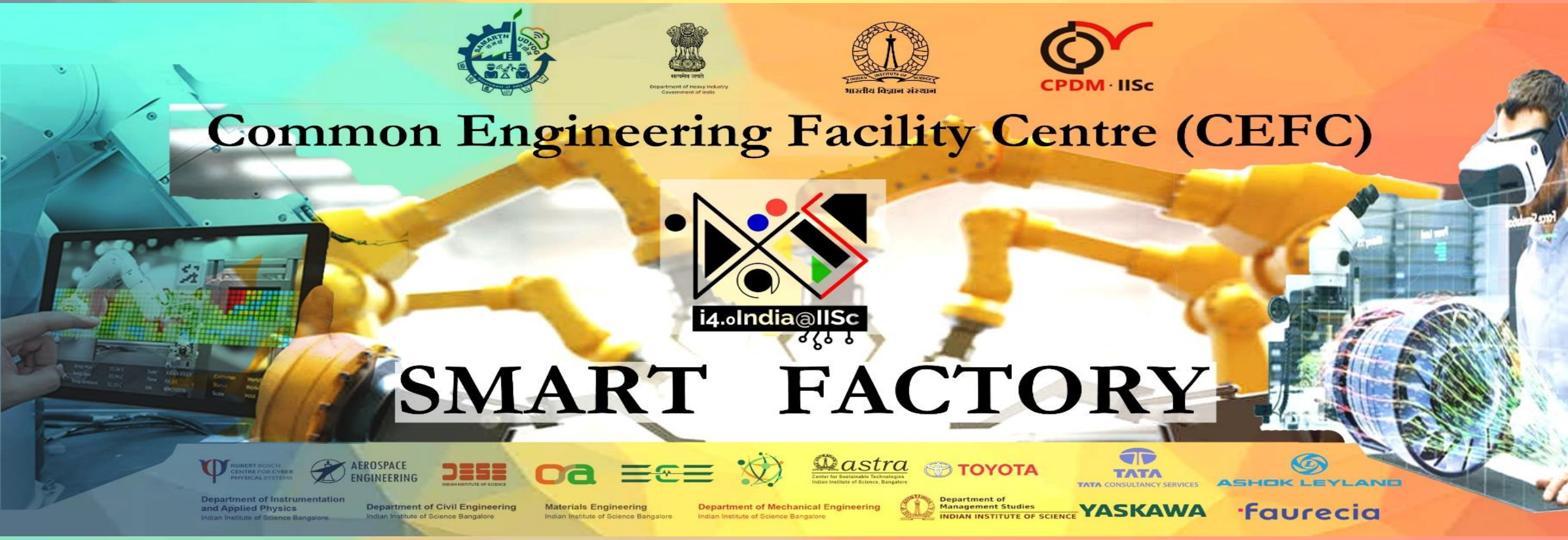
Smart Factory Projects

E-BOOK


Common Engineering Facility Centre (CEFC)
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SMART FACTORY
CPDM · IISc
Department of Heavy Industry
Government of India
AEROSPACE ENGINEERING
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Indian Institute of Science Bangalore
Department of Civil Engineering
Indian Institute of Science Bangalore
Materials Engineering
Indian Institute of Science Bangalore
Department of Mechanical Engineering
Indian Institute of Science Bangalore
Department of Management Studies
INDIAN INSTITUTE OF SCIENCE
YASKAWA
faurecia

Over 1Cr for **training industry partners**

Over 4Cr worth joint **projects with Industry**

426 **trained** in events and workshops + **7200** visited on Open Day

6 **Smart Technologies** (PoC) completed

5 **Smart Tools** & **14** **solutions** initiated

I4AM **first International Conference** (June 2019)

MTech & PhD **in Smart and Advanced Manufacruring** (July 2019)

CEFC Smart Factory – I4.0 India @ IISc

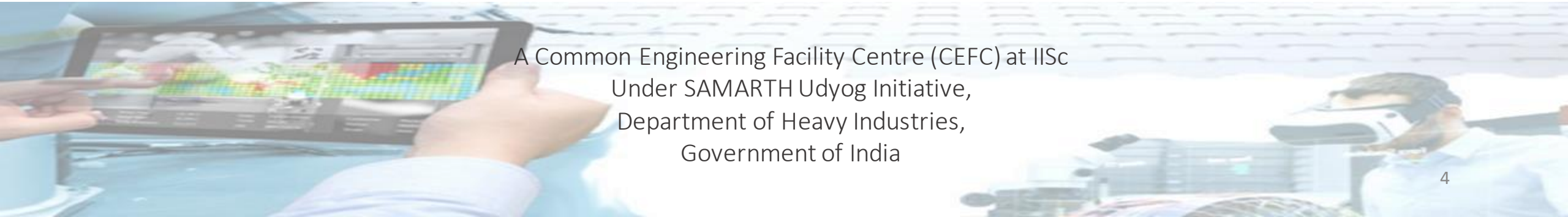
I4.0 India @ IISc – The vision

Goal

To support India's industry, especially MSMEs, to improve its global competitiveness by developing and adopting affordable, smart solutions for Industry 4.0.

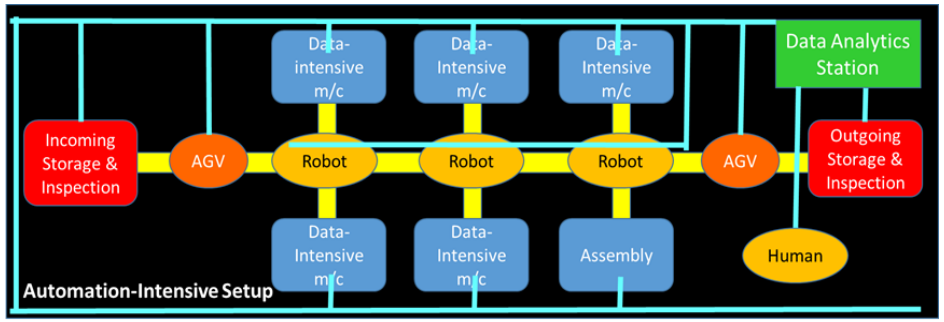
Key Objectives

- To develop an indigenous smart factory with **two contrasting platforms** –
  - an automation-intensive platform and
  - a labour-intensive platform,
- To develop and adapt technologies, tools and solutions, and integrate these into the platforms
- To test the efficacy of the intended factory

