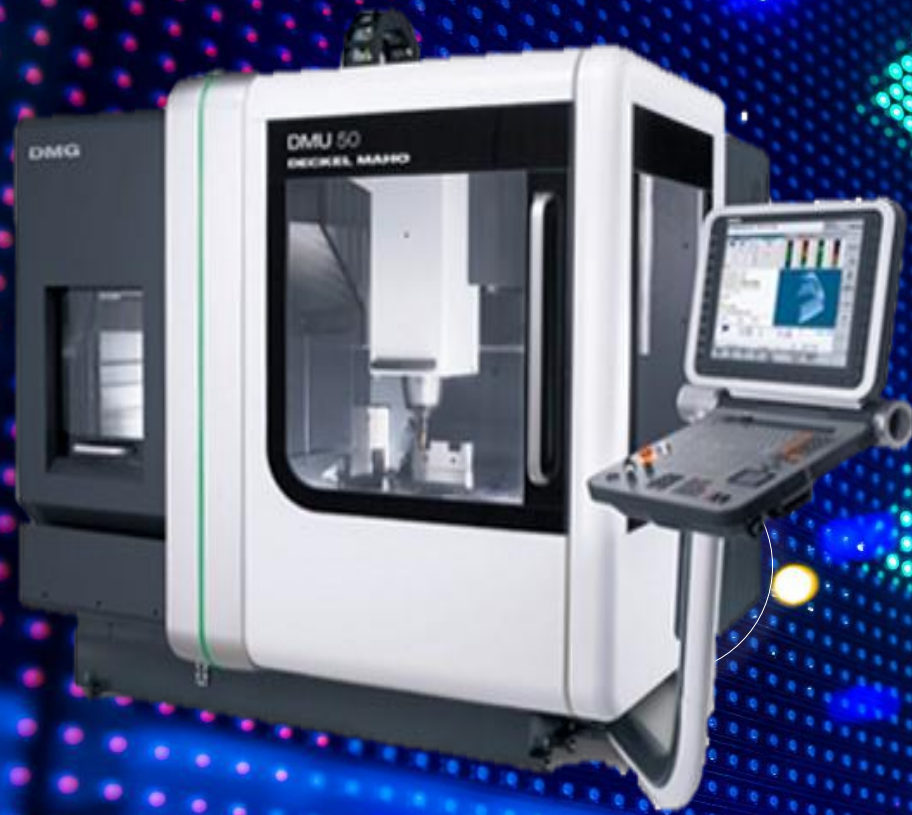


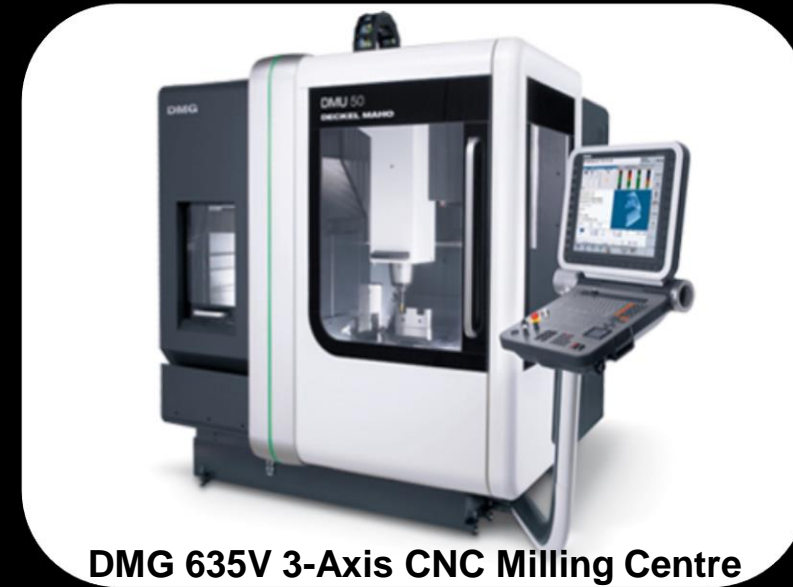
# THE DIGITAL AND ADVANCED MANUFACTURING LIVING LABS



**SMART EQUIPMENT  
LIVING LAB**

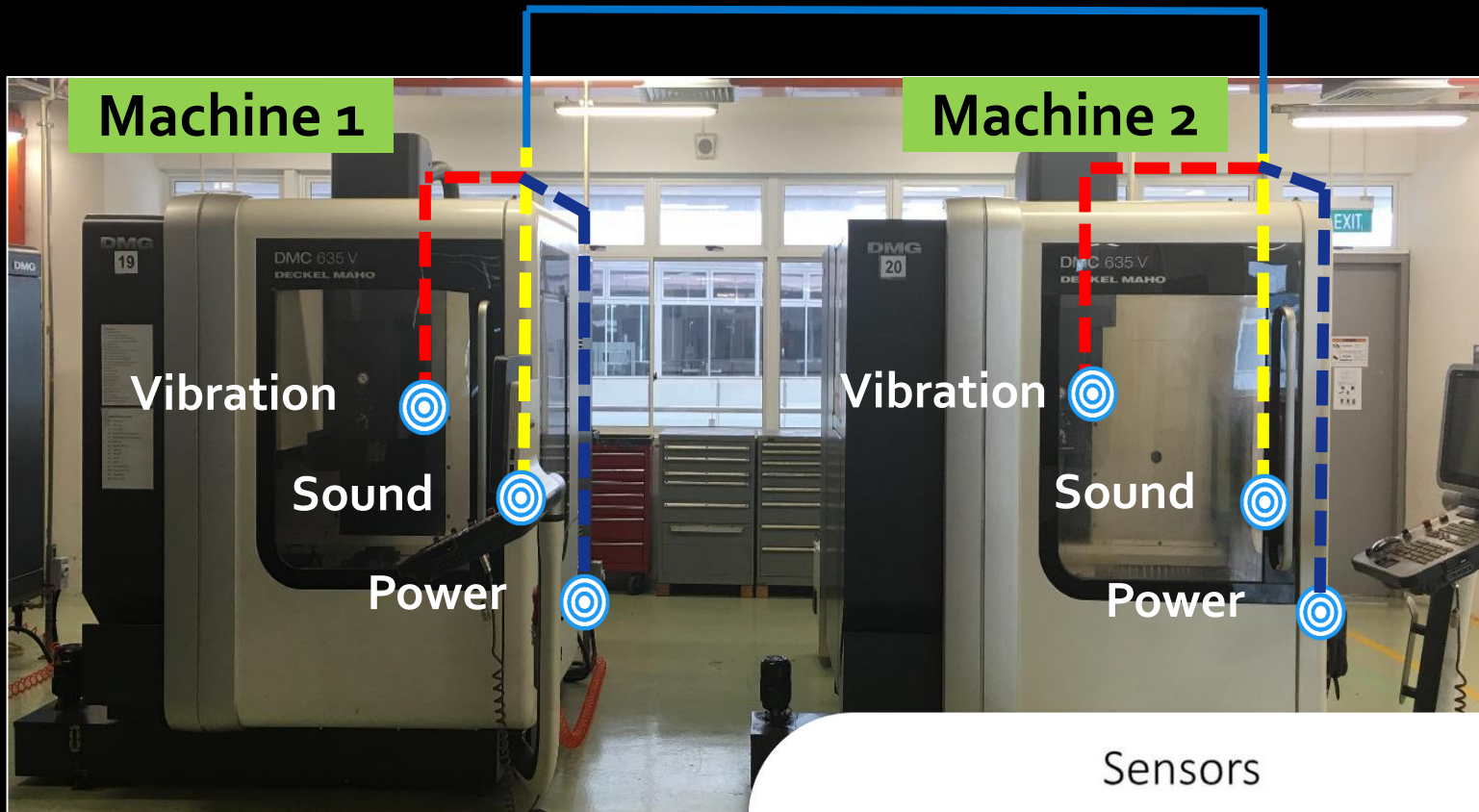
# About Smart Equipment Living Lab

- The Smart Equipment Living Lab provides an authentic smart factory environment for industry to learn about IoT Sensors and apply them in CNC machines.
- Industry players can use the lab as a proof of concept lab to try the concept and experience the solution.
