# Industry 4.0 Awareness Seminars Reports Template

MS Word File, Font Arial 12, space 1.5

<p>| | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1.</td>
<td>Date of the Seminar</td>
<td>27 February 2019</td>
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<tr>
<td>2.</td>
<td>Organizers</td>
<td>CII and FSM</td>
</tr>
</tbody>
</table>
| 3. | Title of the seminar | Awareness Workshop on Industry 4.0  
*The Indian Perspective* |
| 4. | Programme | Annexure 1 |
| 5. | Report: suggested contents | (1) Main takeaways / good suggestions  
(2) Clusters covered – **Gurgaon, Haryana**  
(3) Nos attended - **46**  
(4) Success stories that need to be compiled / shared – **FSM case study** |
|   |   | (1) Main takeaways / good suggestions  
- Overview of Industry 4.0 concepts  
- Exposure to explore the possibilities of ‘Digitalization’ - its benefits as well as key challenges  
- Understanding of a basic framework of readiness for Industry 4.0  
- Additive manufacturing – its relevance, challenges and applications  
- Case-study of Pilot cyber-physical line through remote demonstration  
- Levels of Smart Manufacturing and applications, key ingredients and survey on Industrial IoT  
- Understanding of the digital journey of a company with Augmented Reality and Machine |
<table>
<thead>
<tr>
<th></th>
<th>Learning</th>
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<tbody>
<tr>
<td>6</td>
<td>List of Speakers with contact details</td>
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<tr>
<td></td>
<td>Annexure 2</td>
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<td>Presentations</td>
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<td>Annexure 3</td>
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<tr>
<td>8</td>
<td>Resource persons for providing consultancy, skilling, guidance etc.</td>
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<tr>
<td></td>
<td>Dr Sunil Jha, Mr Anup Wadhwa and Mr Saroop Chand</td>
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<tr>
<td>9</td>
<td>Photographs</td>
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<td>Annexure 4</td>
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<td>10</td>
<td>Leanings from the seminar</td>
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<td>- Industry has a basic understanding of the concepts of Industry 4.0 at</td>
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<td>a broader level (as understood from the participants who attended</td>
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<td>the workshops). They are keen on understanding in detail about the</td>
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<td>applications of how to benefit from implementing Industry 4.0</td>
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<td>through specific case.</td>
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<td>- studies by companies who have deployed Industry 4.0.</td>
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<td>- Working models and demonstrations of Industry 4.0.</td>
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<td>Applications were very well received by the participants. It was</td>
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<td></td>
<td>also quite engaging and insightful.</td>
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<td>- Participants attending the workshops have shown great interest on</td>
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<td>interacting with DHI officials to understand about the various</td>
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<td>initiatives taken by Government in creating an enabling ecosystem for</td>
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<td>Industry 4.0 adoption.</td>
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**Program Outline**

**Awareness Workshop on Industry 4.0**

*The Indian Perspective*

**Date:** 27th February 2019  
**Time:** 10:30 AM – 4:00 PM  
**Venue:** CII Office, Plot No. - 249F, Phase IV, Udyog Vihar, Sector 18, Gurugram, Haryana

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>10:00 – 10:30</td>
<td>Registration</td>
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</table>
| 10:30 – 10:40 | **Welcome Address**  
Mr Satendra Singh, Member – CII Smart Manufacturing Council and Head- Manufacturing & Strategy, Nokia Solutions and Networks India Pvt. Ltd. |
| 10:40 – 10:50 | **Special Address**  
Ms Sukriti Likhi, Joint Secretary, Department of Heavy Industry (DHI)*                        |
| 10:50 – 11:10 | **Business Disruptions and Opportunities for Smart Manufacturing in India**  
Mr Ravi Agarwal, MD, Pepperl+Fuchs Factory Automation & President, Automation Industry Association |
| 11:10 – 11:20 | Tea Break                                                                                  |
| 11:20 – 12:25 | **Getting started with Smart Automation and IIoT Layers – Case Study of Pilot Cyber Physical Line**  
Dr Sunil Jha: Director, FSM & Lead Facilitator FSM Technology Team |
| 12:25 – 12:50 | **Challenges in Automated Tracking, Tracing and Remote Supervision**  
Mr Sandeep Singh, Director, Reckers Mechatronics Pvt Ltd |
| 12:50 – 13:10 | **Relevance of Additive Manufacturing beyond Prototyping**  
Mr Saroop Chand, MD, Adroitec Information Systems |
| 13:10 – 13:15 | Q&A                                                                                        |
| 13:15 – 14:00 | Lunch Break                                                                                |
| 14:00 – 15:05 | **Preparing for the next level of Digital Journey with Augmented Reality and Machine Learning**  
Dr Sunil Jha, Director, FSM & Lead Facilitator FSM Technology Team |
| 15:05 – 15:35 | **Business Value Creation through Automation and Digital Deployment – Open House Facilitation**  
Mr Pravin Purang, former MD, Royal Enfield Motors and Eicher |
| 15:35 – 15:50 | **Leveraging the Common Engineering & Cyber Physical Facilities Centre**  
Mr Anup Wadhwa, Director, Automation Industry Association |
| 15:50 – 16:00 | Summing up                                                                                 |
# Awareness Workshop on Industry 4.0 - Gurugram