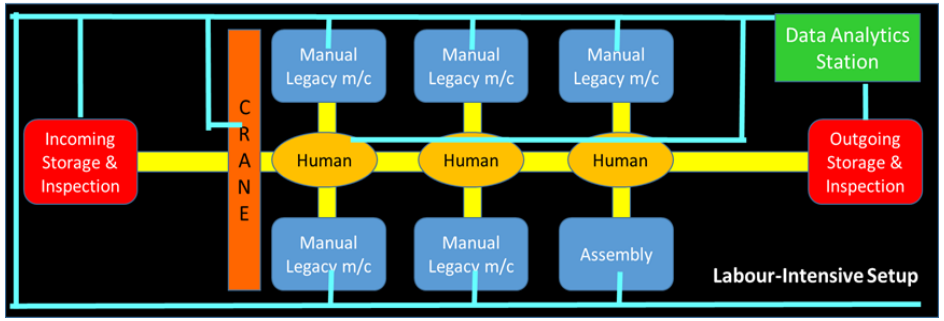


Two contrasting platforms

These platforms will collect data from all interconnected tools, people, processes, resources and environment, and analyse these using advanced data analytics to help manufacturers enhance productivity, quality, safety and resource utilisation

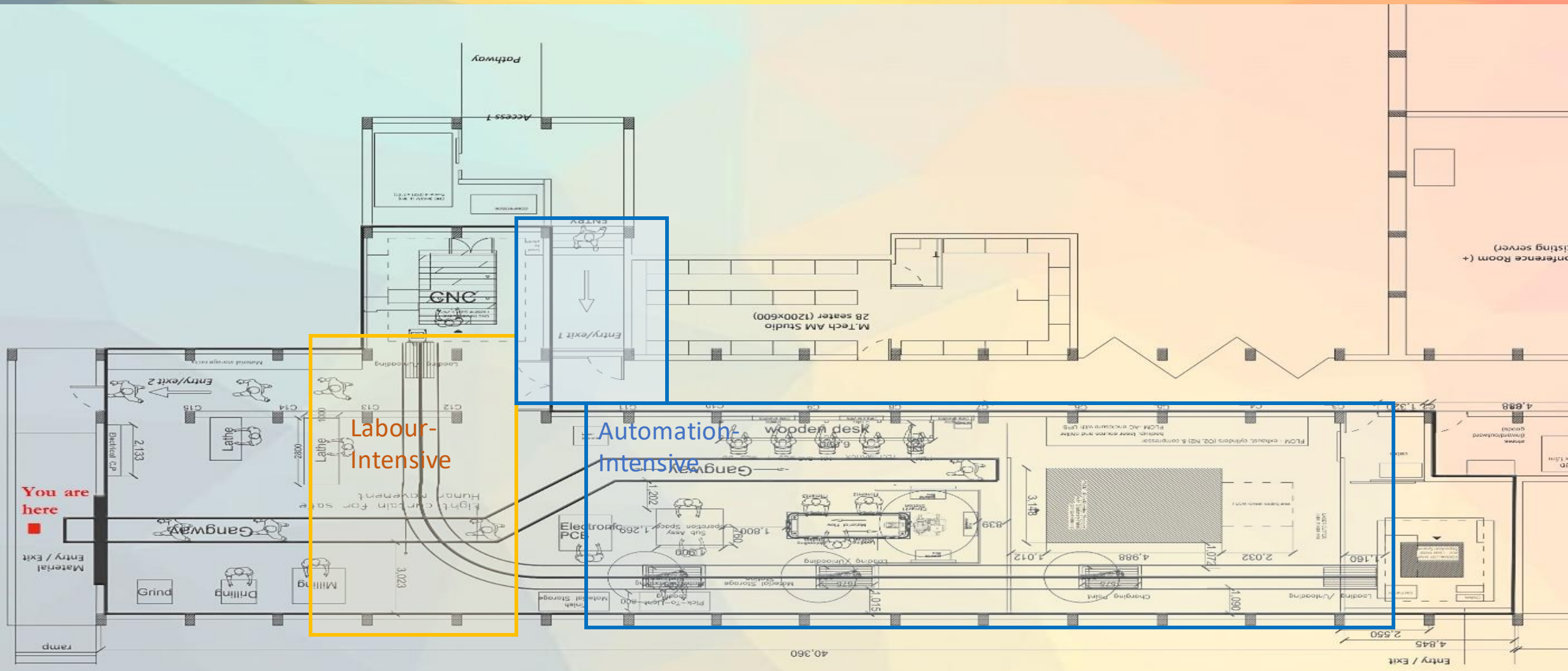


An **Automation-Intensive platform** for high-value manufacturing to showcase what networked automation can offer.



A **Labour-Intensive platform** for high impact manufacturing that uses smart solutions to empower labour for the majority of MSMEs

