Pressure / Temperature / Timing control
- **QA/QC**
- **Utilities**



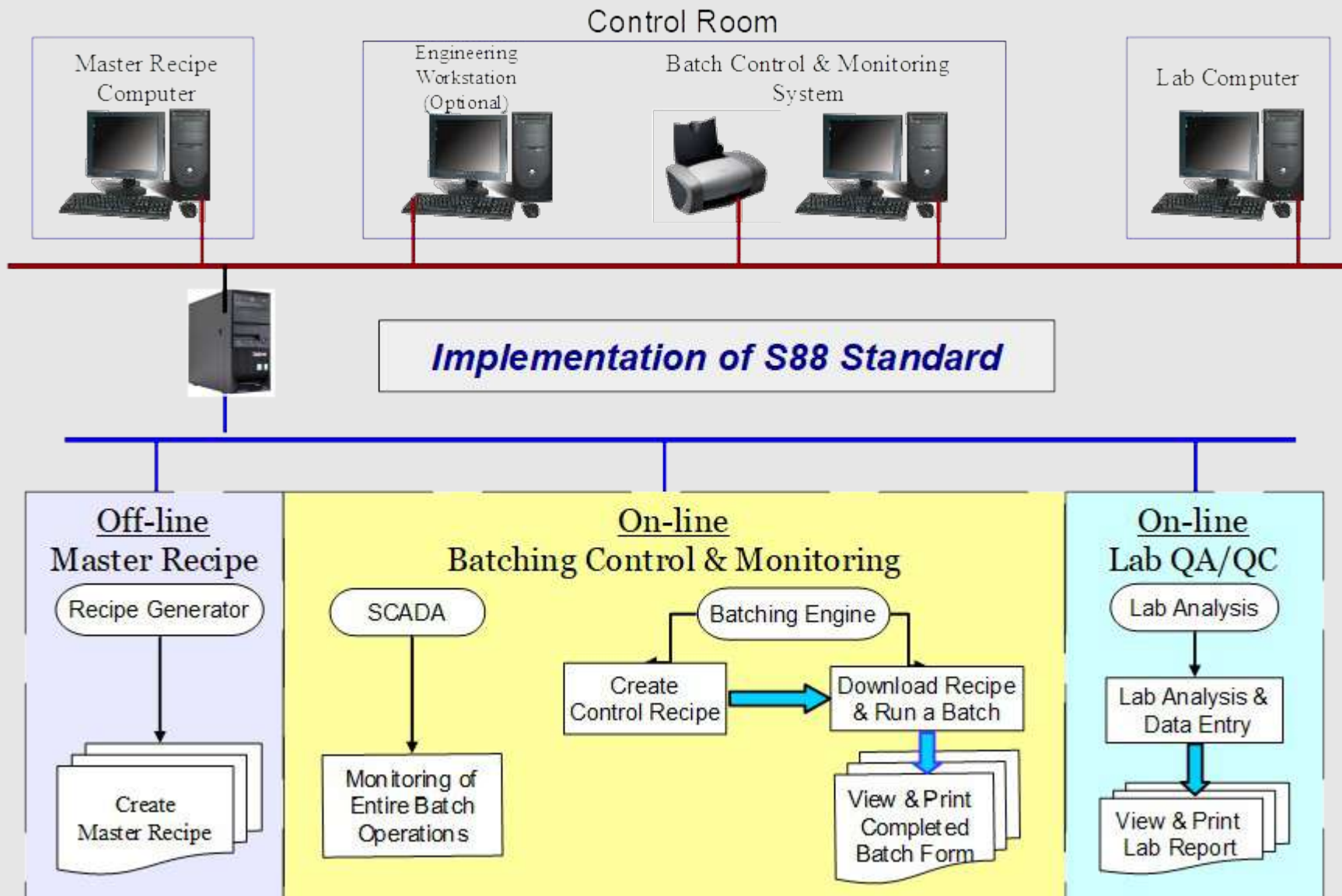
C. Summary of Applicable Technologies



Matrix of Applicable Technologies:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	
1	List of Automation Systems & Technology for the Malaysian Rubber Industry																									
2																										
3	Automation Technology Matrix (for Latex Products)																									
4																										
5	Station	Processes / Operations	Key Parameters	Automation Technology (II/OT)																						
6				Process Measurement			Automatic Control			Statistical Control	Machine vision	Mechanical Automation		Robotic		Identification & Labeling			Big data		Control Hardware					
7				Real time measurement	Operator Alert	Customized Control	Discrete Control	Batch control	SPC/SQC		Mechanical Cam	e-Cam	Traditional	Collaborative	Mobile (AGV/AMR)	Barcode, 1D barcode	RFID	Blockchain	Predictive maintenance	AI & Data Mining	IoT	PLC	PC-based			
8	1	Compositing (Dilution/Mixing)																								
9		Raw material handling															Advanced	Proven	Advanced	Advanced						
10		Batch Control																								
11		Motor Recipe generation, Control Recipe generation, Control Recipe Execution	Weighing Temperature	Proven	Proven					Proven	Recommended															
12			Raw Material consumption, Production throughput, Quality Analysis, OEE calculation																							
13	2	Production Line:																								
14		Overall Operations:																								
15		Data analysis	consumption, Production/ Glove Size throughput, Former Analysis, Quality Analysis.	Proven	Proven																					
16		Chain Speed control (Geared Motor, Servo-drive, VSD-drive)	Motor Control, Running Hr. & performance monitoring	Proven	Proven	Proven	Proven																			
17																										
18		Former Cleaning																								
19		Acid, Alkaline, Coagulant Dipping & Rinsing	Level, Temperature, TSC, pH	Proven	Proven	Proven				Proven																
20		Former Bypass Synchronization		Advanced			Advanced																			
21		Mechanical Brushing (Brush, Geared Motor, Servo-drive, VSD-drive)	Motor Control, Running Hr. & performance monitoring	Proven	Proven	Proven	Proven																			
22			Brush & Former surface QA									Advanced														

D. Case Study – Recipe Batch Control



D. Case Study – Recipe Batch Control



Rubber Glove Manufacturing: Compounding Recipe Batch Control (ANSI-SP88 Std.)

Benefits:

- Master Recipe for unlimited Methods & Formulation
- Automatic recipe encryption (protection)
- Traceability for every batch
- Dynamic weighing error correction
- improves:
 - Management control & accountability
 - productivity
 - Consistency, Accuracy & Quality
- Eliminate reworks
- Reduces Manpower & Wastage

The image displays two screenshots of the BatchExpert software interface. The top screenshot is a 'Batch Completed Form' for 'Latex Compounding'. It includes fields for Plant, Form Code, Category, Color Code, Description, and a table of ingredients with columns for Item, Recipe, Weight, Chemical Code, Chemical Name, Qty, Unit, %W, Yield, Actual, and %Yield. A barcode is also present. The bottom screenshot shows the 'Latex Mixer 1 Process View' with a complex piping diagram of the mixing process. A 'Main Menu' box is overlaid on the diagram, containing options: 'Make A Batch', 'View Recipe Queue', 'View Completed Batch', and 'View Current Batch'. Below the screenshots are two physical manuals or brochures.