## List of Speakers

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name</th>
<th>Designation</th>
<th>Company Name</th>
<th>Email</th>
<th>Phone</th>
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<tbody>
<tr>
<td>1</td>
<td>Satendra Singh</td>
<td>Head-Manufacturing &amp; Strategy</td>
<td>Nokia Solutions and Networks India Pvt. Ltd.</td>
<td><a href="mailto:satendra.singh@nokia.com">satendra.singh@nokia.com</a></td>
<td>9940122470</td>
</tr>
<tr>
<td>2</td>
<td>Ravi Agarwal</td>
<td>President, Automation Industry Association and MD</td>
<td>Pepperl+Fuchs Factory Automation</td>
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<tr>
<td>3</td>
<td>Dr Sunil Jha</td>
<td>Director</td>
<td>FSM &amp; Lead Facilitator FSM Technology Team</td>
<td><a href="mailto:suniljha@mech.iitd.ac.in">suniljha@mech.iitd.ac.in</a></td>
<td>9958198399</td>
</tr>
<tr>
<td>4</td>
<td>Sandeep Singh</td>
<td>Director</td>
<td>Reckers Mechatronics Pvt Ltd</td>
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<tr>
<td>5</td>
<td>Saroop Chand</td>
<td>Managing Director</td>
<td>Adroitec Information Systems</td>
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<tr>
<td>6</td>
<td>Anup Wadhwa</td>
<td>Director</td>
<td>Automation Industry Association</td>
<td><a href="mailto:anup.clair@gmail.com">anup.clair@gmail.com</a></td>
<td>9810026674</td>
</tr>
</tbody>
</table>
Presentations
Samarth Udyog
Digitization of Markets and Industry in India

Ravi Agarwal
AIA, FSM, P+F
Unlocking the Industrial potential?

All of it has Industry around it!
I4.0/SMART manufacturing/Samarth Udyog in India

स्मार्ट Manufacturing – A balancing Act
Applying it

Cut
Copy
Paste
Wouldn’t work!
Inspiration &
Ingenuity would!
Key Technologies @ FSM

- IIoT
- RFID
- Augmented Reality for Enhanced Visualisation & Learning
- Cyber Physical System
- Computer Vision
- 3D Printing with Multi-material capability
- Collaborative Robots (Cobots)
- Manual Operating Station
- Smart Sensors
- Safety
- Network Security
- Implementation of OPC-UA
- MTConnect Agent based Services
- Pallet & different conveying system
- Manufacturing Execution System
- Manufacturing Analytics
- Grippers & Material Handling
Methodology

Operational, Technical, Financial, and Skill Assessment
- Process capability study
- Safety & Energy assessment
- Remote Monitoring, Tracking & Tracing
- Training Needs

Absorption and Implementation in the existing facilities
- Instrumentation
- M2M Communication
- Introducing Digitalization
- Upgradation of existing plant/facility
- Proof of technology model

Upgrading to Smart Manufacturing / Industry 4.0
- Inclusion of best practices
- Proving ROI and increased competitiveness and productivity
- Inclusion in National & Global integrated supply & production chain

www.iafsm.in  IITD-AIA Foundation for Smart Manufacturing
Thank You!

www.iafsm.in
IITD-AIA Foundation for Smart Manufacturing
Smart Automation and IIoT Layers

Case Study of Pilot Cyber-Physical Lab

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suniljha@mech.iitd.ac.in

IITD-AIA Foundation
for Smart Manufacturing
www.iafsm.in
Smart Manufacturing

Economic Potential

Ability to accelerate corporate decision-making and adaptation processes

Agility

Ability to implement changes in the company in real-time
Smart Manufacturing

The **significance** of Smart Manufacturing lies in the role of **information processing** in enabling **rapid** organisational **adaptation** processes.