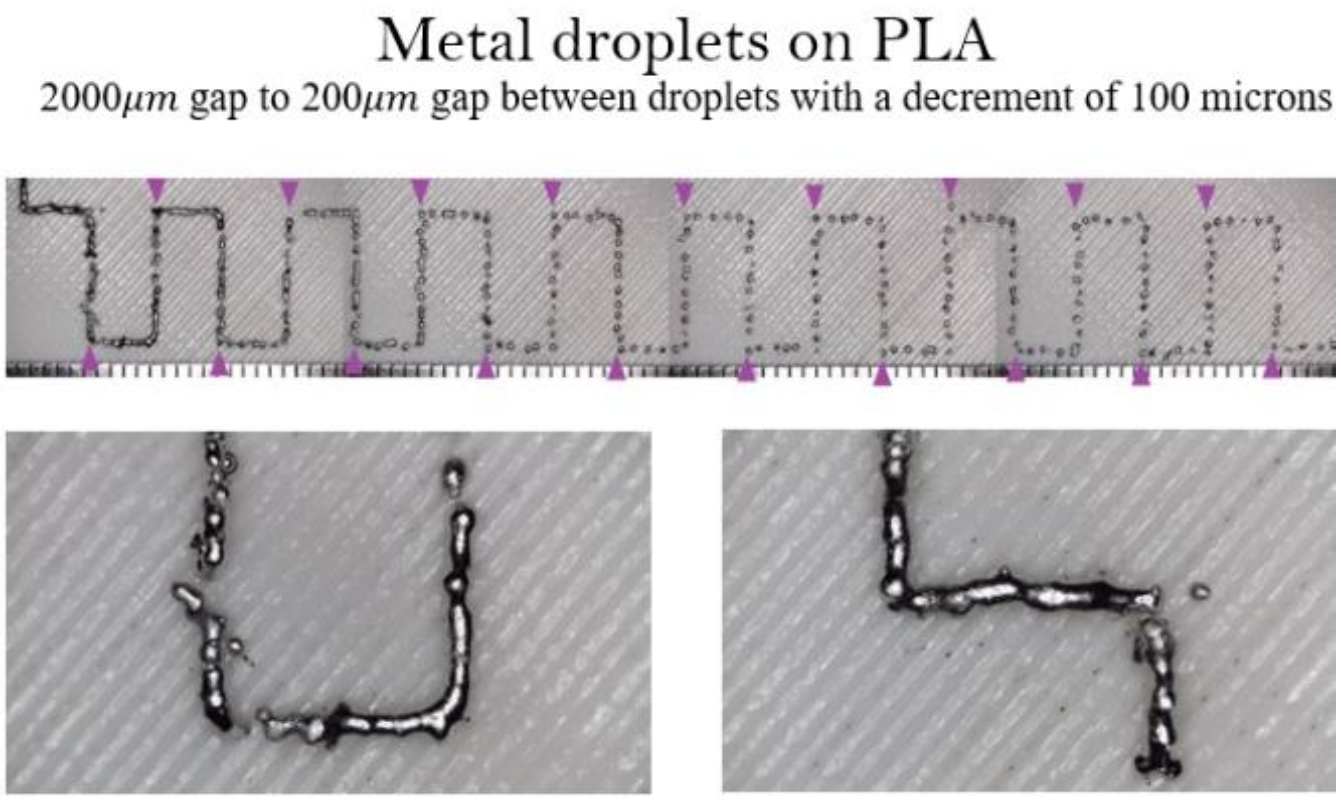
CEFC FACILITY

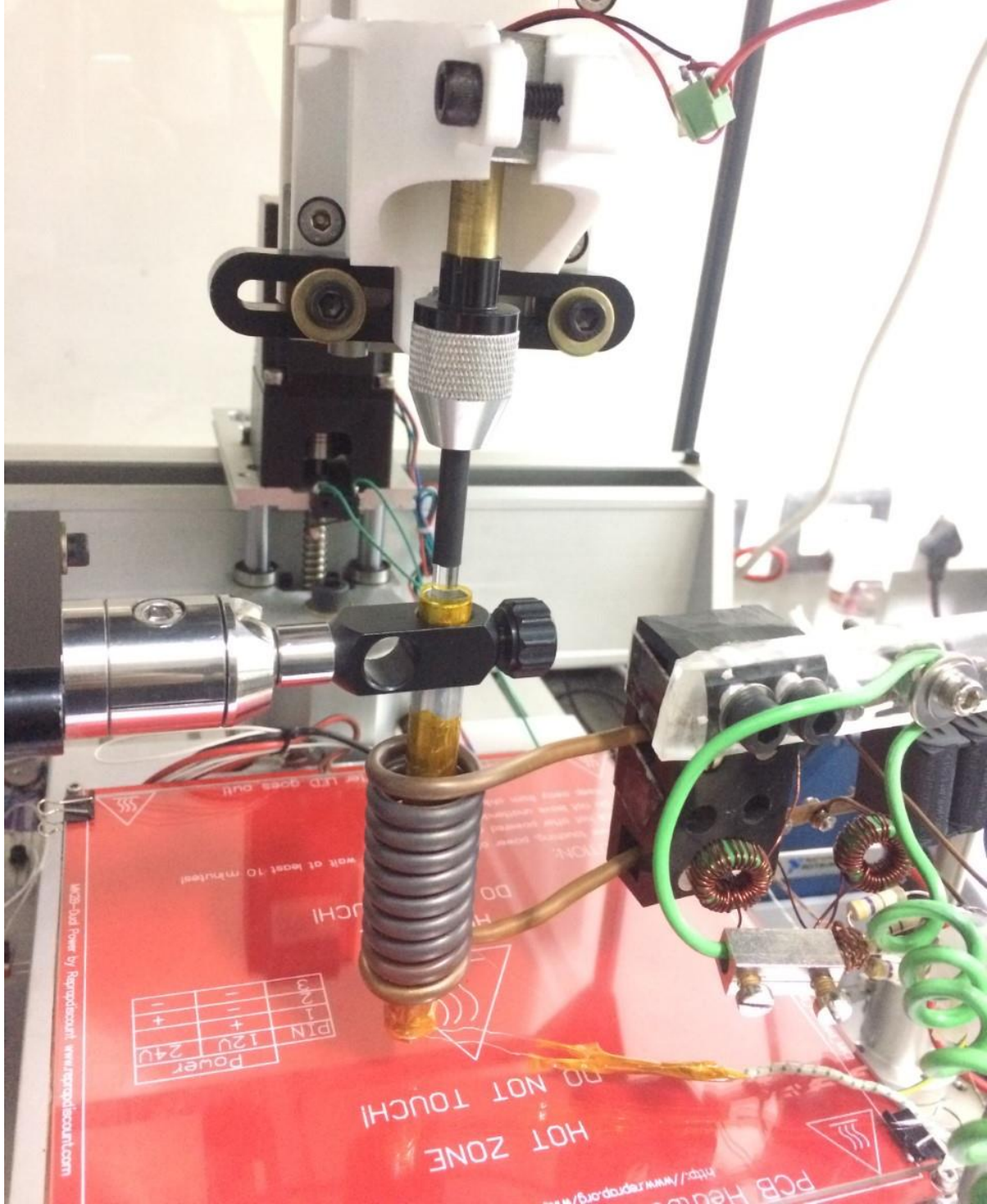


3D Metal printing using Droplet on Demand

Scope and objectives:

To design and develop a desktop 3D printer, which should be capable of printing customized electrically working prototype by connecting electronic components in 3D along with its insulating body.





Automated Part Inspection System

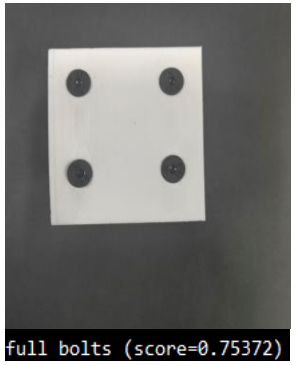
Aim: Design and develop an automated inspection system, which is capable of capturing images of parts moving over a conveyer belt and detect presence or absence of pre-defined features.

Objectives:

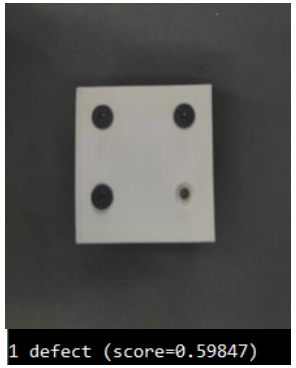
- Design and develop of a software for automated image capturing
- Design and develop a software for automated visual inspection of manufactured parts
- Design and develop a mechanical system with conveyer belt, supporting electrical-mechanical setup for automated part transportation from one side to the other
- Integrate the software with the hardware setup

Significance:

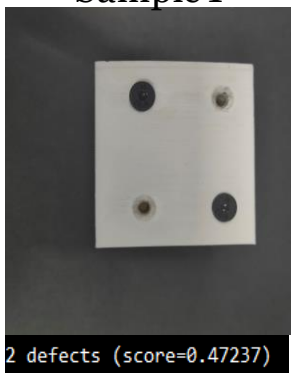
There is gap in the market for an inspection system which can inspect different category of parts which may have considerable size difference
The system should identify presence and absence of features or components on a part