Thank You

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Next Presentation

to follow ...

Vision Inspection Systems in Manufacturing

Ir. Dr. Chang Yoong Choon

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Traditional Manual Quality Inspection



Traditional Manual Quality Inspection



Challenges of Manual Quality Inspection

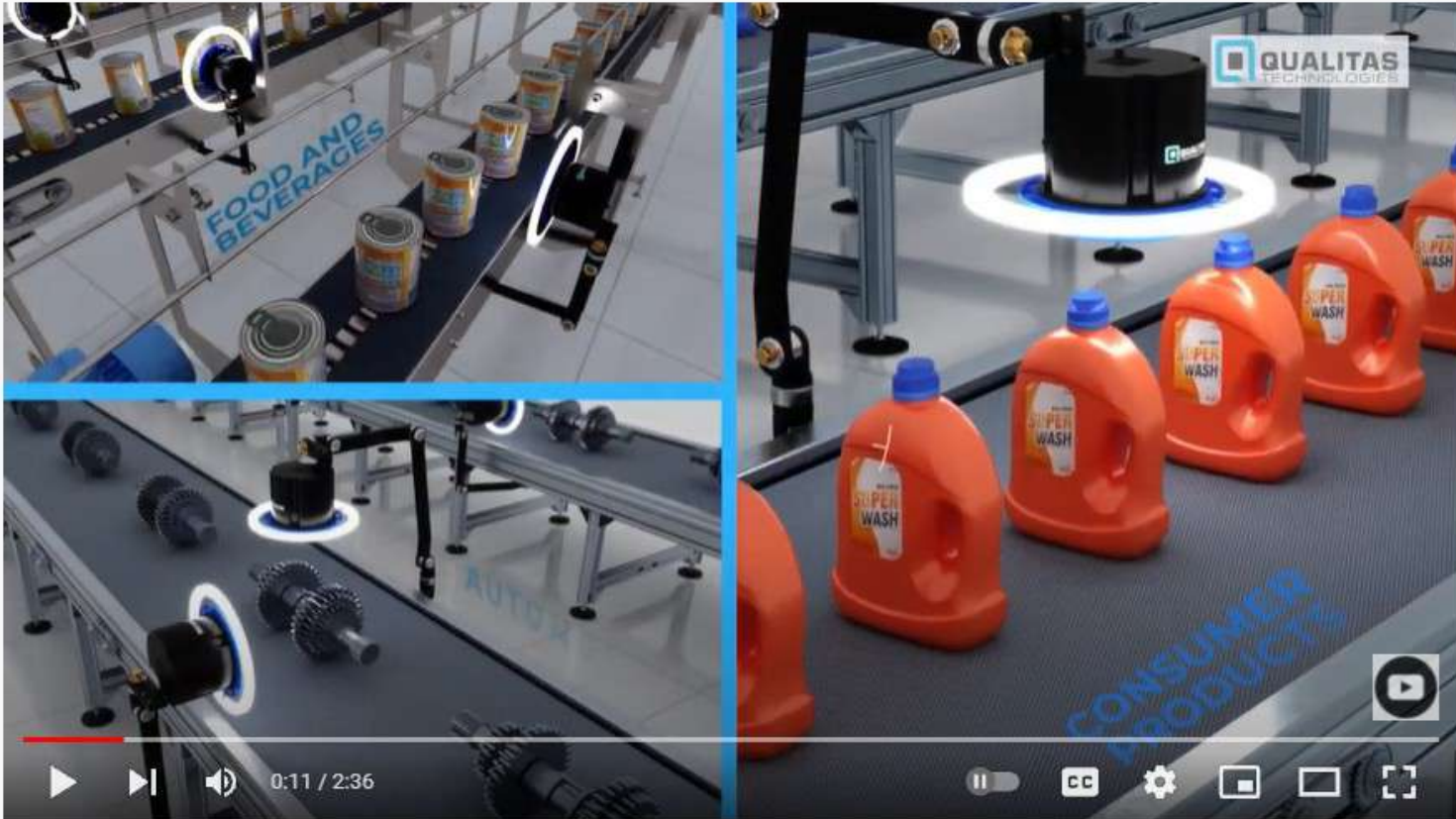
- Work fatigue



- COVID restrictions (social distancing, lockdown, etc)



Vision Inspection System (Video)



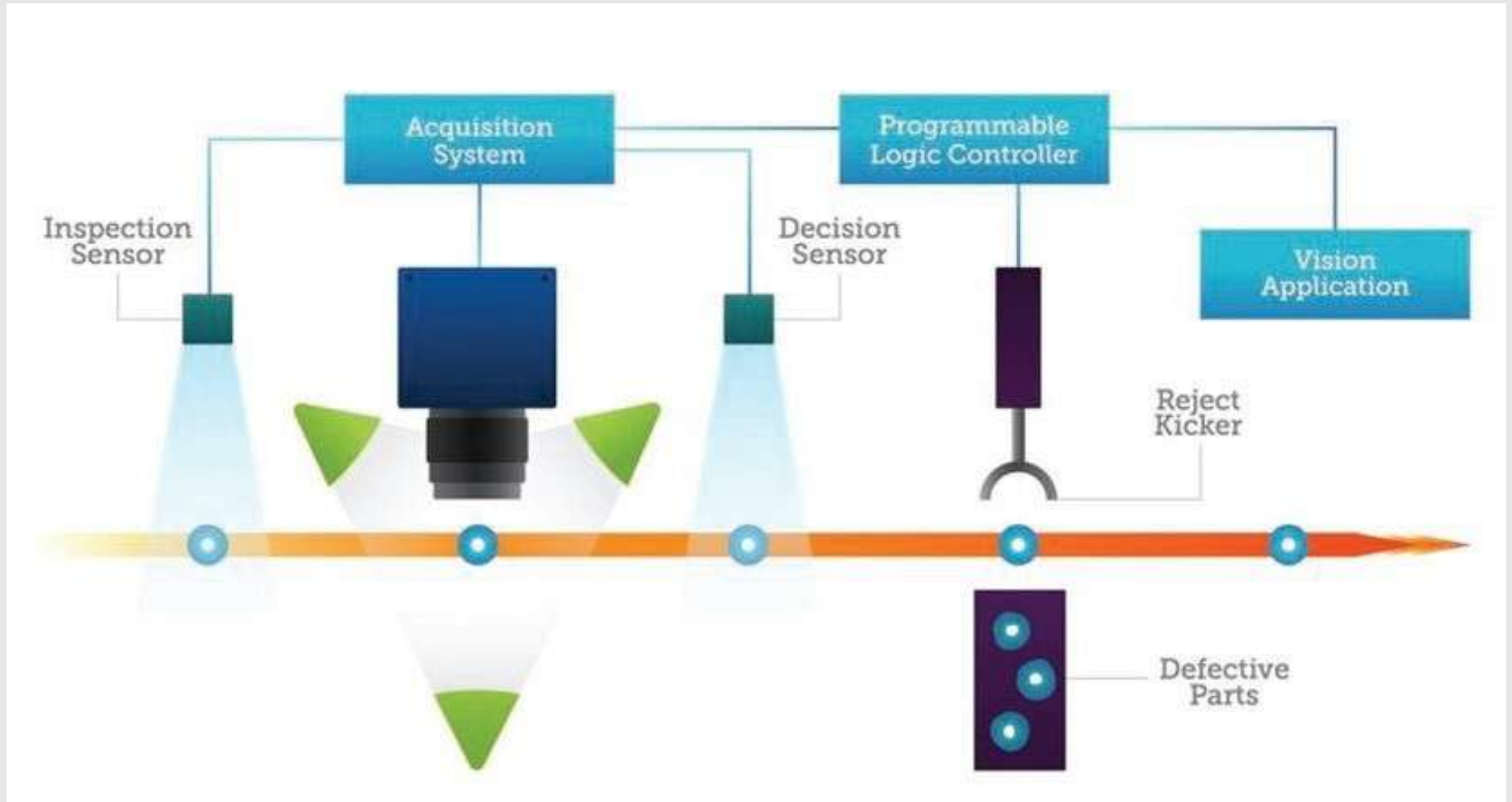
The video player interface includes a search bar at the top, a play button, a progress bar showing 0:11 / 2:36, and various control icons like volume, closed captions, settings, and full screen. The video content shows a vision inspection system in a factory. The video is titled "Introduction to Machine Vision | Vision Inspection System | Qualitas Technologies" and is 2:36 long. The video content shows a conveyor belt with cans and bottles being inspected by a camera system. The text "FOOD AND BEVERAGES" and "CONSUMER PRODUCTS" is visible on the conveyor. The Qualitas Technologies logo is also present.