The **faster** an organisation can **adapt** to an event that causes a change in its circumstances,

Greater the **benefits** of the **adaptation**.
Corporate Adaptation Processes

![Diagram showing Corporate Adaptation Processes]

- **Event**: Insight about event become available
- **Analysis Completed**: Analysis Latency
- **Measures Approved**: Decision Latency
- **Measures Take effect**: Action Latency

**Benefits / Value of adaptation**
- Real Time Capability
- Data Analytics, ML, AI
- Visualization, DSS, Automated Decision Making
- System Integration, CPS

Source: based on Hackathon 2002; Muehlen/Shapiro 2010

Sunil Jha, Department of Mechanical Engineering, I.I.T. Delhi
Smart Manufacturing

Smart Manufacturing is about manufacturing “with intelligence” at each step along the “Design - Make - Use” continuum.

Smart manufacturing will transform how products are:

- Designed
- Manufactured
- Used / Operated
- Serviced

It will transform the operations, processes, and energy footprint of factories.

and the management of manufacturing supply chains.
Levels of Smart Manufacturing

- **Decision Making**: Make **optimised, real-time decisions** on production levels, locations, options etc. based on **corporate intelligence** created by Smart Manufacturing enterprise.

- **Data Analytics**: Applying DA to broad manufacturing **intelligence** to **optimise processes** and to iteratively design **smart products**.

- **Digital Thread**: Consolidates **information streams** from individual machines across **factory floor** by linking multiple process-chains together.

- **Intelligent Machines**: Production equipments equipped with **sensors** integrated into **IIoT (information stream)**.
Stages in Smart Manufacturing Development Path

(source: RWTH Aachen University)
1: Computerisation

- Different **information technologies** are used in **isolation** from each other within the company.

- Computers are primarily used to perform **repetitive tasks** more efficiently.

- Still possible to find many machines **without** a **digital** interface.

- One example for the computerisation stage would be a **CNC milling machine**.
  
  CAD data detailing actions still often has to be transferred to the milling machine manually – in other words, the **machine is not connected**.

- Semi-automated quality assurance is carried out at a test station, but the recorded data is not associated with the corresponding work order.
2: Connectivity

- The isolated deployment of information technology is replaced by connected components.

- Widely used business applications are all connected to each other and mirror the company’s core business processes.

- Parts of the operational technology (OT) systems provide connectivity and interoperability, but full integration of the IT and OT layers has not yet occurred.

- Connectivity means seamless information exchange between design, production, maintenance and service.
3: Visibility

What is happening?

- **Sensors** enable processes to be captured from **beginning to end** with large numbers of **data points**.

- This makes it possible to keep an up-to-date **digital model** of **factories** (company’s **digital shadow**) at all times.

- Producing a digital shadow is a **major challenge** for many companies.
  - data is often held in decentralised silos,
  - very little data collected,
  - data captured is only visible to a limited number of people
3: Visibility
What is happening?

- In order to achieve the goal of an **agile learning enterprise**, comprehensive **data capture** right across the company is **essential** for the provision of **relevant data about the operation** throughout the business.

- The **combination** of existing data sources with **sensors** on the shop floor can deliver significant benefits.

- Integrating **PLM**, **ERP** and **MES** systems provides a comprehensive picture that creates **visibility** regarding the **status quo**.
4: Transparency

Why is it happening?

• The next stage is for the company to **understand** why something is happening and use this understanding to **produce knowledge** by means of **root cause analyses**

• In order to **identify** and **interpret** interactions in the digital shadow, the captured **data** must be **analysed** by applying **engineering knowledge**.

• New technologies that support the **analysis** of **large** volumes of **data**

• Recorded parameters are **searched** for mutual **events** and **dependencies** that are then **aggregated** to produce complex events reflecting the condition of the machine or equipment.
5: Predictive Capacity
What will happen?

• Once it has reached this stage, the company is able to simulate different future scenarios and identify the most likely ones.

• Companies are able to anticipate future developments so that they can take decisions and implement the appropriate measures in good time.

• A company’s predictive capacity is heavily dependent on the groundwork that it has previously undertaken.

• A properly constructed digital shadow combined with a knowledge of the relevant interactions will help to ensure correct forecasts and the right recommendations.
6: Adaptibility
Achieving Autonomous Response

• Predictive capacity is a fundamental requirement for **automated actions** and **automated decision making**.

• **Continuous adaptation** allows a company to **delegate** certain decisions to **IT systems** so that it can **adapt** to a **changing** business environment as **quickly** as possible.

• The degree of adaptability depends on the complexity of the decisions and the cost-benefit ratio.

• Important to **carefully assess** the **risks** of automating approvals and acknowledgements for customers and suppliers.