- Industry partners will be able to train their technicians on IoT sensors, sizing, system requirements and apply. The knowledge thus gained can be applied in the company for productivity improvement in the machining.



DMG 635V 3-Axis CNC Milling Centre

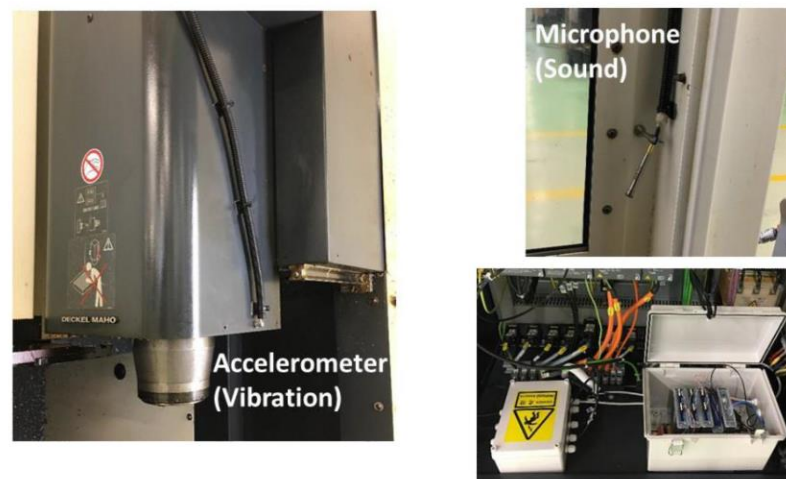




# Smart Equipment

- Trainees are exposed to authentic work scenarios during CNC machining.
- Learning is enhanced with the use of sensors and data acquisition software.
- Machining parameters are optimised analysing the data captured during machining to enhance productivity.