Introduction to Machine Vision | Vision Inspection System | Qualitas Technologies

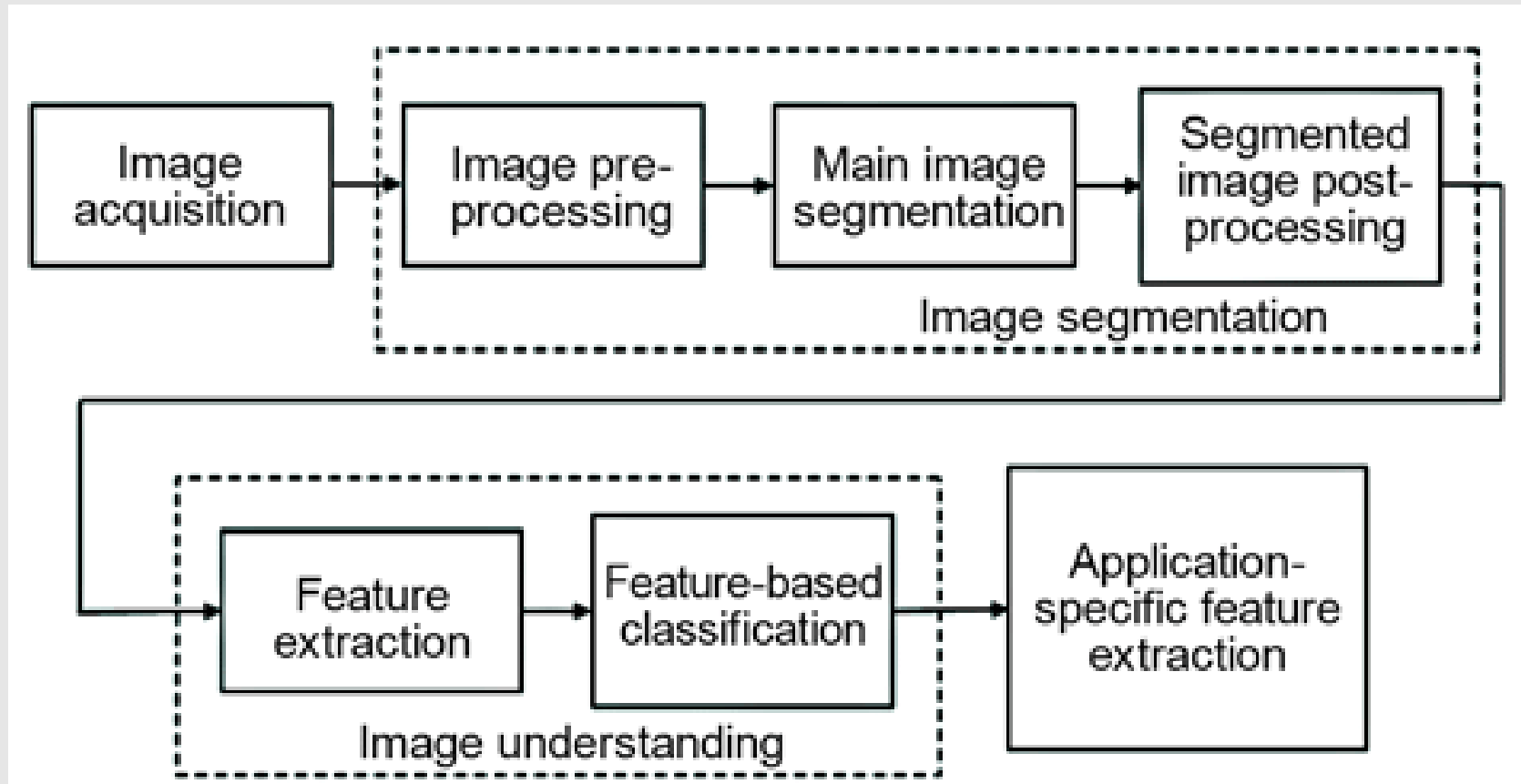
Vision Inspection Systems



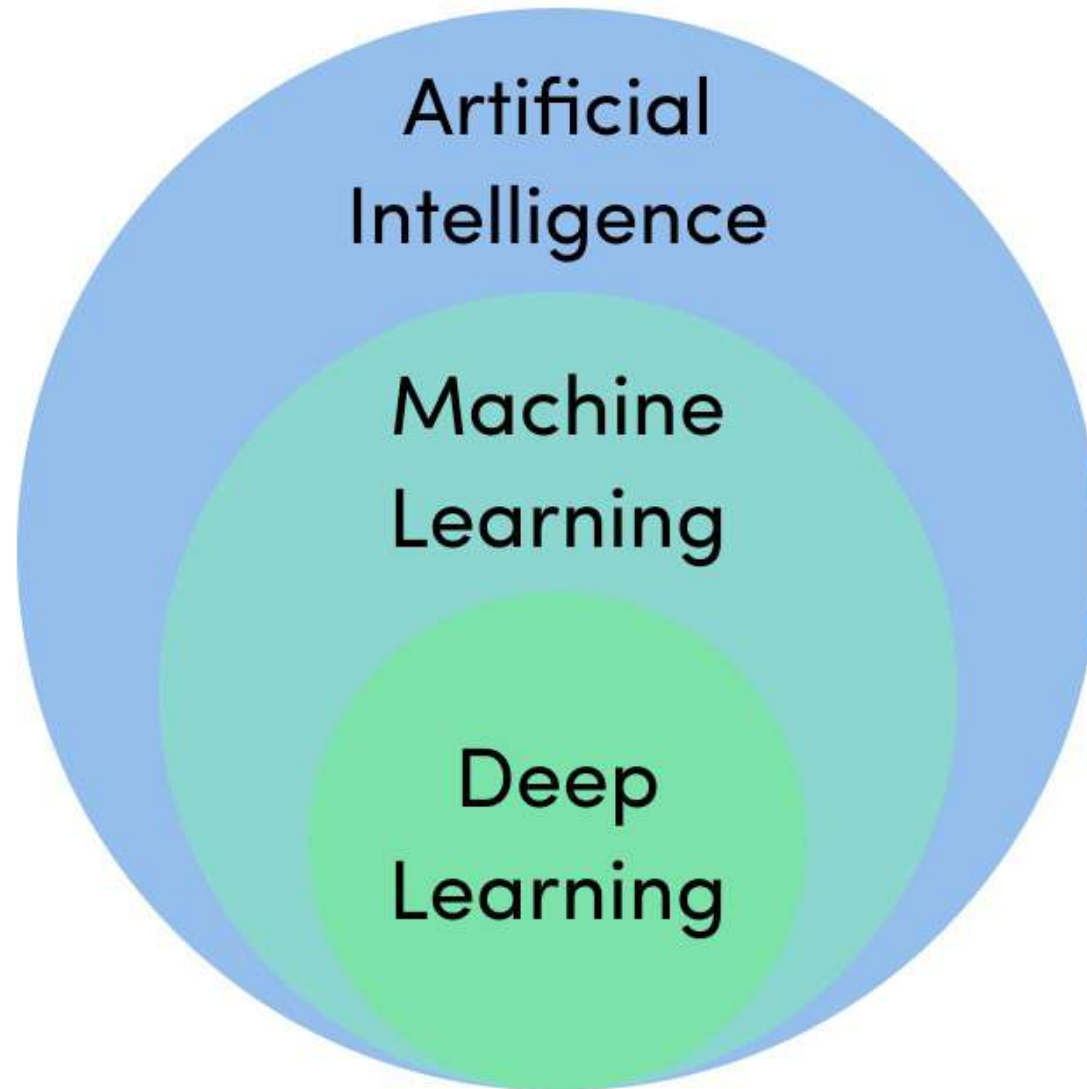
Vision Inspection System



Vision Inspection Technique



AI in Computer Vision Techniques



AI vs Machine Learning vs Deep Learning

- AI: Technique which enables a machines to mimic human behaviour



Computer Vision Techniques

- From Machine Learning to Deep Learning
- Increase of dataset (increase of storage space)
- Increase of GPU computational power (Moore's law)
- Increase of Internet bandwidth (data rate)

Vision Inspection Systems: Advantages

- Consistent quality, not affected by work fatigue