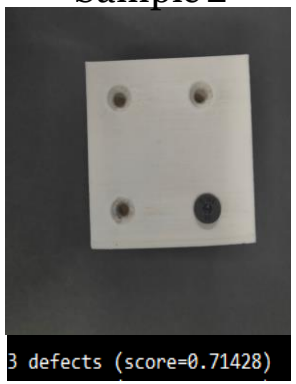
Sample 1



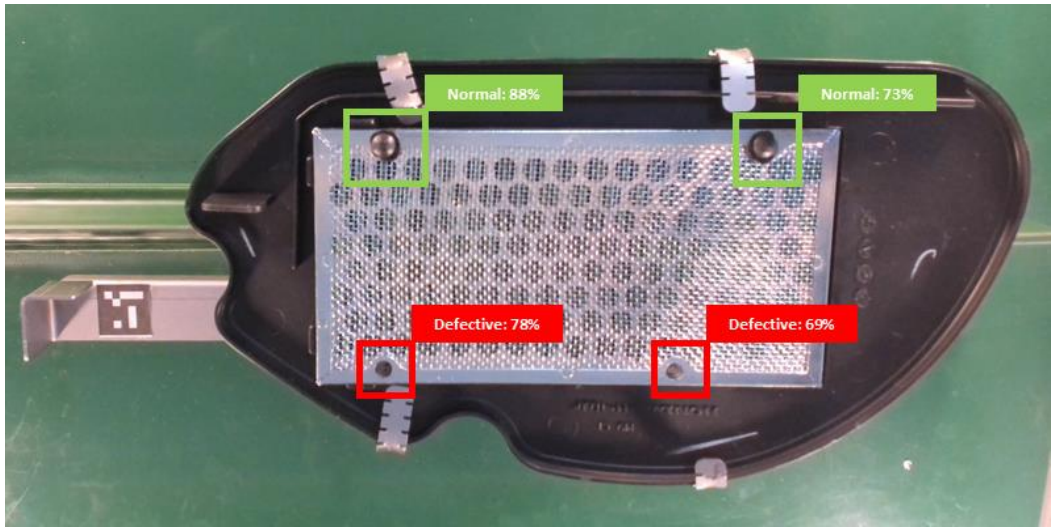
Sample 2



Sample 3

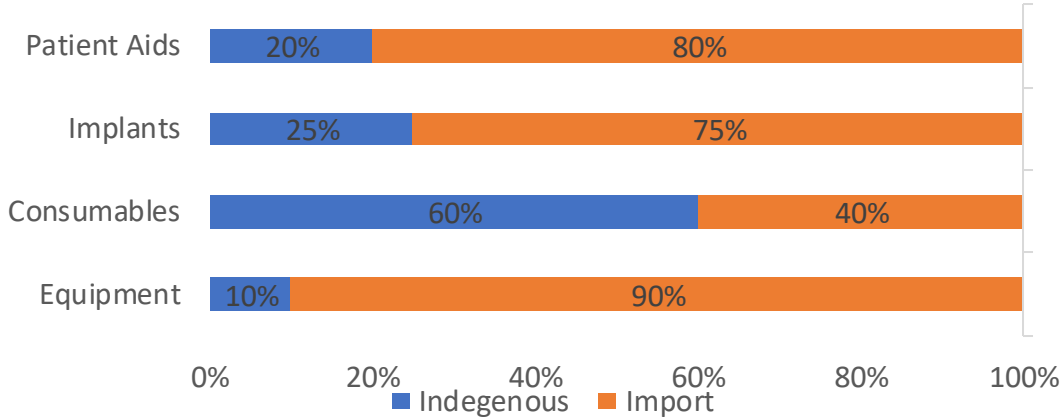


Sample 4



Certification by I4.0

- In India, Medical Device Sector has market of **5.2 billion USD**. But total import of medical devices is more than **75%** of total medical device's sales.
- The reasons- **Certification regulations**, market competitiveness, unaffordable manufacturing technologies.
- **65%** of indigenous manufacturers falls under MSME category.

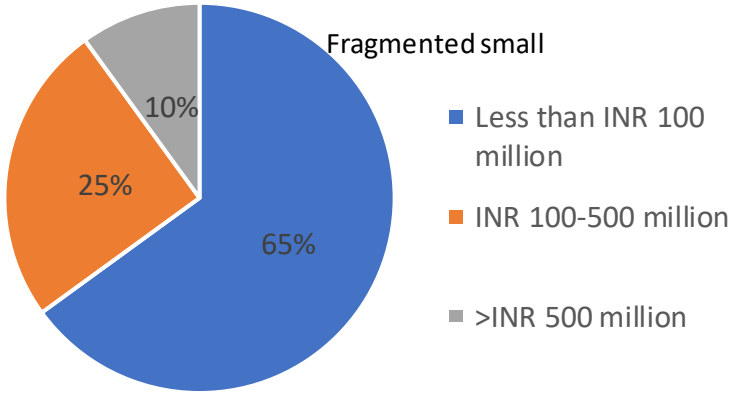


To get certification the manufacturer must follow Quality management system (QMS) as one of the requirement to sell his product.

The accepted QMS standard globally is **ISO 13485:2016.** In India, the **Medical Device Rule 2017 schedule V**

The literature and field survey shows following reasons for MSMEs, find **difficult to implement** QMS:

- Time for implementation
- Lack of Resources (Infrastructure, Manpower)
- Lack of Training and guidance