## Sensors



DAQ + Power consumption monitor



Vibration Sensors



Noise Sensors



Power Sensors

# Application Methodology



## Process Flow

1. Description of the working characteristics of the CNC machine
2. Choosing the tool and deciding on the cutting strategy
3. Creating the CNC CAM program
4. Machining of components

## Collect Data

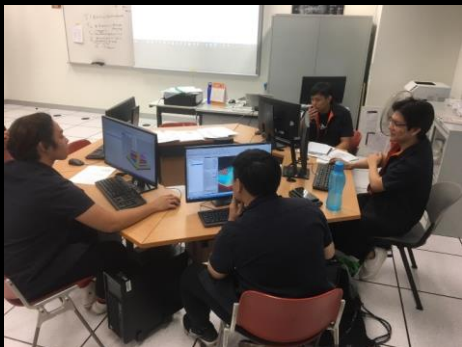
1. Vibration
2. Noise
3. Power to machine spindle

## Analysis

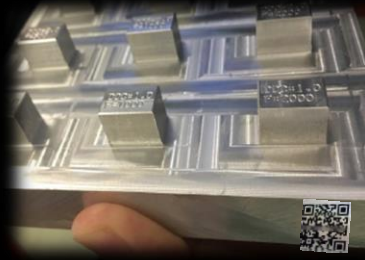
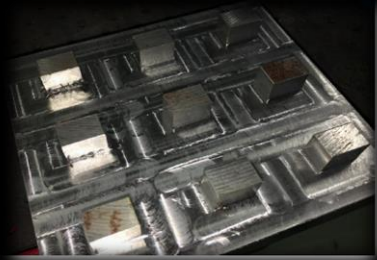
1. Cause and effect of machining from data

## Dual Heuristic Learning

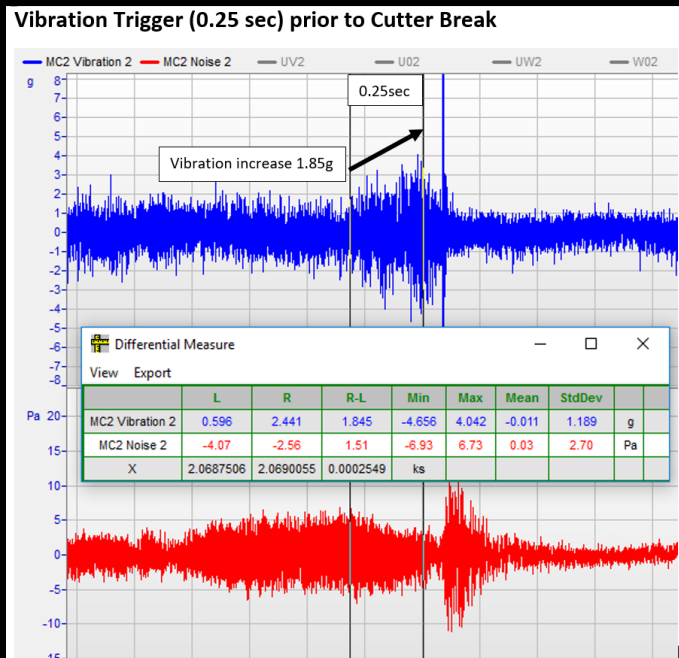
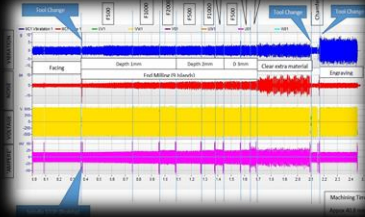
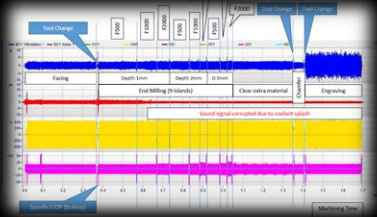
1. Present the overall solution
2. Formulate proposed solution
3. Achieving mastery



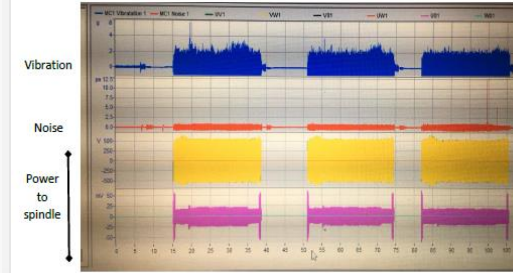
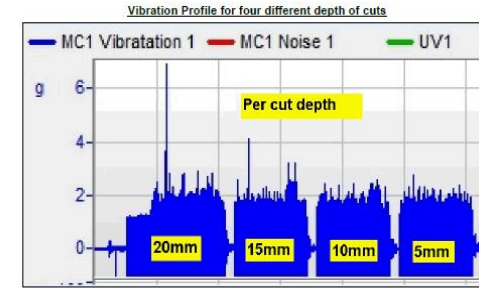
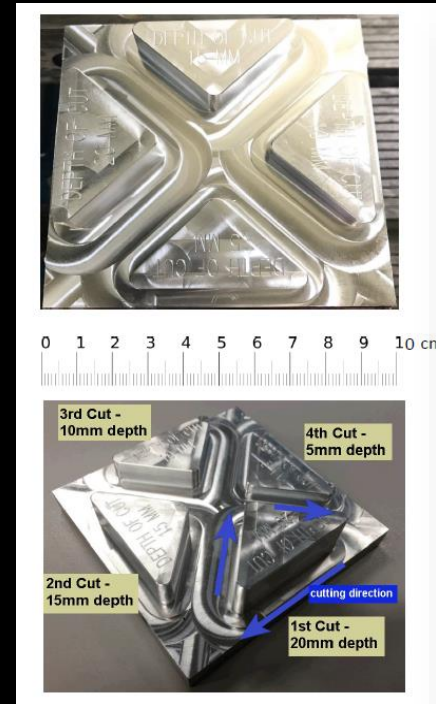
# Smart Equipment Living Lab Benefits