- Increased manufacturing throughput
- Up to 99% accuracy (provided sufficient samples)
- Minimal impact by COVID restrictions
- Industry 4.0 ready with data analytics (e.g. reject rate, inspection throughput, etc)
- Potential ROI in 2 years

Thank You

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Next Presentation
to follow ...

SCADA and Robotics Applications in Rubber Industry

Tiong Khe Hock

President

Malaysia Automation Technology Association (MATA)



Outline

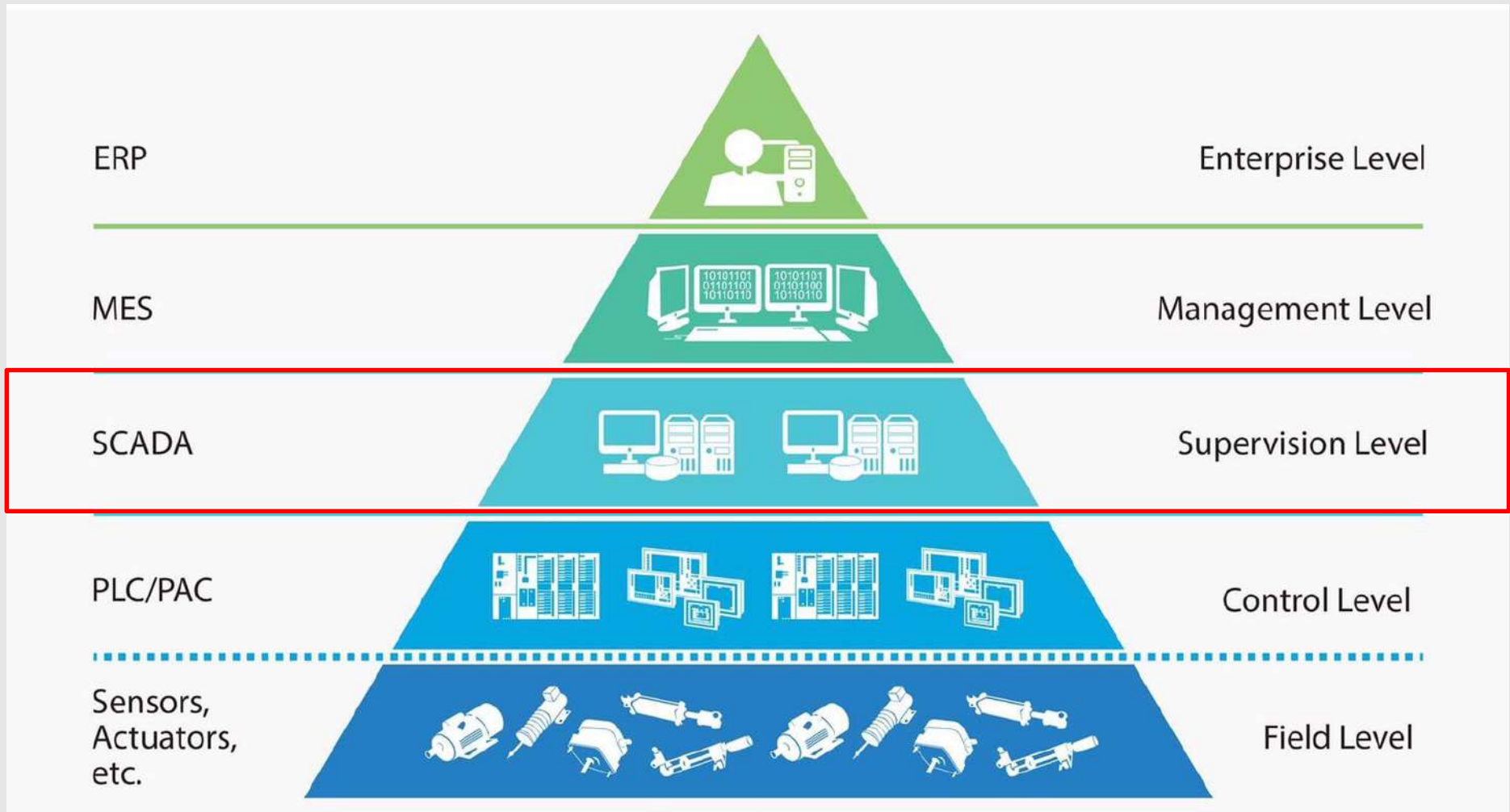


- Automation Pyramid & SCADA
- SCADA Applications
- Robotic Installations in Malaysia
- Robotic Applications

Automation Pyramid & SCADA



Supervisory Control & Data Acquisition (SCADA)