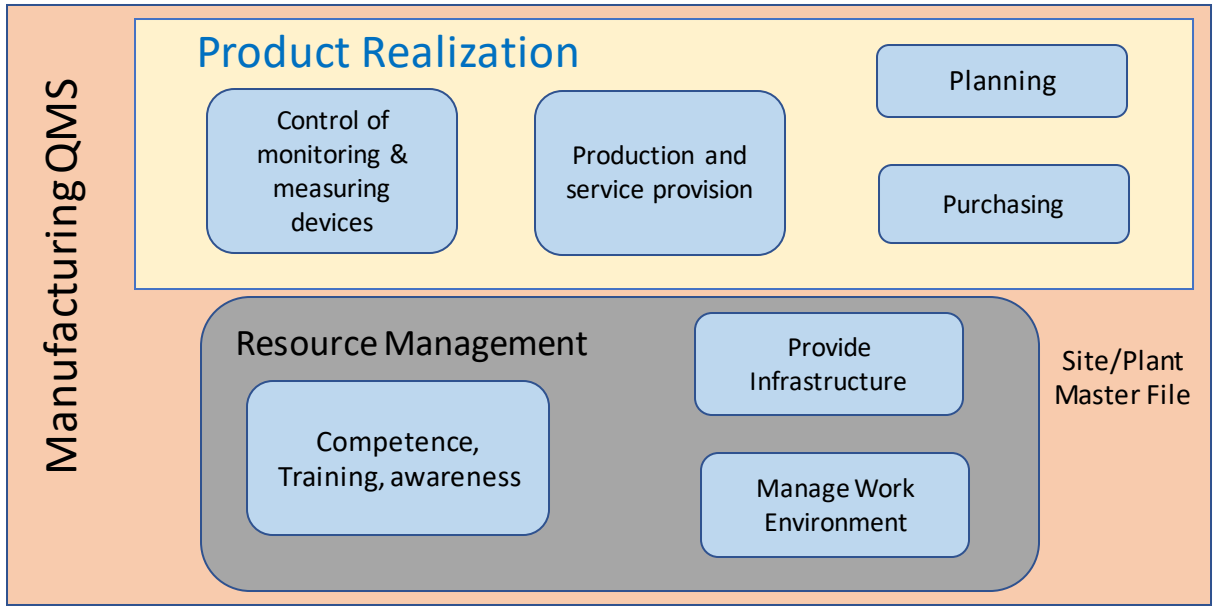


Certification by I4.0

The Research concentrates on the manufacturing part of QMS.

The QMS elements in Manufacturing are:

- **Resource management**
- **Training**
- **Infrastructure**
- **Environment Monitoring**
- **Inspection/ Quality of process and product**
- **Testing / Performance Analysis/ Calibration**
- **Identification and Traceability**
- **Cleaning and Sterilization**



A **Framework** to support manufacturing QMS using I4.0 technologies and smart solutions.

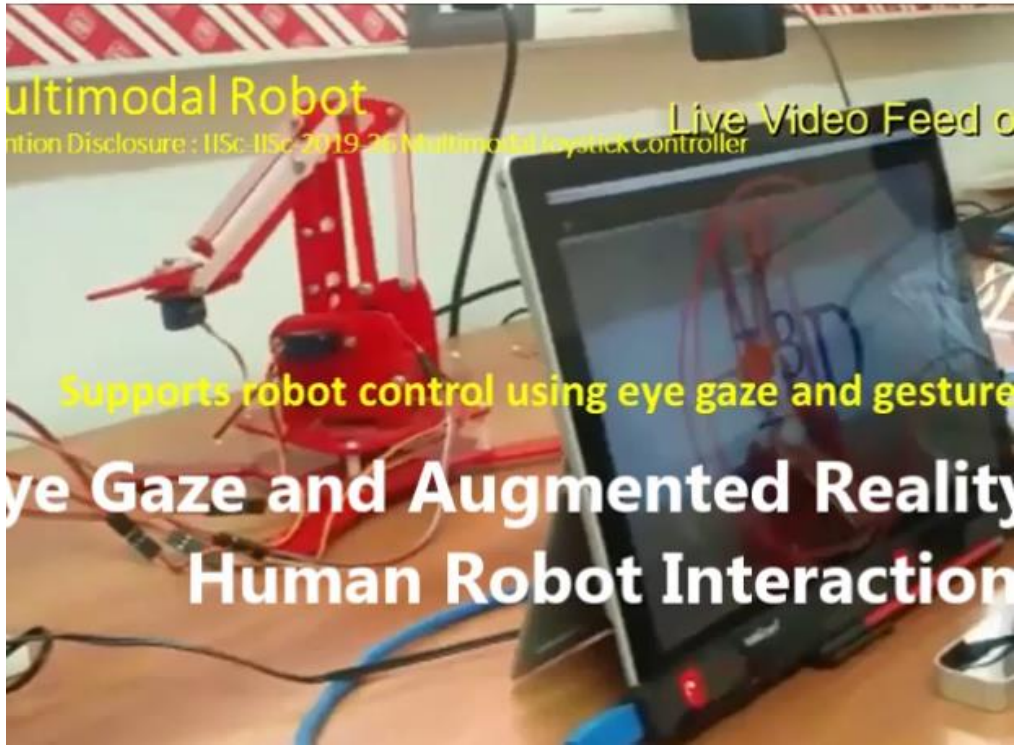
The framework will support the **data collection** from critical manufacturing processes, **analyze** the collected data and **utilize** to useful information.

The information will then be used for the **documentation** of QMS, ERP, MES, PLM, SCM and vice versa.

The validated results are to be compared with the actual scenario.
This will help in reducing the burdens of QMS implementation and will make the device worthy for certification.

Inclusive CoBot

- Eye gaze controlled video see through display
- Integrated to Robotic manipulator
- Helps in rehabilitation program to users with motor impairment
- Validated through user trials at the Spastic Society of India, Chennai
- Can be used for Multimodal CoBot development



Medical Device Manufacturing

Aim

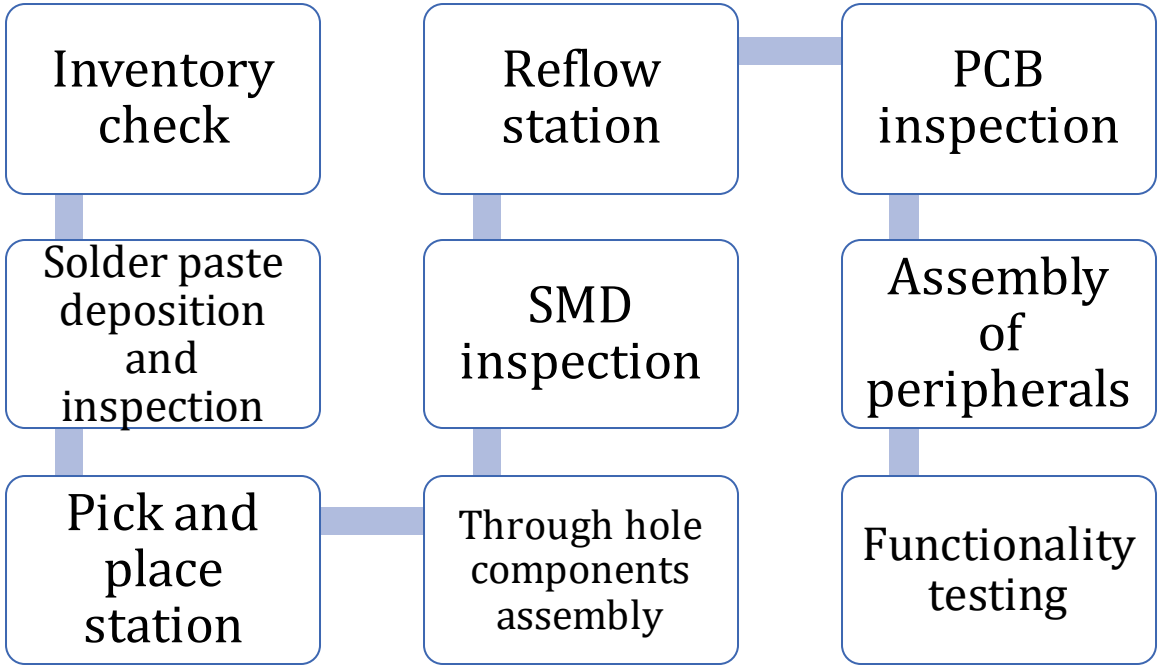
Modelling an assembly line for in house medical device manufacturing