• The **goal** of adaptability has been **achieved** when a company is able to **use the data** from the digital shadow to **make decisions**.
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What are Smart Sensors?

Smart sensors are advanced platforms with onboard technologies such as microprocessors, storage, diagnostics, and connectivity tools that transform traditional feedback signals into true digital insights.

These smart sensors can provide the timely and valuable data to power analytical insights that can in turn drive improvements in cost, performance, or customer experience.
Smart Sensor Ecosystem

- Physical environment
- Smart sensors
- Transmission standards
- Secure gateway/controller device
- Centralized platforms

Network Protocols:
- Wi-Fi
- Bluetooth
- Near field communication (NFC)
- Radio frequency identification (RFID)
- Zigbee

Cloud Services:
- Local area network (LAN)
- External/central database
Smart Sensors

Need of smart sensors

Smart sensors transform the physical world into digital insights that are used to create new value.

By arming managers with real-time information about their inventory, machinery, and purchased materials,

Smart sensors create visibility across the supply chain and fuel analytics that can be used to understand and anticipate demand, optimize sourcing, and drive high-value manufacturing decisions.
Smart Sensor

Recent Developments

Enabling data processing and analysis at or near the source ("edge computing") and reducing the amount of data that moves between the device and platform.

MEMS technology allowed for more compact, higher functioning smart sensors by effectively incorporating microelectronic functions in minimal space.

New wireless technologies are offering connectivity solutions that are more scalable and tailored.

Low-power wide area networks (LoPWAN), for example, have reduced cost, power consumption, and range issues for smart sensor usage.
Smart Sensor Recent Developments

**Recent Developments**

- **Analytics Tools**
  - Extracting **insights** from sensor-created data is getting **easier** as **analytics** tools continue to improve.

- **Big Data**
  - Handling and storing large, complex data sets is becoming more **manageable** through **Big data platforms**.

- **Real Time Processing**
  - Tools enable **processing** and **analysis** of data on a **real-time** or a near-real-time basis, driving **timely decision making** and **action**.

- **New Algorithms**
  - Algorithms continue to advance, expanding the **capability** to **predict** and **prescribe** courses of **action**.
Industrial IoT

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Why IIoT?

- Ensuring **reliability** and **quality** of the product or process
- Improving **efficiency** of the manufacturing processes and adding **predictive maintenance**
- Introducing **products** faster with more **intelligent asset management**
- **Connecting** interdependent **multi-located** manufacturing facilities

White Paper on “Smart Factory Connectivity for the Industrial IoT”, Ashish Pathak, Industrial Automation Segment, Renesas Electronics America Inc. February, 2017
Smart Factory Connectivity for IIoT

White Paper on “Smart Factory Connectivity for the Industrial IoT”, Ashish Pathak, Industrial Automation Segment, Renesas Electronics America Inc. February, 2017
IIoT for Condition Monitoring

**Reactive**
Fix it When it Breaks

**Preventive**
Schedule Maintenance

**Predictive**
Maintain it Before it Breaks

Condition Monitoring Enables

Increase in Productivity
12-18%
8-12%
IIoT Key Ingredients

People
- How are they identified?
- How do they interact with the data (near real-time)?
- How do they consume the data (notifications, trends, alerts)?

Devices
- What are they?
- How do they communicate with systems?
- How are they managed?

Data
- What happens with data flowing in?
- What happens when data needs to flow out?
- How can data be converted into business value (Monetization)?
What qualifies as complete IOT use case?

- Uniquely identifiable and connected things
- Data capture, contextualization and storage
- Analytics triggering automated responses
- Measurement and reporting of relative changes in performance
Return on Assets

Use Case Theme

**Sense**
- Visual
- Temperature
- Vibration
- Wear
- Energy Consumption

**Analyse**
- Maintenance History
- Asset Specifications
- Useful Life
- Repair Parts/Spares
- Resource Availability
- Usage Schedule

**Intervene**
- Alert Operators
- Schedule Inspection
- Order Parts
- Schedule Maintenance
- Reroute Production
- Update Records

**Learn**
- Asset Selection
- Maintenance Planning
- Operating Conditions
- Training
- ROI
IIoT Survey

Source: www.infor.com
IIoT Survey

Priority

How important is IoT in your business?

A. Top Priority
B. Top Three
C. Top Five
B. Not a Priority
IIoT Survey

Business Impact

Indicate the impact you anticipate IoT will have on your business?

A. Major
B. Moderate
C. Minimal
B. None
IioT Survey

Benefits

Where do you anticipate the biggest benefits of IoT in your business (select 3)?