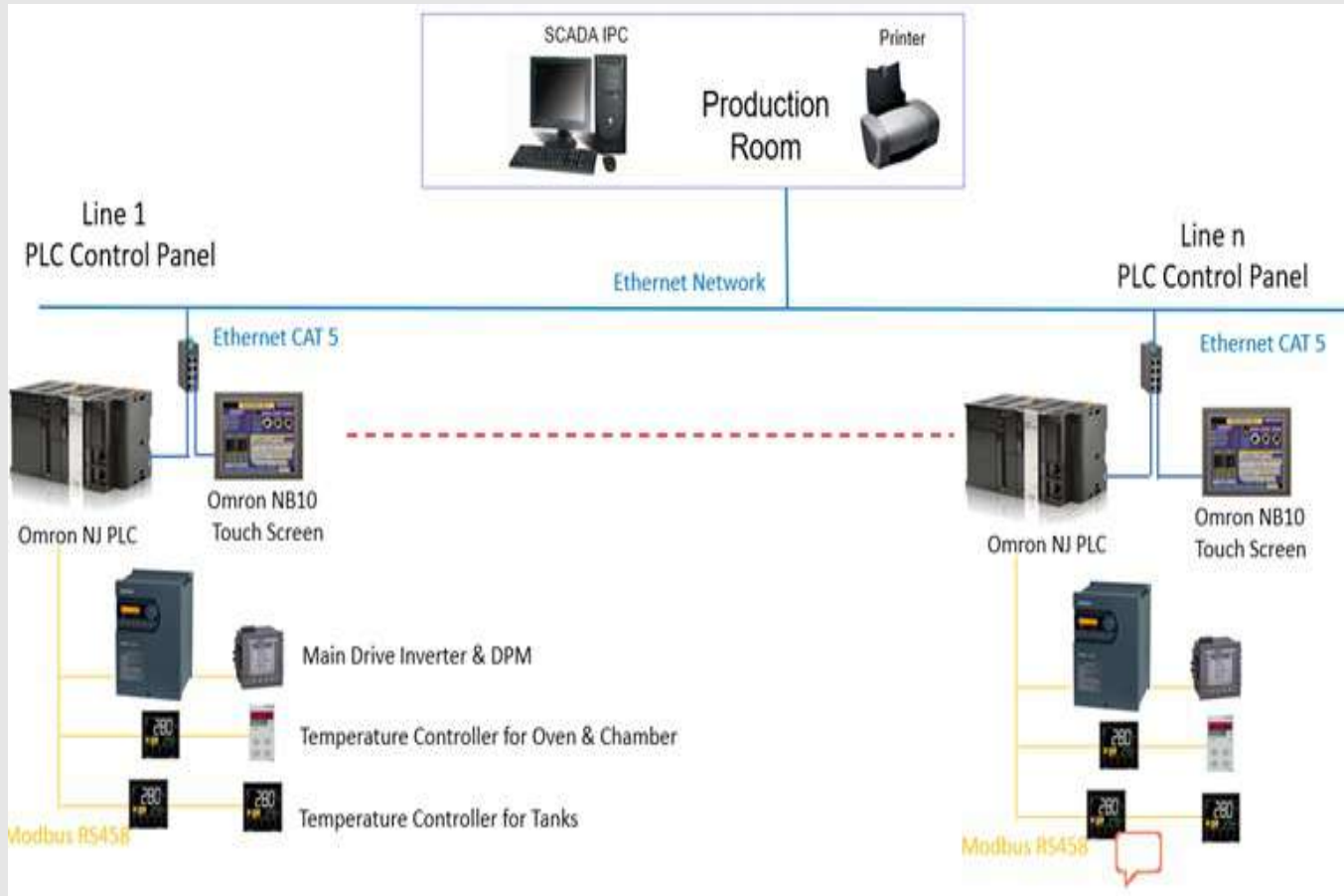


SCADA Applications – Rubber Glove Industry



Dipping Line Supervisory Control and Data Acquisition

Benefits



- Reduce manpower and eliminate human error during start up.
- Reduce energy consumption at the blower motor.
- Reduce signal wiring between Main panel & fields devices via Fields Bus network.
- Reliable data sending direct to SQL without SQL knowledge.
- Real-time monitoring to quickly identifying waste/performance opportunities.
- Auto- reporting generation for production

SCADA Applications – Rubber Glove Industry



Overview Screenshot: This interface shows a schematic diagram of a production line with various tanks and equipment. A 'CLORINE OVEN' is highlighted with a red box. The top navigation bar includes 'SCHEMATIC', 'MOTOR', 'UTILITIES', 'OUTPUT', 'ALARM', and 'REPORT'. The 'SCHEMATIC' tab is active, and the 'LINE 01' button is highlighted at the bottom.

Overview

Temperature Parameters Setting Screenshot: This interface displays a table of temperature parameters for various tanks. The 'SCALING' tab is active. The table includes columns for 'ALARM LOW', 'ALARM HIGH', 'SCALING OFFSET', and 'SCALING SCALED'. The 'LINE 01' button is highlighted at the bottom.

Parameter	ALARM LOW	ALARM HIGH	SCALING OFFSET	SCALING SCALED
ACID TANK 1	20.0	80.0	0.0	76.8
ACID TANK 2	60.0	72.0	0.0	71.0
ACID TANK 3	60.0	80.0	0.0	74.0
ALKALINE TANK 1	60.0	70.0	0.0	76.9
ALKALINE TANK 2	60.0	80.0	0.0	76.3
RINSE TANK 2	60.0	66.0	0.0	48.2
RINSE TANK 3	60.0	70.0	0.0	40.6
RINSE TANK 4	65.0	70.0	0.0	39.2
COAGULANT TANK 1	63.0	63.0	0.0	32.4
COAGULANT TANK 2	0.0	63.0	0.0	0.0
FORMER TEMP	0.0	200.0	0.0	90.0
GAS FLOW		0.0	500.0	0.0
WATER FLOW		0.00	50.00	6.80
STEAM FLOW		0	2460	954

Temperature Parameters Setting

Temperature Trending Screenshot: This interface displays a 'Trend' window for 'LINE 3 FORMER TANK'. The graph shows a sharp increase in temperature from approximately 30 to 75 over time. The 'Trend' tab is active. The 'LINE 03' button is highlighted at the bottom.

Temperature Trending

SCADA Applications – Rubber Glove Industry



The image displays three overlapping SCADA interface windows. The top-left window, titled 'MOTOR LINE 02-PAGE 01', shows a grid of motor status controls for various brush types (Horizontal, Cooling, Round) with 'AUTO', 'RUN', 'STOP', and 'START' buttons. The top-right window, titled 'OVEN LINE 02-PAGE 01', displays detailed monitoring for four ovens: Main Oven 1, Main Oven 2, Main Oven 3, and Coagulant Oven 1. Each oven has a 'BLOWER' and 'BURNER' section with status indicators and temperature readouts for 'CHAMBER' and 'OVEN'. The bottom-right window, titled 'ALARM', shows a table of alarm events with columns for Date, Time, Date, Name, and Comment. The table contains several entries from February 2021, all with a status of 'UNACK'. Below the table is a section for 'Update Successful' and a 'Default Query' section with a table for alarm details.