Objective

- Create a framework for small scale medical device manufacturing applying Quality Management System
- Implement smart manufacturing tools and techniques for data analytics at various stages of manufacturing

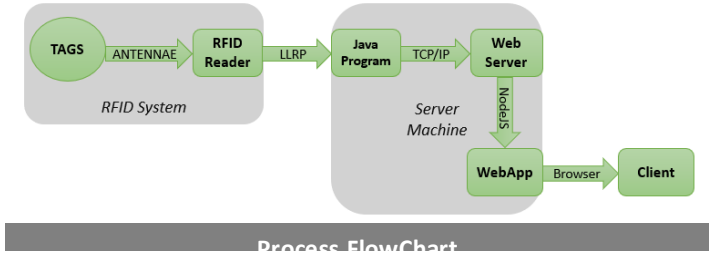
Deliverables

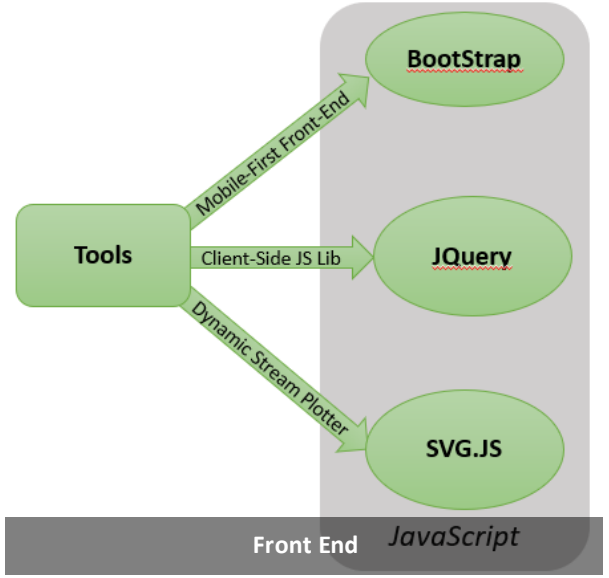
- Design and development of an IV Drip Monitoring device as a use case for in house manufacturing
- Identification and installation of equipment for assembly and inspection of electronic subsystems



RFID based Indoor Positioning

- ***Objective***: Develop a cross-platform application for indoor positioning of metal parts using passive UHF RFID system
- ***Deliverables***: Single software application for indoor positioning with configurable layout map. Reliable and repeatable performance in controlled environment, followed by actual factory. Quasi real-time positioning of multiple parts.
- ***Industrial significance***: Automated asset tracking helps visibility in factory, minimise time lost in searching for parts and effort of printing and scanning barcodes. UWB systems perform well but cost several times an RFID system.





Mixed Reality Digital Twin

- Digital twin with real time sensor information
- CAD models of real set up are imported in VR environment
- Live video rendered within VR twin
- Allows controlling AGV or Robotic manipulator from remote location
- Simulates AGV and Robot cooperation from VR environment

PCB Inspection System

- PCB Inspection system for MSME
- Inspection through classical computer vision algorithm
- Real time feedback on IC orientation
- Does not require training models
- Does not require CAD model (e.g. gerber file) of IC

Semi-Automated Assembly-Line for Drone Manufacturing

Aim: Design and develop a part-tracking software and a GUI with cloud database connectivity, remote 3D printing capability, taking semi-automated drone manufacturing as an example

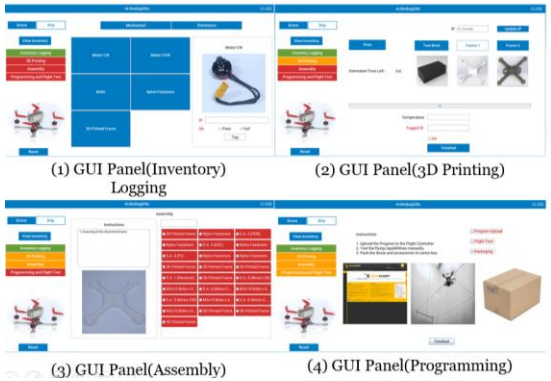
Objectives:

- Develop a part tracking algorithm for the drone manufacturing assembly-line,
- Inventory tagging and part tracking with cloud connectivity
- Design and assemble a drone
- Integrate remote 3D printing algorithm to the software for facilitating user to print parts without physically present next to the 3D printer
- Assembling the electronics and mechanical parts to realize the drone
- Develop a back-end software and a Graphical User Interface (GUI) for part tracking, data logging, and remote 3D printing management.

Significance:

- In-house developed, low cost part-tracking software for MSME
- Drone manufacturing detailed information

Assembled Drone



(1) GUI Panel(Inventory) Logging

(2) GUI Panel(3D Printing)

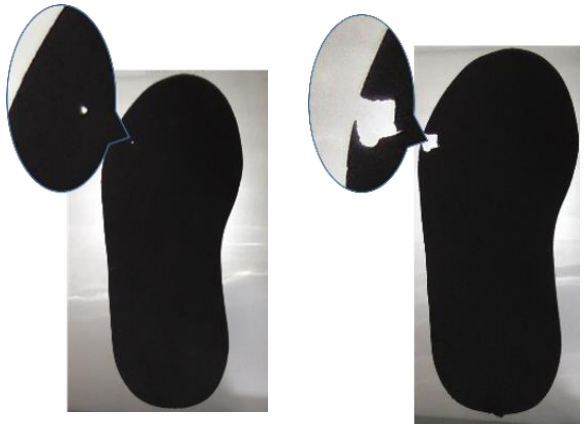
(3) GUI Panel(Assembly)