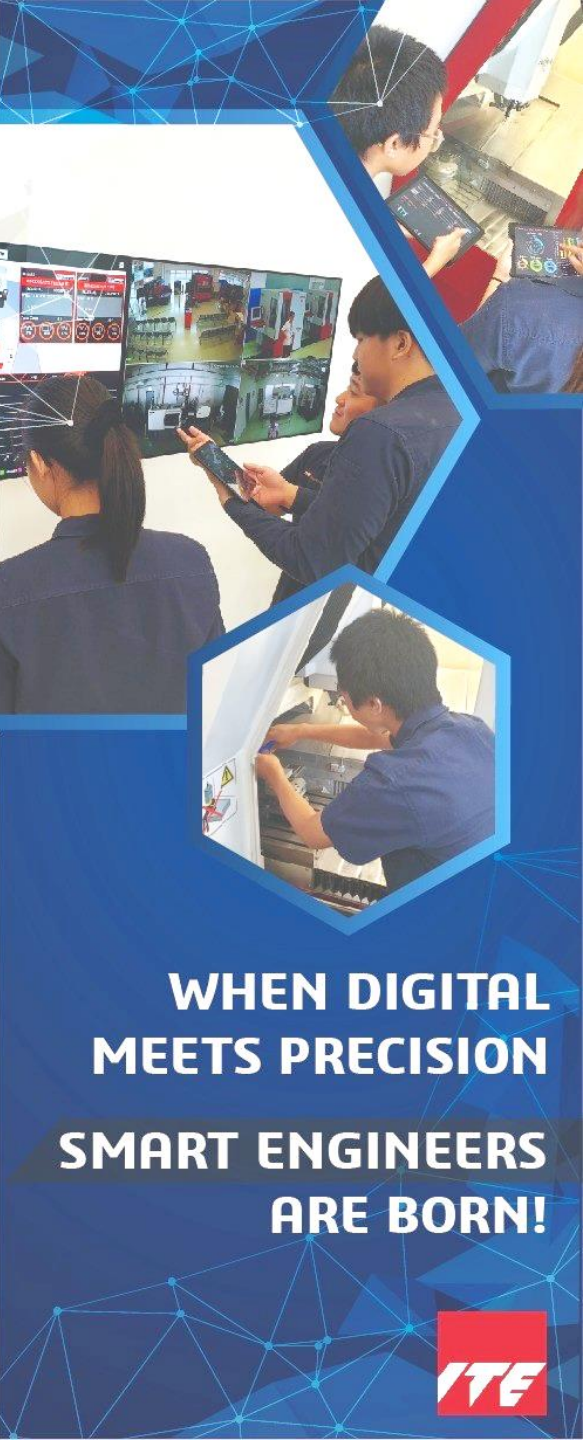


Improved  
Machining  
Process



- Industry can use this lab for technician on boarding and upskilling programs.
- Trainees are able to understand the machining parameters of various cutting profiles and depths of cut and capture online data with the use of the IOT sensors.
- Industry can use this lab Proof of concept.





# Digital Manufacturing Living Lab

## ITE College Central

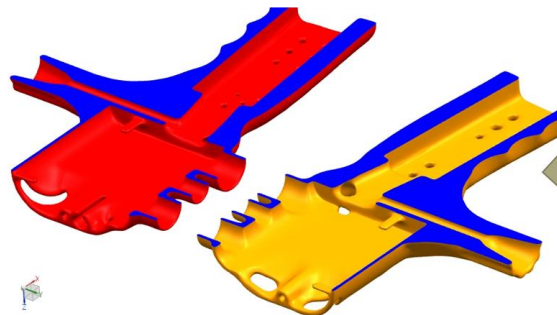
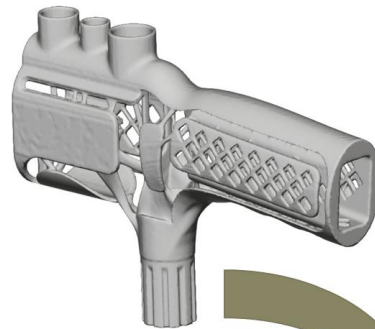