Blower Status Monitoring

Oven Status Monitoring

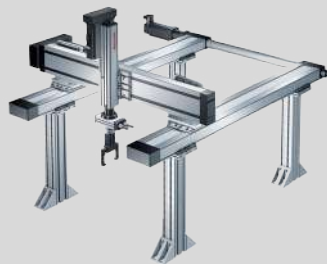
Alarm Logging

Robotics Installations in Malaysia



ROBOTIC INSTALLATIONS BY INDUSTRY

TYPES OF INDUSTRIAL ROBOTS



CARTESIAN ROBOT
Built for medium weight loads needing repetitive stacking, improves productivity by freeing-up manpower



SCARA ROBOT
4-axis Scara Robots ideal for mechanical assembly, material handling, packaging, machine tending, and screw driving.



DELTA ROBOT
Four-axis parallel robot achieves high speed and high precision

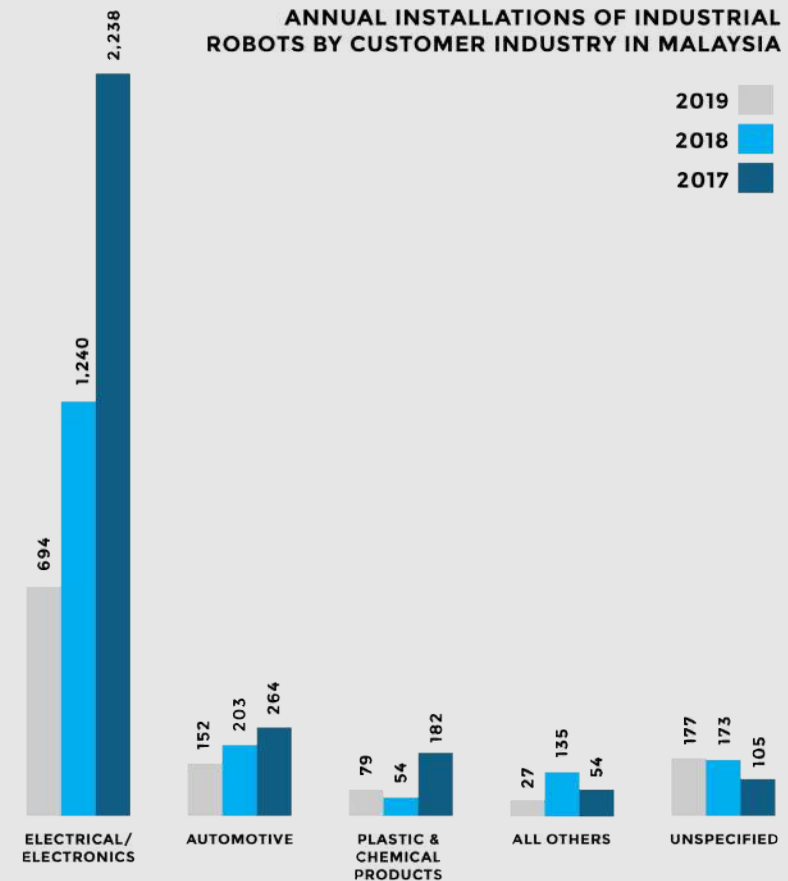


ARTICULATED ROBOT
6-axis Articulated Robots ideal for mechanical assembly, material handling, packaging, and palletising.



COLLABORATIVE ROBOT
The robot system allows collaborative operation with humans without safety fences

ANNUAL INSTALLATIONS OF INDUSTRIAL ROBOTS BY CUSTOMER INDUSTRY IN MALAYSIA



Automated packaging process for productivity improvement

Issues

Labor Intensive

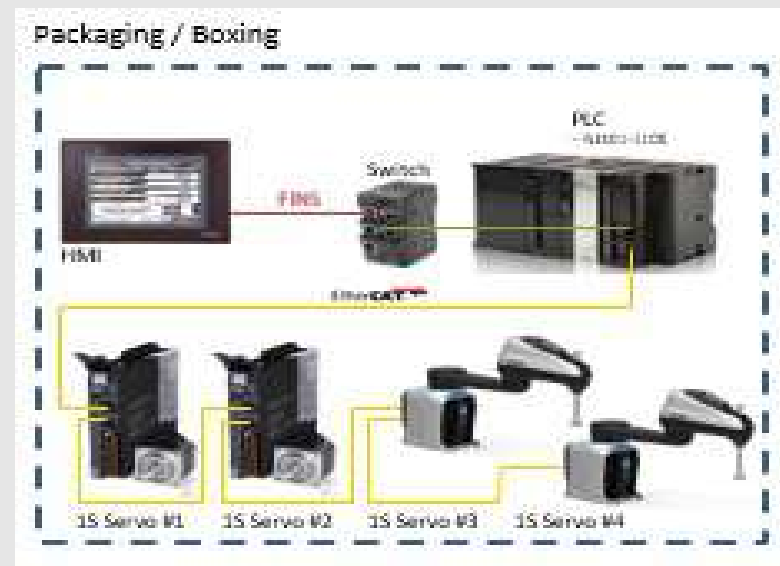
- Very dependent on workers.
- Manual counting leads to quality issue
- Low efficiency with long working hours
- Process bottleneck.



Solutions

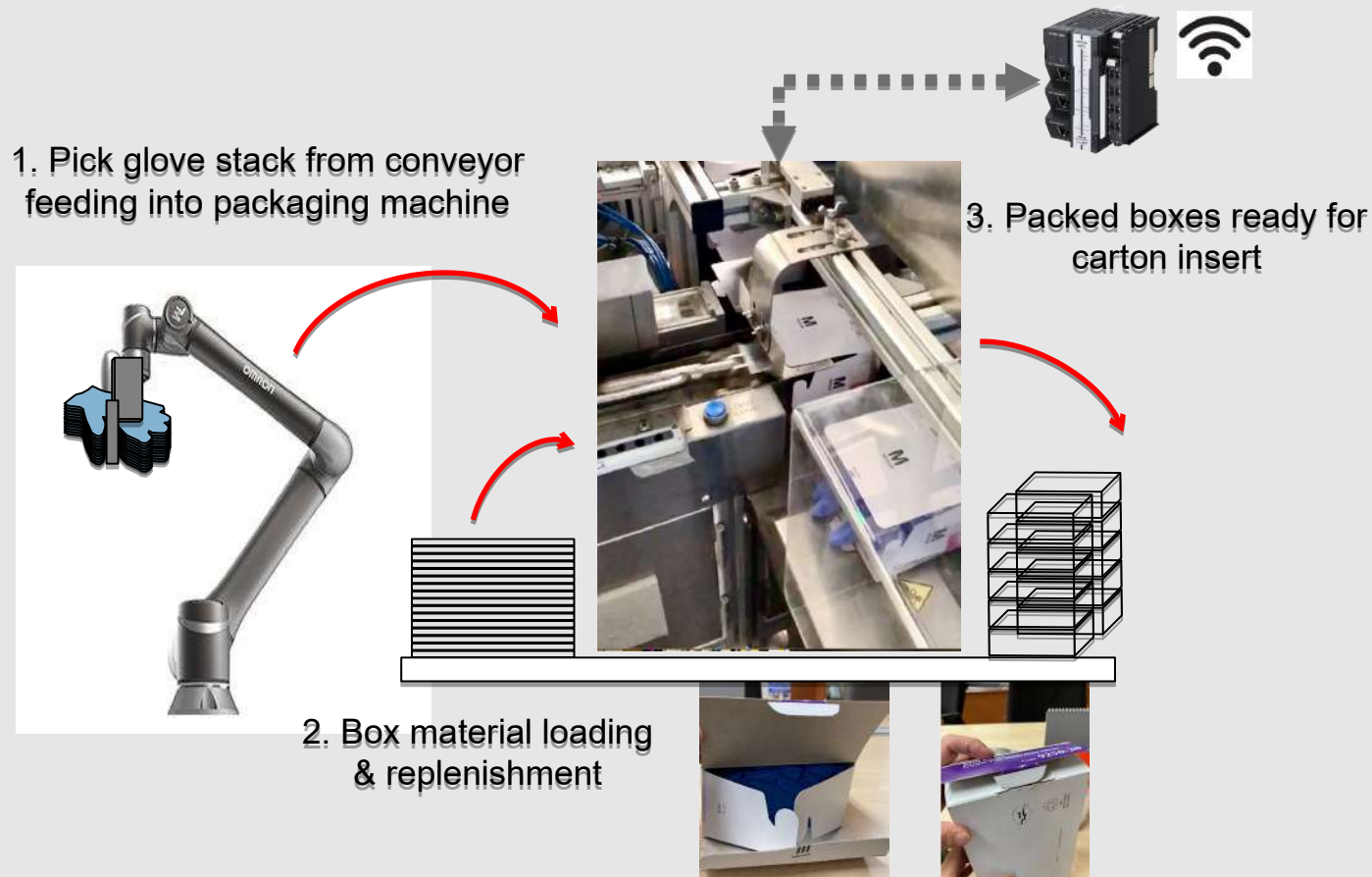
Auto-Insertion System with Robotic Picking