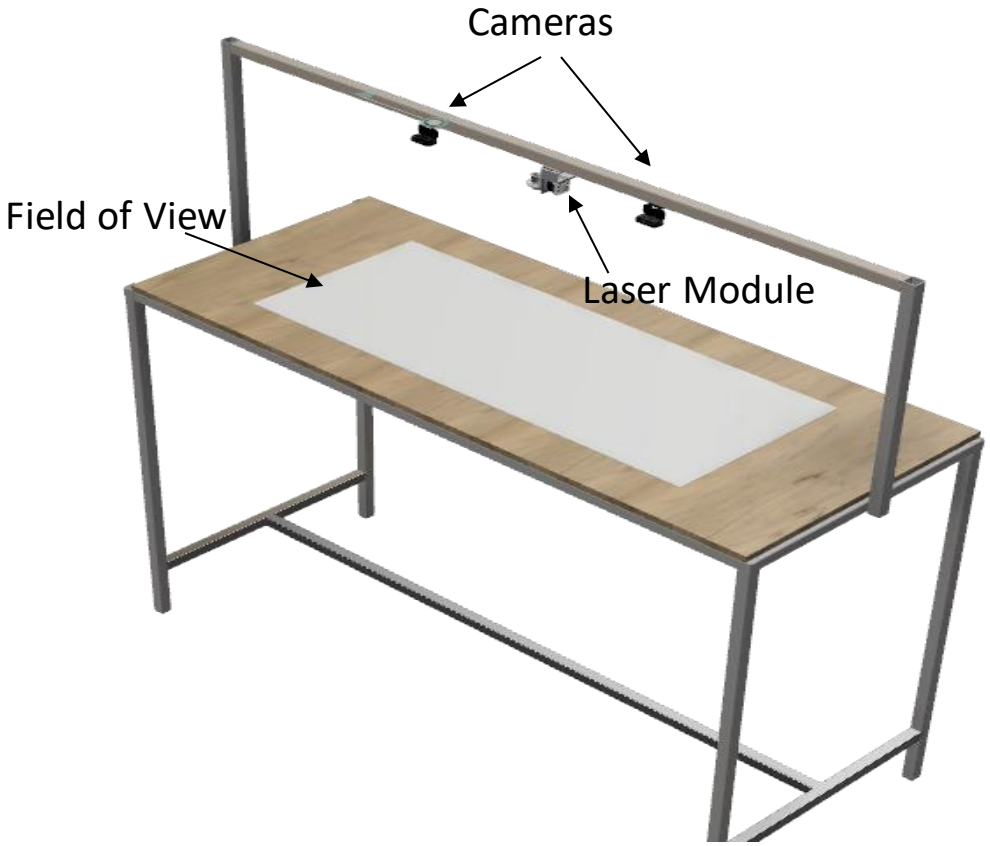
(4) GUI Panel(Programming)

Drone (Rendered image)

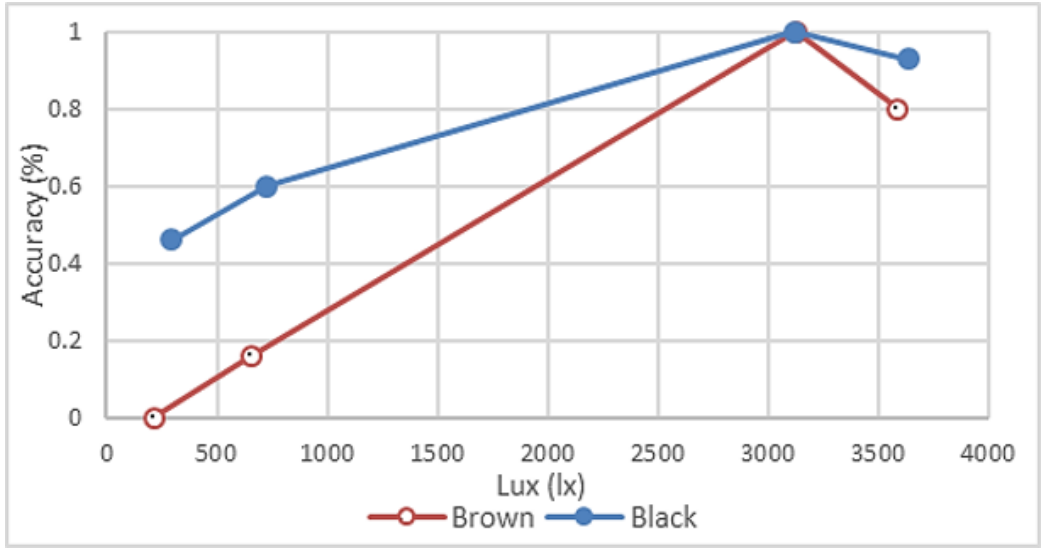
Smart Incoming Inspection System

- Project deliverable to a Medical Device Manufacturing MSME (Orthotic Footwear manufacturer)
- Defects were identified during the production- post cutting of soles.
- Affordable solution for Inspection and quality check
- at the incoming stage of raw materials
- A machine vision algorithm and off the shelf cameras with a robotic laser pointer to assist highlighting the defect
- Reduces wastage, time, human effort and cost of production





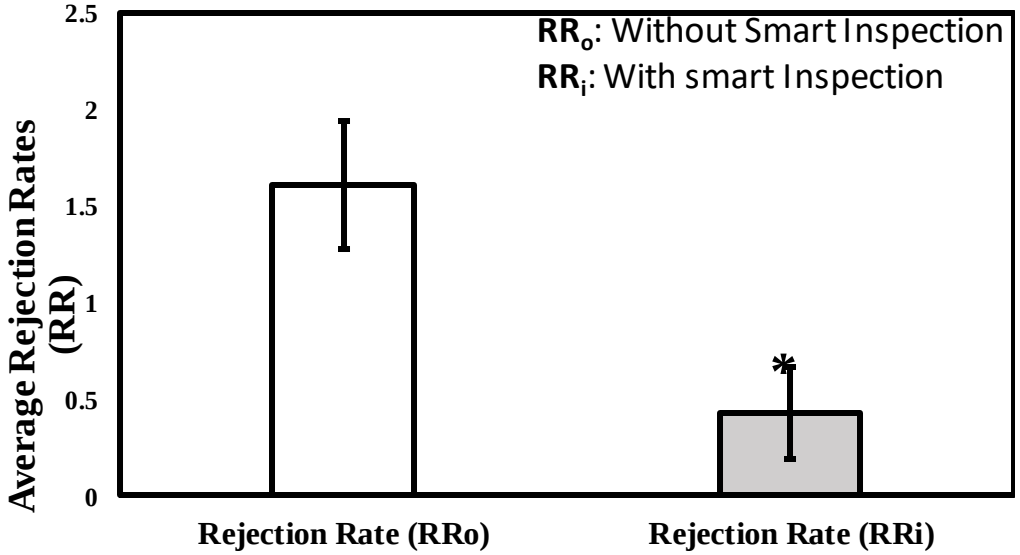
Smart Incoming Inspection System



Optimized light setting for accurate identification of defects (min: 1mm)

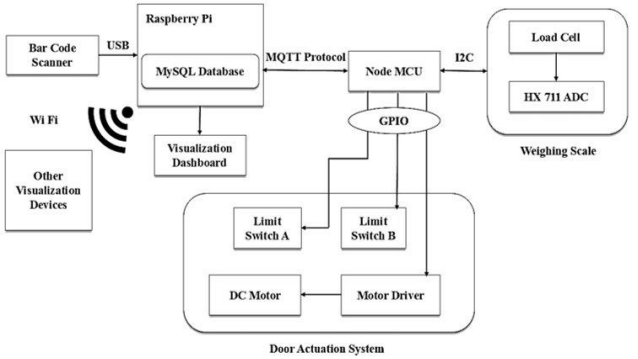
Defects are displayed as blobs and numbered for easy identification