# The Digital Manufacturing Living Lab:

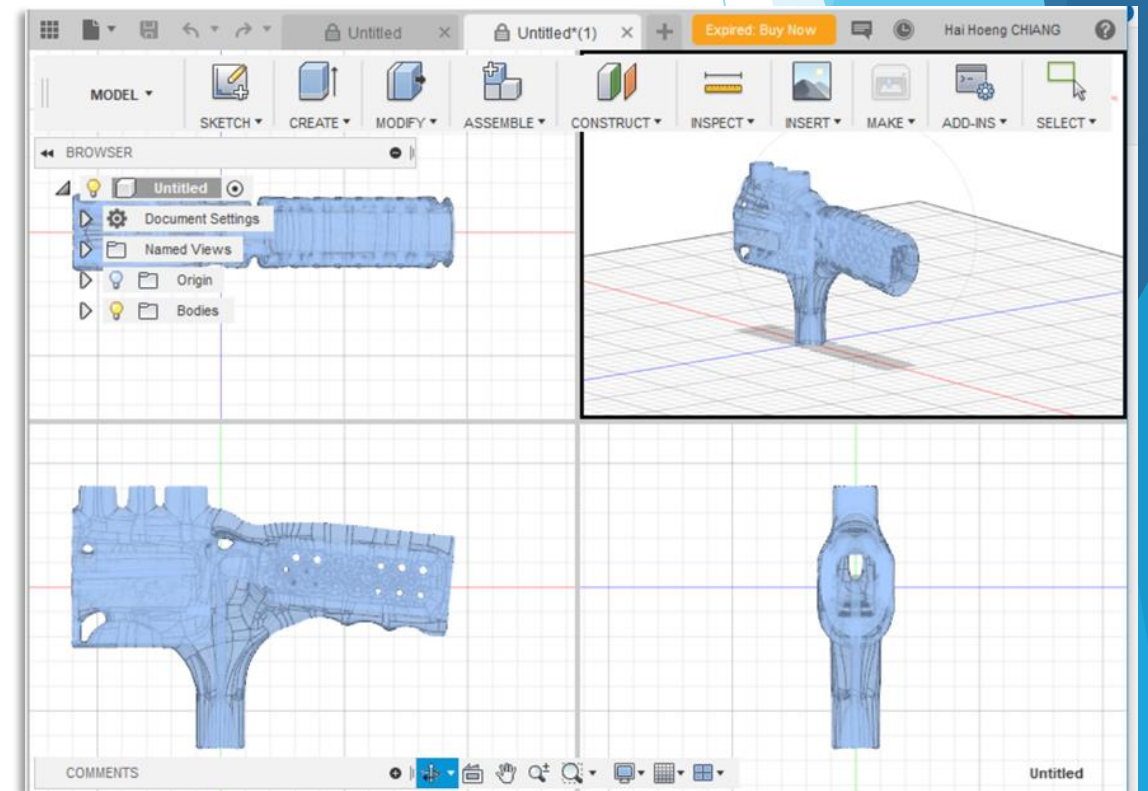


Data Acquisition and Visualisation

The Living Lab provides hands-on skills training in CNC 3 to 5 Axis High Speed machining with product designs optimised by Generative AI technology, CNC Laser cutting and Precision Sheetmetal applications. The experiential experiences in the lab are augmented by digital technologies for Machine Data Acquisition, IIoT (Industry Internet of Things) and Collaborative Engineering between labs via video conferencing.



CAD/CAM Design with Generative AI Designs for Manufacture





# The Digital Manufacturing Living Lab (cont):

The **Autonomous Logistics Distribution system (ALDS)** in the Lab serves to connect the facilities via Autonomous Intelligent Vehicle (AIV) for unmanned material movement across the facility & **Drone Inventory Inspection** programmed using Open source with AI algorithms to scan stock items. The ALDS could supply Lot size 1 material & tools to various work sites in the lab.



Autonomous Logistics Distribution



Drone Inventory Inspection



# Digital Manufacturing Facilities:

The following facilities in the lab provides a platform for the development of critical digital skills set:


- **Machine Monitoring System (MMS)** for the acquisition of shop floor manufacturing data across three clusters of manufacturing processes connected digitally ie complex machining, plastic moulding and laser cutting for Overall Equipment Effectiveness (OEE) monitoring. To develop analytical skills and knowledge in the interpretation and analysis of data generated by the MMS for OEE report submission.
- **Quality Measuring System (QMS)** for in-process and finished parts to be inspected via wireless measuring devices and the measured data uploaded wirelessly. To develop skills in the correct use of the wireless measuring devices and knowledge to monitor and compare finished parts with design specifications for quality assurance and process control.
- **Tool & Store Management System (TMS)** for the pre-set of tools required for parts production, management of tools, tool components and accessories with an overview on storage location, circulation and stocks. To develop key skills in performing tool pre-setting, generating identification tags for transfer of data to and from tool pre-setter, machining centres, and tool storage. Monitors supplies and tool location of individual parts with the consumption report for the planning and coordination of the movements within the shop floor.