- Robotic glove transfer after stacking.
- Mechanical movement with servo control during glove insertion
- Auto case packer system into carton box



Automated packaging using Servo Control and Collaborative Robots

Benefits



- Reduces manpower dependency during layering process.
- Fully automate process to ensure quality consistency.
- Seamless software integration using EtherCAT for wiring cost reduction.
- Easy Troubleshooting – online to PLC, able to configure, set and tune every motor.
- Simple Proven Integration and allows remote troubleshooting.

Intelligent Carton Erector using Collaborative Robots

Issues

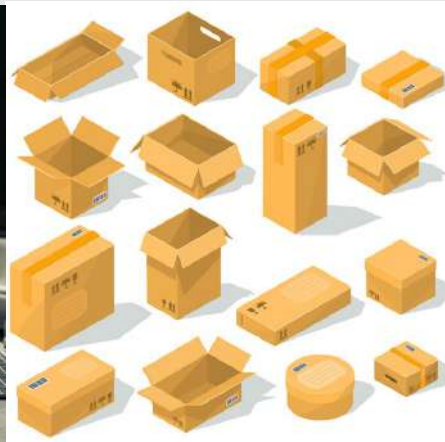
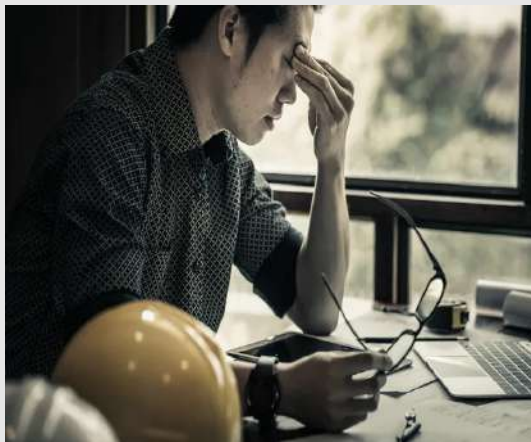
Labor Intensive & inflexible

- Very dependent on workers.
- Multiple carton sizes – hard to automate.
- Long changeover time (for standard carton erector) – mechanical adjustment is needed.

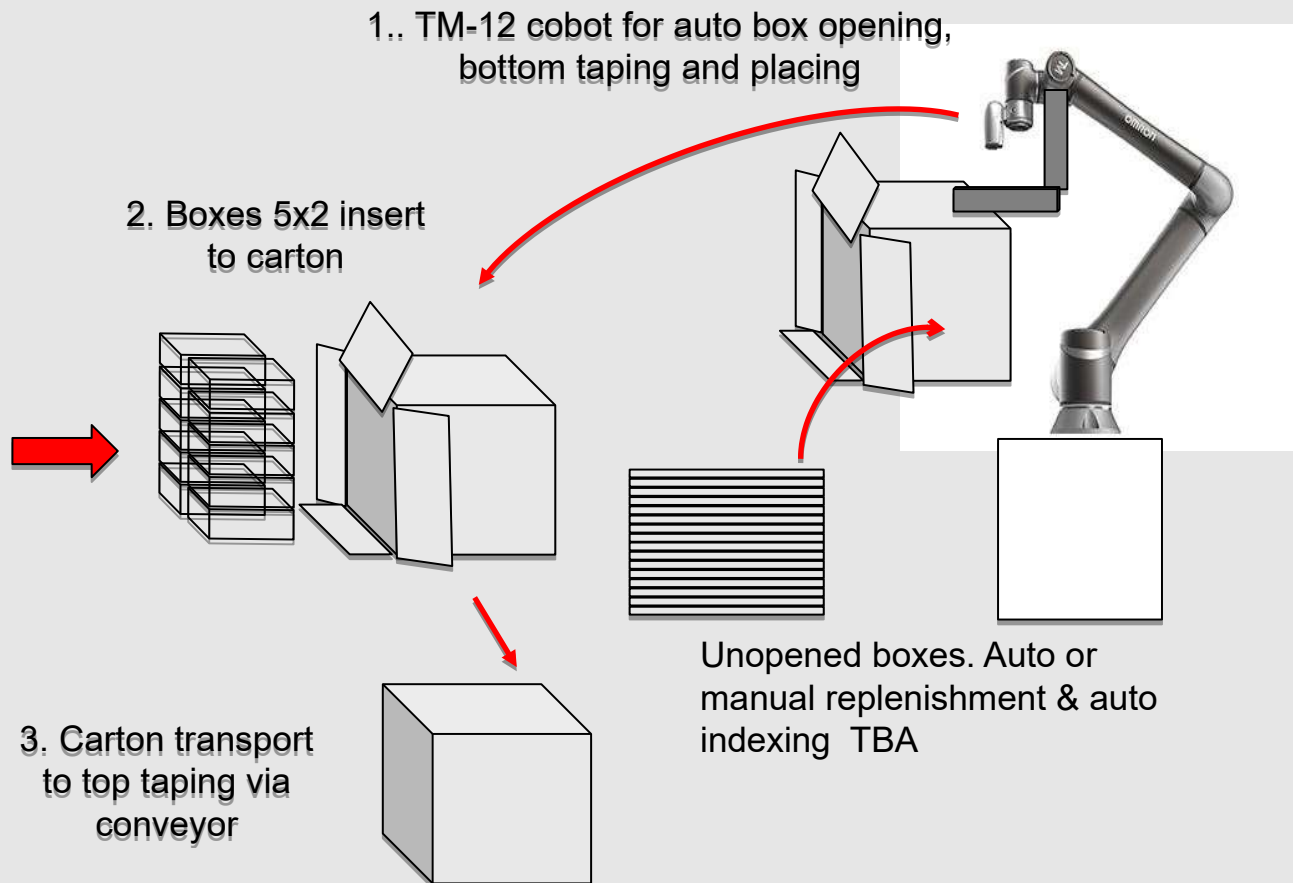
Solutions

Cobot handling for multiple SKU

- Carton erector by using cobot.
- Mechanical design with servo control for inner boxes arrangement.
- Conveyor transfer for finish box.