A. Machine & Equipment Utilization
B. Productivity
C. Insight & decision Making
D. Visibility & Traceability throughout Supply Chain
E. Plant Floor Automation
F. New Revenue Streams
G. Product Quality
H. Safety & Security
I. No benefits anticipated from IoT in our business
J. New Services
IIoT Survey

Urgency

What would be your **top concerns** if your business were **not** to implement an IoT strategy in the **next 3 yrs**?

A. Competitor will gain productivity & cost advantage

B. We might not catch up innovative services / product

C. May become harder to stay Compliant

D. May not be able to support customers & suppliers

E. Employee productivity will fall

F. Harder to attract new customers

G. Harder to attract / retain skilled employee

H. No Concerns
IIoT Survey

Readiness

How ready is your business to Capitalize on the opportunity of IoT?

A. Hardware & Software in place, fully equipped

B. Capturing data, but Unconnected to application

C. Capturing data but No Smart business systems

D. No Smart devices / sensors deployed in the business
IIoT Survey

Summary
Customer Survey
Source: www.infor.com

Priority

How important is IoT in your business?

Over half report IoT in Top 5 priorities

20% identifying it as a ‘Top 3’ business priority
Customer Survey
Source: www.infor.com

**Business impact**

Indicate the impact you anticipate IoT will have on your business?

- **Quarter** anticipate **major** impact
- Only **13%** anticipate **no** impact

- **None**: 13%
- **Minimal**: 24%
- **Major**: 25%
- **Moderate**: 38%
Customer Survey

Source: www.infor.com

Benefits

Where do you anticipate the biggest benefits of IoT in your business (select 3)?

- Productivity
- Visibility
- New revenue

Utilization

- Machine and equipment utilization: 30.2%
- Productivity: 52.3%
- Insight and decision making: 40.7%
- Visibility & traceability throughout the supply chain: 31.4%
- Plant floor automation: 19.8%
- Product quality: 19.8%
- Safety & security: 12.8%
- New services: 19.8%
- New revenue streams: 25.6%
- No benefits anticipated from Internet of Things in our business: 5.8%
Customer Survey

Source: www.infor.com

Urgency

What would be your top concerns if your business were not to implement an IoT strategy in the next 3 years?

Productivity, Service Innovation & Compliancy major concerns of failing to adopt IoT
Customer Survey
Source: www.infor.com

Readiness
How ready is your business to capitalize on the opportunity of IoT?

Only 13% fully ready to capitalize on IoT

45% report no smart devices deployed in the business

Source: www.infor.com
Cyber Physical System (CPS)

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Cyber Physical System (CPS)

- Making **machine tools intelligent** for Smart Factory which can implement **self-aware, self-prediction, self-compare, and self-configure** to be more **resilient** to dynamic changing environments.

![Cyber Physical System Diagram]

<table>
<thead>
<tr>
<th>Configure</th>
<th>Supervisory Control</th>
<th>Required Actions</th>
<th>Resilient Control System (RCS)</th>
<th>Actions to Avoid</th>
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<tr>
<td>Cognition</td>
<td></td>
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<td>Decision Support System (DSS)</td>
<td>Prioritize and Optimize Decisions</td>
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<tr>
<td>Cyber</td>
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<td>Cyber-Physical Systems (CPS)</td>
<td>Self-Compare</td>
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<td>Conversion</td>
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<td>Prognostics and Health Management (PHM)</td>
<td>Self-Aware</td>
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<tr>
<td>Connection</td>
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<td>Condition Based Monitoring (CBM)</td>
<td>Condition Monitoring</td>
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Cyber Physical System (CPS)

5C architecture for CPS as a guideline for implementation in manufacturing

Machine Learning

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Machine Learning

Powering Predictive Maintenance

- **Maintenance** represents a **significant** part of any manufacturing operation’s **expenses**.

**Traditional Predictive Maintenance:**

Using SCADA systems set up with **human-coded thresholds**, alert **rules** and **configurations**.

**Semi-manual approach**

- doesn’t take into account the more complex dynamic behavioural patterns of the machinery,
- or the contextual data relating to the manufacturing process at large.
Machine Learning

Powering Predictive Maintenance

ML Approach: Machine Learning algorithms are fed

- **OT data** (from the production floor: sensors, PLCs, historians, SCADA)
- **IT data** (contextual data: ERP, quality, MES, etc.)
- **Manufacturing process information** describing the synchronicity between the machines and the rate of production flow

In AI, “training” enables the ML algorithms to **detect anomalies** and **test correlations** while searching for **patterns** across the various **data feeds**.
Machine Learning

Powering Predictive Maintenance

The power of Machine Learning

- Capacity to **analyze** very large amounts of data in **real time**, and propose **actionable** responses to issues that may arise.