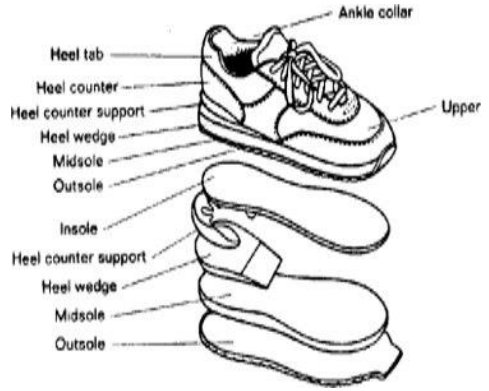
Established statistical significance on average rejections post introduction of the system



Smart Multi-Material Resource Bin

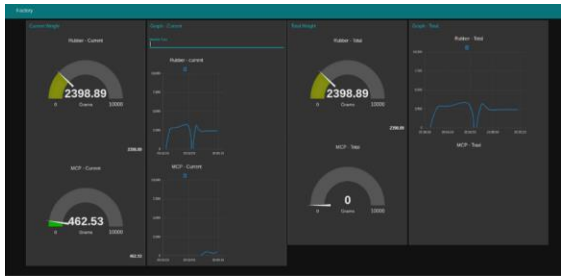
- Project deliverable to a Medical Device Manufacturing MSME (Orthotic Footwear manufacturer)
- Orthotic footwears are cut in different size and shape using different materials
- No quantification of wastage/ scrap and account of raw material consumed
- Affordable solution for quantifying scrap and segregation using simple door mechanism
- IoT enabled Material Tracking using Barcode identification
- Cloud database for remote data retrieval and analysis

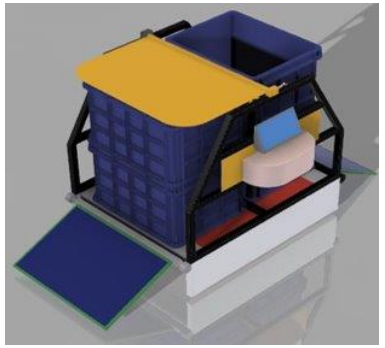


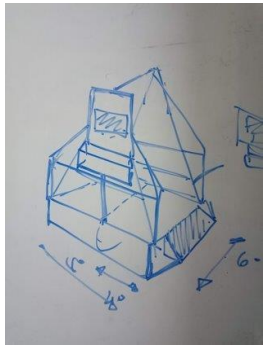


Smart Multi-Material Resource Bin

- Customized visualization of wastage generation of different materials.
- The historical data collected thus is then available for data analytics on productivity data.
- Should provide further insights supporting the reduction of waste and cost and improvement in productivity and sustainability.

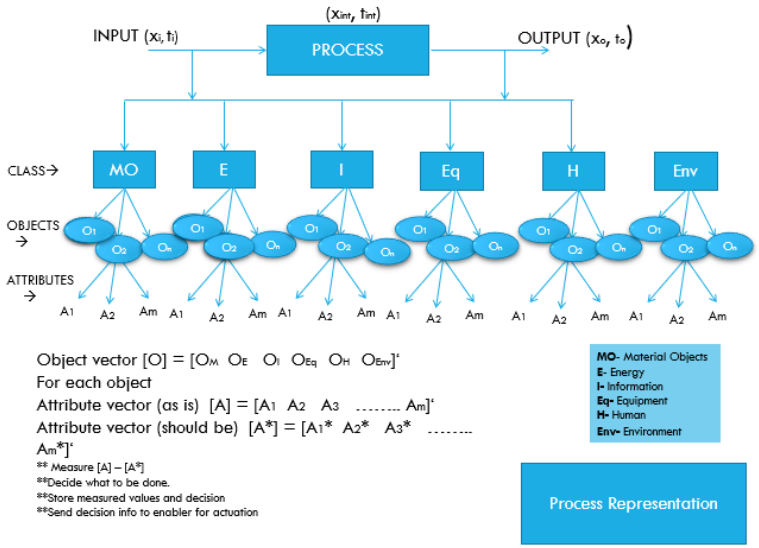


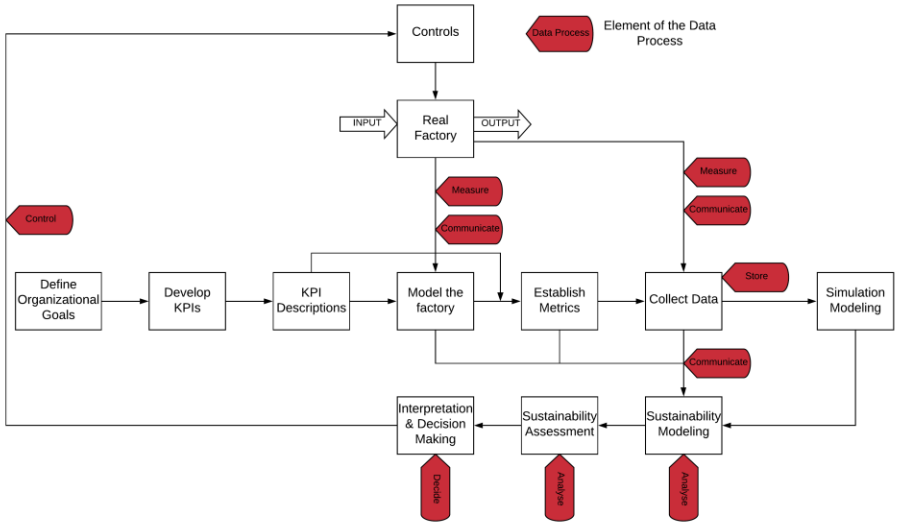




Smart Sensor DashBoard

- Visualization and alert module for multiple sensors
- Using AR technology to render both temporal and spatial information
- Sensors connected via WiFi to Dashboard without requiring internet connection





Smart Sustainability Assessment

Objectives:

- Modelling manufacturing system for collecting inventory (sustainability) data in MSMEs.
- Key performance indicators (KPIs) selection and Assessment.
- Deliverables:
- Capability to show online sustainability assessment.

Significance for industries:

- Environmental concerns, economic benefits, social issues and government legislations are forcing industries to improve their sustainability performance. Our work will help industries to systematically map the whole factory to identify data sources for performing sustainability assessment.
- Current status:
- Frameworks for a) modelling manufacturing process and factory and b) KPI selection and assessment are developed.

Thank you!