# The Digital Manufacturing Living Lab with Integrated Material Handling System

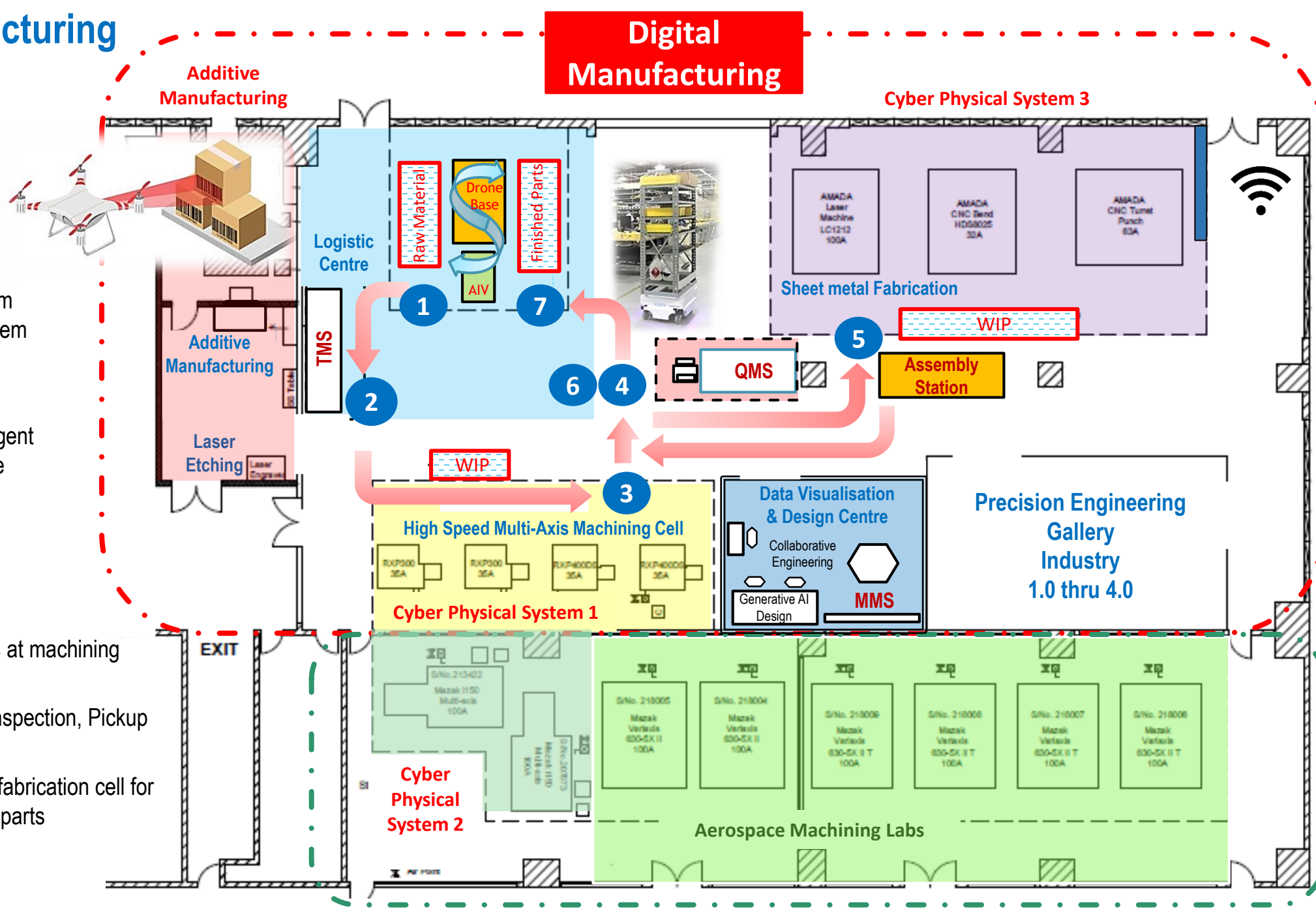
## Key Systems

- MMS**- Machine Monitoring System
- QMS**- Quality Measurement System
- TMS**- Tool Management System
-  - Parts Storage

 Autonomous Intelligent Vehicle (AIV) Route

## AIV Route & Activities

- 1** Pickup raw materials
- 2** Pickup tools
- 3** Drop off tools & raw materials at machining cells, Pickup machined parts
- 4** Drop off machined parts for inspection, Pickup inspected parts
- 5** Drop off parts at sheet metal fabrication cell for assembly, Pickup assembled parts
- 6** Final inspection.
- 7** Finished parts storage



**Digital Manufacturing**

**Cyber Physical System 3**

Logistic Centre

TMS

Sheet metal Fabrication

Assembly Station

High Speed Multi-Axis Machining Cell

Cyber Physical System 1

Data Visualisation & Design Centre  
Collaborative Engineering  
Generative AI Design  
MMS