Auto Box to Carton Insertion with Collaborative Robots



Benefits

- Flexible, safe & space saving.
- Support wide range of carton size without any mechanical changeover.
- Minimize manual works to reduce human dependency.

Collaborative Robot Palletizer

Issues

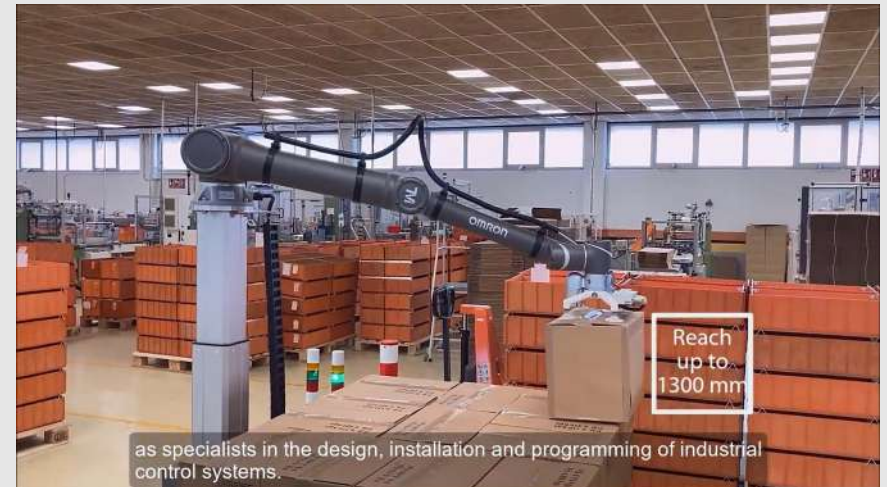
Labor Intensive

- Manual palletizing with heavy load (worker ergonomics)
- Conventional palletizer robot need big floor space to implement

Solutions

Flexible palletizing with proven Cobot

- Provide cobot palletizer which required minimum footprint
- Install stacker system if the reach is more than 1300mm
- Bundling with 2D code or RFID reader for full traceability

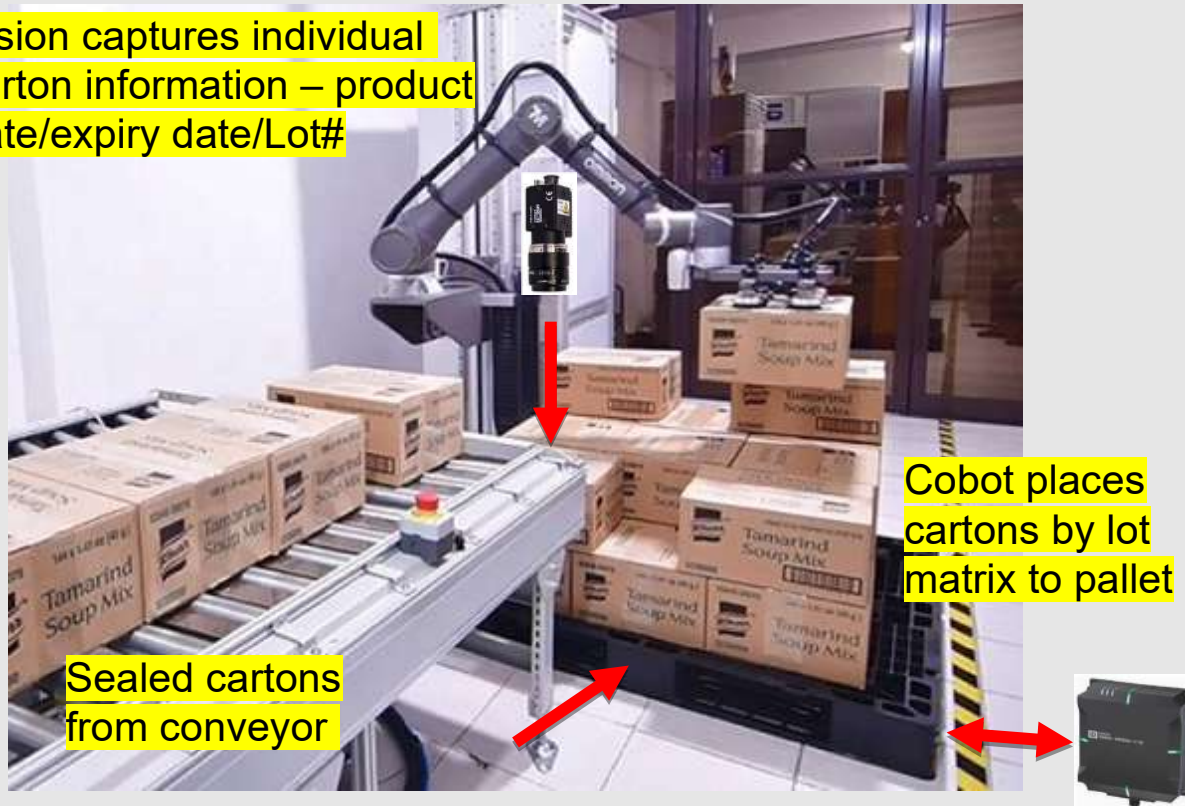


Collaborative Robot Palletizer

Benefits

- Flexible, safe & space saving. (no cage)
- Up to 9 pick per minute
- Integrated vision to detect carton position before pickup
- Minimize manual works
- Collaborative Robots are designed to be easily redeployed to different tasks and applications, making production as flexible as needed

Vision captures individual carton information – product date/expiry date/Lot#



Cobot places cartons by lot matrix to pallet

Sealed cartons from conveyor

RFID write Lot information & qty to pallet tag

Robotics Applications in Manufacturing

Automated Material Transfer using Mobile Robot

Issues

Manual transport & traceability

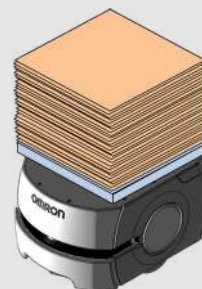
- Labor dependent. (pushing trolley / pallet jack / driving forklift in production floor)
- Low efficiency
- Safety concern (Forklift)
- Not traceable



Solutions

Autonomous transportation with traceability

- Adopt Mobile Robot for Carton replenishment or finish goods pallet transfer to storage area
- Full material movement traceability with ID code reader
- Payload up to 1,500 kg with Fleet Manager system can manage up to 100 robots



Thank You

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