- The **health** and **behaviour** of **every asset** and system are constantly **evaluated** and component **deterioration** is identified **prior to malfunction**
Machine Learning

Enabling Predictive Quality Analytics

The **quality** of **output** is **crucial** and product quality deterioration can also be predicted using Machine Learning.

Knowing beforehand that the **quality** of products being manufactured is destined to **drop**

- prevents the wastage of raw materials
- valuable production time
Machine Learning

Machine learning is the process of developing, testing, and applying predictive algorithms to achieve the goal of efficient data sets.

Focus is over the application of machine learning to maximize the benefits it brings to improve situational intelligence, performance, and reliability.
In **Manufacturing**, one of the most powerful **use cases** for Machine Learning is **Predictive Maintenance**, which can be performed using two Supervised Learning approaches: **Classification** and **Regression**.
Machine Learning

Unsupervised Learning

Used to draw inferences from datasets consisting of input data without labeled responses

Unsupervised learning can be used to find normal operating modes of your assets and detect trends and anomalies
Machine Learning

Data Preparation

Machine learning is all about data, so understanding some key elements about the quality and type of data needed is extremely important in ensuring accurate results.

With Predictive Maintenance, for example, we’re focused on failure events.

Therefore, it makes sense to start by collecting historical data about the machines’ performance and maintenance records in order to form predictions about future failures.

• historical data of many years
• static information about the machine/system
Machine Learning

**Data Preparation**

**What question** do we want the **Machine Learning** model to **answer**?

Is it **possible to answer** this question using the **data** that’s **available**?
Machine Learning  

Data Preparation  

Certain **questions** should be answered to help focus on the **data** that is **most crucial** to our needs:

- What are the various **types** of **failure** that can occur with this component / machine / system?
- Which **failure events** are we interested in trying to **predict**?
- Is the **failure** a **sudden, focused event**, or is there a **slow decline** before complete malfunction?
- Which **components** are typically associated with this type of failure?
- Which **parameters** should be measured that **most signify** the state of component / machine health?
- What is the required accuracy and frequency of the measurements needed?
Cyber Physical Lab

Electromechanical Component Assembly

1. Raw part Storage, Loading & QC
2. Axisymmetric part Storage, QC & Insertion
3. Prismatic Part Assembly & Screwing

Robot Multiprocess Cell

4a. Product Functional Testing
4b. Product Packaging
4c. Finished Product Storage
4d. Raw part Storage, Loading & QC
4e. Axisymmetric part Storage, QC & Insertion
4f. Prismatic Part Assembly & Screwing

Conveyor
Pallet with RFID
Cyber Physical Lab

Electromechanical Component Assembly

Raw part Storage, Loading & QC

Axisymmetric part Storage, QC & Insertion

Prismatic Part Assembly & Screwing

Smart Manufacturing @ IIT Delhi
Cyber Physical Lab – Modular Stations

- Raw part Storage, Loading & QC
- Axisymmetric part Storage, QC & Insertion
- Prismatic Part Assembly & Screwing
Digital Thread in FSM

Cyber Physical Lab

- Concept & Detail Design
  - 3D Modeling & Detailed Design
  - Design Validation
  - Engineering Calculation

- Manage Design Information
  - Engineering BOM
  - Associative Manufacturing BOM
  - Collaboration
  - Requirements Management

- Smart Manufacturing
  - Operational Intelligence/OEE
  - Remote Diagnostics
  - Analytics

- Connected Service
  - Predictive Service
  - AR Enabled Service
  - Remote Expert Collaboration

Smart Manufacturing @ IIT Delhi
Thank You
Adroitec....

......Enabling you to leap forward

Saroop chand
Saroop.chand@adroitecinfo.com
Adroitec Group

- Design
- Engineering
- Robotic & Automation
- IOT
- Knowledge Management
- 3D printing
Evolution of 3D printing – Beyond Prototyping

- Material to meet standard
- Speed for Prebatch Production
- Size of parts
- Ease of operation
- Functional parts
- Reliable systems for 24X7 operations

Factory on the move
3D printing to meet the growing challenges

Personalisation

Frequent ECO systems

Global development, manufacturing & usage

Smart Products

Global product development for global customers requires global development teams to work collaboratively.