Precision Engineering Gallery Industry 1.0 thru 4.0

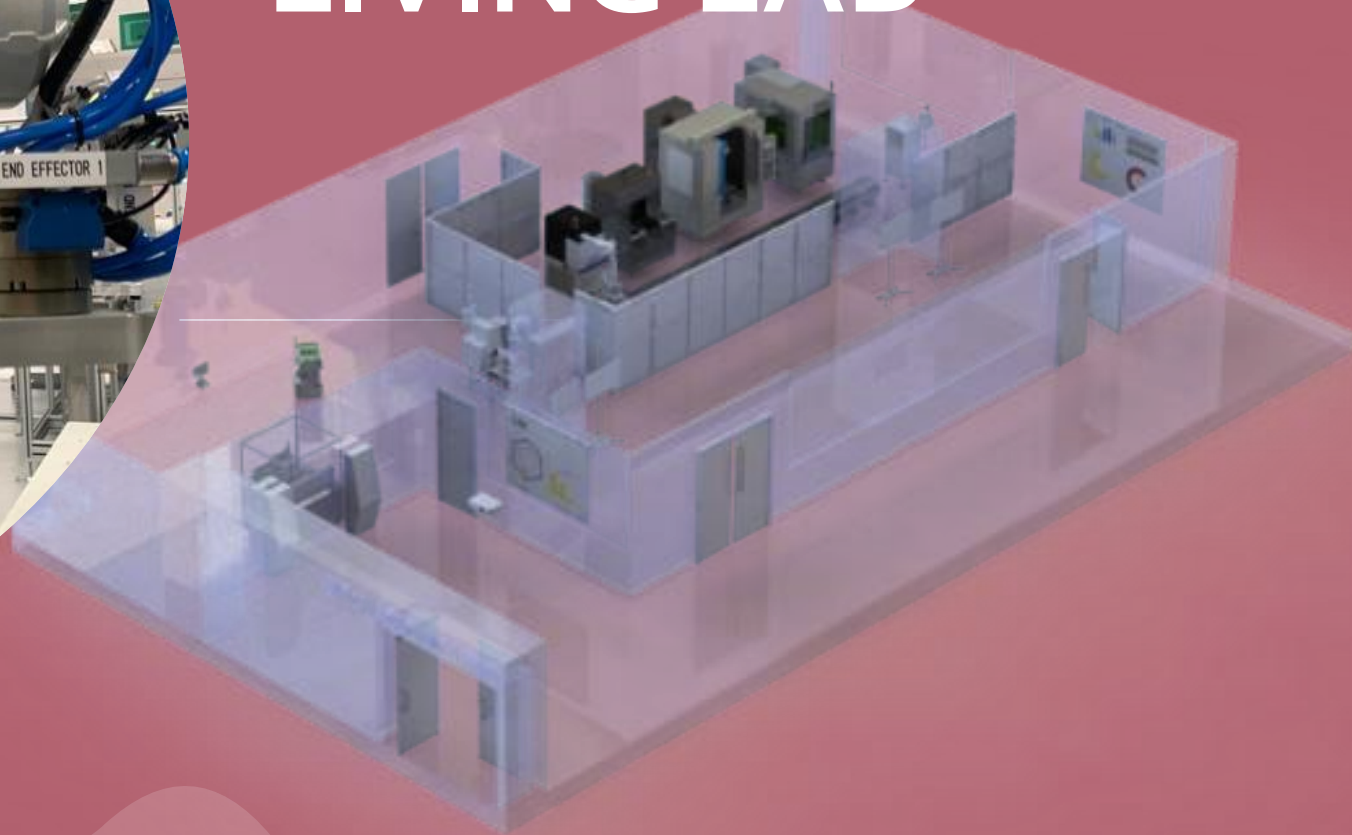
Cyber Physical System 2

Aerospace Machining Labs

EXIT

Air Port

# SMART MANUFACTURING LIVING LAB



# THE LIVING LAB

Implementation of real authentic i4.0 techniques and solutions for  
Smart Manufacturing.



# AUTHENTIC SHOP FLOOR

The Smart Manufacturing Living Lab implements today's IIOT 4.0 solutions for advanced Smart Manufacturing.

- Industry revolution
  - Drivers: Mechanization, Mass production & Lot 1, Automation, Industry Internet of Things
- Elements of i4.0
  - IIOT, Smart sensors, Cloud computing, data analytics, cyber-physical systems, Articulated Robot, autonomous vehicle, collaborative robot, Simulations, cyber security
- iFMS@ITE
  - Informative, Innovative and IIoT systems
  - Integration of different machines across various communication platforms

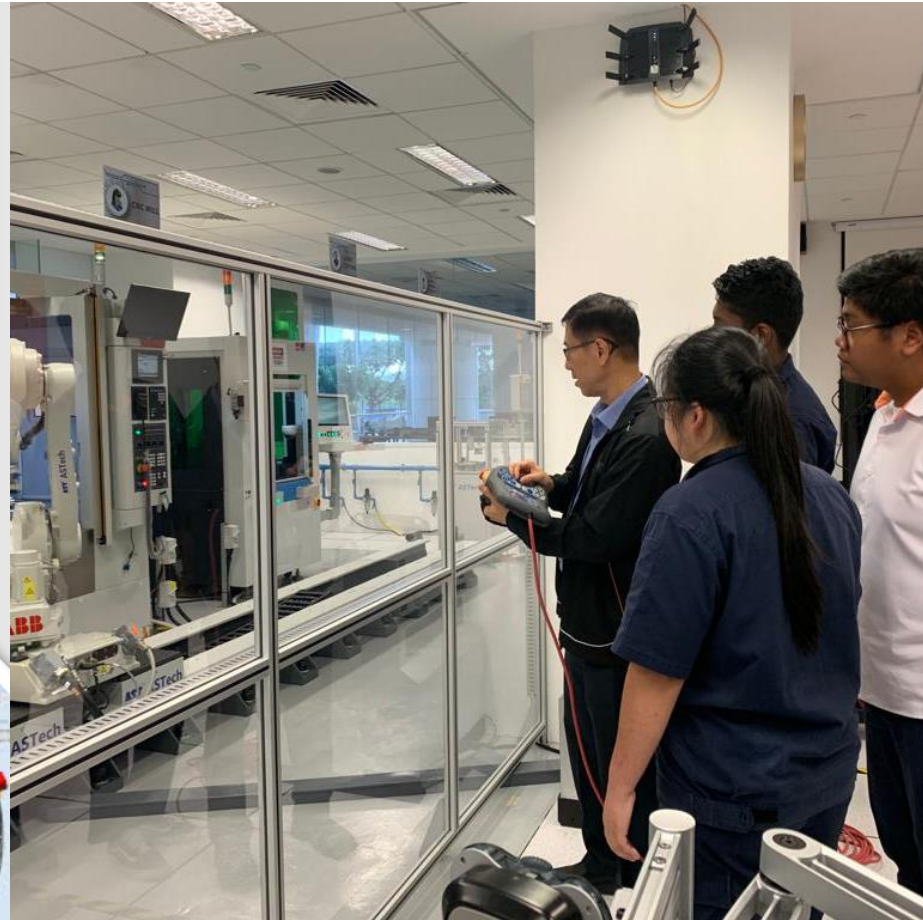
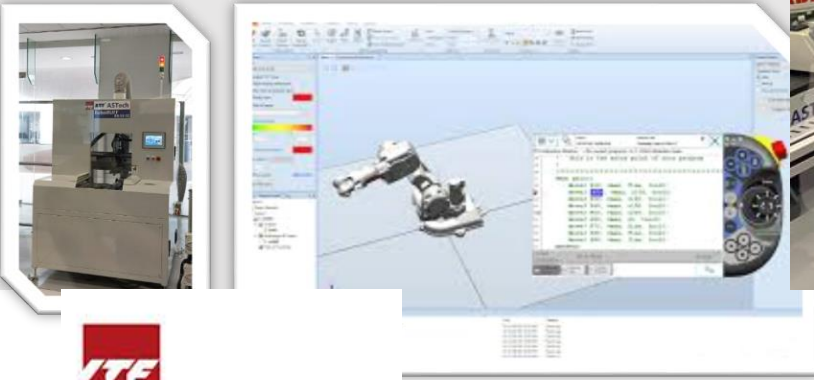