The Challenge:

- Ensuring the product is delivered on time and to the right specifications
- Minimising cost and risk
- Reducing time to market

+ Agile: ensure modular, product architecture definition to significantly improve on time delivery of product specifications
+ Making Distributed Design and manufacturing: work and be ready to service anywhere, any time

Intelligent, adaptive, self diagnostic
Introduction of new product – 100’s of parts need to be developed or procured
Present multiple Processes

Significant cost and time
SME and Start-up: Challenges

- Limited Capital
- Skilled resources
- Vendor Network
- Economy of scale
- Market Branding
3D printing - Great Equaliser for SME & Startups

- Rapid Innovation
- Toolless manufacturing
- Economic Pre-batch production
- Early roll out to market
- Multivariant for Market Branding
- Less inventory for today and for maintenance
- Higher Capital Efficiency

Design Without boundaries
Developers emerging and evolving the 3D print process to reduce cost, time impossible products and assured parts meeting standards

**Technologies:**
- Laser-SLA, SLS, SLM, DLP
- Binding- Mark forged/desktop metal
- Continuous fibre reinforcement
- Voxel Jetting HP - MJF

**Materials:**
- Plastic, high temperature, composite, continuous reinforced, strong and castable resins, metals and alloys, ceramics, Clay
  - BASF, GKN, SABIC, HOGAN, Arkem, Lubrizol, Evonik, Henkel

**Software:**
- PTC, Siemens, Dassault, ANSYS, Nastran, Altair, Moldflow

**Standards:**
- ASTM, ISI-NASSCOM, FDA
- Size, SPEED, Post processing, cost, Standards
HP Driving the transformation to industrial-scale 3D manufacturing

Large build size for heavy production
Continuous printing
Economics to disrupt manufacturing
Siemens - Digital Enterprise Suite for Additive Manufacturing

*Integrated end-to-end process in one system*

Original design

Generative design

Topology optimization

Light weighting*

Adapt design (Convergent Modeling™ Technology)

Post-printing and inspection

Slicing, hatching printing*

Prepare for printing*

*Powered by Materialise

Final part

Validate

Associative - Iterative
MATERIALS

PLASTICS: ABS, TPU, PC, NYLON ETC

CLAY, SOIL, CONCRETE ETC

METAL: SS, TS, TI, AL, INCONEL, ALLOYS ETC

CASTABLE, WAXES

RESINS, PHOTOCURABLE

CERAMICS

LIVE CELLS, TISSUE, ORGANS ETC

BIO COMPATIBLES

DAY TODAY WASTES
Additive Printing/3D printing
- Beyond Prototyping,

Functional parts,
Tool Room- jigs & fixture,
Gauges, CMM Testing,
Assembly process,
Manufacturing,
Die making – conformal cooling,
Pattern making – sand mould
TYPICAL APPLICATION CATEGORIES

Machine Setup
Calibration jigs and machine repair and maintenance tools improve line startup efficiency when getting production up to speed

Fixturing, Positioning & Tooling
Inspection fixtures, soft jaws, assembly jigs, and other workholding devices require alignment features that can be hard to machine

Line Optimization
Custom end effectors, line add-ons and upgrades, and ergonomic equipment can improve line efficiency and safety
Every QC/QA room needs fixtureing.

3D printed fixtures are cheap, repeatable and have complex geometries.

No machining experience/equipment required.
**LASER MARKING FIXTURING**

Enables laser marking of complex or non-planar surfaces
Quick, cheap solution for positioning
Parallelized fixtures enable high throughput scaling

**CNC LATHE BAR PULLER**

$13 print replaces $700 - $1000 standard CNC bar puller tool
Fully customizable to non-standard geometries
Easily replaceable in-house in case of breakage

**PRINTED FIXTURING**

Complex structures with non-standard geometries are difficult to fixture.

Traditional fixtures make the process lengthy and custom fixtureing is costly.

Printed fixtures are an affordable solution for tack welding steel and simplify setup.
**ALIGNMENT JIGS & CHECK GAGES**

Modular welding fixtures are imprecise and can lead to misalignment.

It takes time to adjust these types of fixtures to achieve the desired results.

Welds may need to be redone if the parts aren’t held or oriented correctly.

**CUSTOM RISERS & MOUNTS**

It may be necessary to keep the frame in the fixture during the entire welding job.

Standard welding fixtures do not guarantee a repeatable process.

Custom fixturing can be costly for odd orientations because of machining capabilities.