# PRODUCTION AND PROCESS



## PRODUCTION

The Smart Manufacturing Living Lab implement authentic eco-system in areas of Robotics Programming, Pneumatics, Smart Sensors, Predictive Maintenance of Automation Systems and Electrical Installations.



## PROCESS

The Lab, with Lean Triangular Kanban, has the Cyber physical twin essences, where the shop floor can be accessed remotely, and run/execute mass or Lot 1 production. The shop floor provides information of its standing, material status and warehouse storage for incoming and outgoing availability for JIT (Just-In-Time).

# OPERATION AND INFORMATION TECHNOLOGY DEPARTMENT



## OPERATION TECHNOLOGY

Manufacturing operations management (MOM) is a methodology for viewing an end-to-end manufacturing process with a view to optimizing efficiency.

The system is used for production management, performance analysis and quality and compliance and enables the different job roles mentioned earlier like supervisor, technician and maintenance engineer and data analytic personnel to perform industrial and process control of the line with the data collected and analysed.



## INFORMATION TECHNOLOGY

Through a modular implementation, the iSCADA collaboration and workflow services support people-to-people, people-to-systems, and systems-to-systems interactions, enforcing procedures and compliance while flexibly adapting to real-time situations with alternate workflows and processes using its manufacturing execution system(MES) and Scada platform.

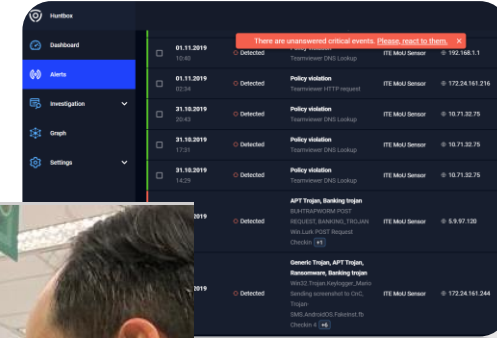
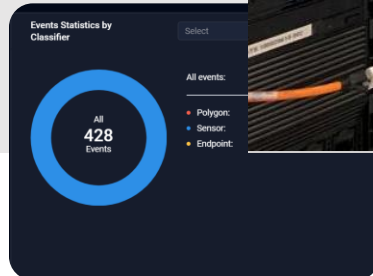


# OPERATION TECHNOLOGY SECURITY DEPARTMENT



## CYBERSECURITY

Cybersecurity practices the protection of systems, networks, and programs from digital attacks. These cyberattacks are usually aimed at accessing, changing, or destroying sensitive information; extorting money from users; or interrupting normal business processes. Implementing effective cybersecurity measures to deter attackers from the shop floor assets and systems.

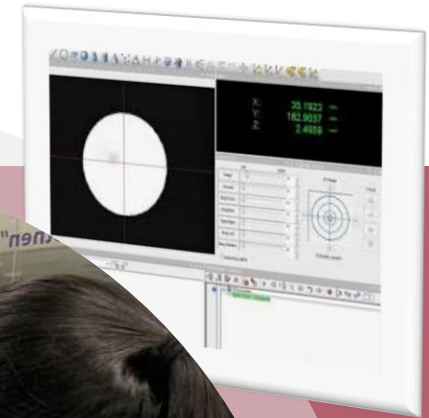


## OPERATION TECHNOLOGY SECURITY

Operation Technology Security enables the mechanism for its Cyber Physical shop floor control with cyber security implemented. This ensures the safety and security of the asset and production line. Real time threats detection is done in the OTS to eliminate malicious activities targeted on the assets and on shop floor production processes.

# QUALITY CONTROL DEPARTMENT

- The Quality Control department uses various type of metrology tools to identify, track and trace defects after production.
- In this department, technical personnel works along side with collaborative robot.
- Collaborative robot performs monotonous routine and functions in the shop floor while technical personnel will implement corrective actions, take on higher level job functions and roles.



# KAIZEN DEPARTMENT

- To do Kaizen, OEE provides us with an overall picture of the improvement potential of the machine. Armed with all the data that the machines are churning out, it is now possible to pinpoint bottlenecks and where improvement can effect maximum gains.
- The key difference here is really the availability of the data. Gone are the days when improvements can only be made at the end of a production run, or between shift changes.
- Data are generated, collected, compiled and presented in real time. Factory managers has the most up to date information to make the most informed decisions.