**PRODUCTION**

Production Support - Assembly Aids

![Large Weld Pickoff](image)
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<th>AEROSPACE</th>
<th>MOBILITY &amp; TRANSPORTATION</th>
<th>HEALTHCARE</th>
<th>CONSUMER Goods &amp; Electronics</th>
<th>INDUSTRIAL &amp; SERVICES</th>
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</table>
SPM manufacturers – Digital Manufacturing of Smart Machines

- Complete trial of the system in short time and low capital cost
- No Minimum Order
- No coordination of multiple vendors
- No inventory for production
- Integration of subassembly- Reduction of parts
- No storage of spares for maintenance
Doctors
Aircraft

- ROKAF, F110 Engine HPT Shroud Support
  - Certified by Engine manufacturer(GE aviation)

- Requirement: repair of worn out parts
- Base: IN718(Ni alloy)
- Printing material: Stellite25(Cobalt)

- Saving Cost
  30K$/EA → 4K$/EA
- Lead time
  60days → 20days

Worlds First Privately Funded 3D Printed Aircraft
Total cost of acquisition

- Material cost
- Processing cost of different machines and manpower
- Inventory cost
- Maintenance part cost and availability
- Cost of capital investment and space
ADROITEC Group

- 350 + Strong Team,
- 25 + Years Old Company
- Focused on Engineering Design solutions
- 10000 + Satisfied Customers base
- Growing 20% Y.O.Y for last 5 Years
- 9 offices spread across the country, Germany and USA
RcSI Introduction

INTRODUCTION-AREA OF WORK

- Industrial Automation
- Smart Productive System Solution
- Data Acquisitions Solutions-[OEE/ENDON]
- M2M interfacing
- Connected Enterprise Network
- Intelligent Safety Solutions
- Condition Monitoring Solutions
- Remote Access Solutions – Cloud Based
- Validations and Compliances in Food and Pharmaceutical Industries.(FDA and MHRA Compliance)
- Handshaking Capability with ERP
PRESENT INDUSTRIAL CHALLENGES

1. Technology Integration
2. Security or Manual Intervention
3. Data Islands
4. Man Management
5. Comparative Reports
# CUSTOMER CHALLENGES

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Delivered Solution</th>
</tr>
</thead>
</table>
| Manual Intervention, Changes in Report, Duplicate signature, Data Manipulation | Meet the Industry Compliance  
- Ex: 21CFR Part 11  
- Privatization of Data  
- Real Time Report                                                             |
| Downtime, Information about Machine, Data Monitoring, Difficult to fault Tracing, Product Back Tracing | Digitization of Equipment  
- Real Time TAG Accessing  
- Diagnosing Feature  
- Real Time Data  
- Multiple Location Of same data |
| Target Achievement, Meet the expected Number, Machine management          | Planning In Controller/SCADA level  
- Utilization of available Equipment                                           |
### CUSTOMER CHALLENGES

- Conventional OEE Calculation
  - Manual Data logging
  - Manual Machine Monitoring
  - Synchronization of DATA

### DELIVERED SOLUTION

- Enhance OEE
  - Provide digital Solution
  - Machine Level calculation
  - Controlling of Quality
  - Monitoring of Availability in Real Time
  - Controlling the Performance of machine/operator

### CUSTOMER CHALLENGES

- The Real Causes of LINE STOP
  - Clarification of Production Stop
  - Manual Intervention
  - Information Channel
  - Downtime

### DELIVERED SOLUTION

- Installation Of END-ON system
  - Work Station Information
  - Operator to Responsible on Channel information
  - LINE STOP with actual CAUSE DISPLAY
  - Intimation to the concern person during Line OFF
Digitization Architecture

- 3G/4G LTE Cellular Gateway (192.168.0.250)
- HMI (192.168.0.30)
- Drive (192.168.0.050)
- PAC/PLC (192.168.0.20)
- ProSoft CONNECT

Access

No Access

- OEM Headquarters (10.3.10.110)
- Remote Access
- IT DMZ/Firewall
- 192.168.0.251 Remote PC Address
- IT Network

Plant Automation Network

- Drive
- HMI
- I/O Devices
- OEM Equipment
- PAC/PLC (192.168.0.20)

Cell Carrier to Internet

Internet
DISCRETE MACHINE DIGITIZATION
RECKERS MECHATRONICS PVT LTD

Database

Redundant WorkStation

Data Concentrator

SAP

Discrete m/c-1

Discrete m/c-n
## Report Structure

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CONTINUOUS LINE DIGITIZATION

PROJECT-VARIANT MANAGEMENT SYSTEM
MIG-WELDING MACHINE DIGITIZATION
Solution-1

Tracking by RFID System

Challenges-

- Metallic Structure
- Limited frequency range

Solution-

- HF vs. UHF
- Integration of RFID with Barcode
After Execution

- Now data is updating itself from remote server.
- Real time Data Flow from Remote data to Discrete Machines.
- Plan vr. Actual Information.
- Operator to Manager Direct Connectivity.
- Use of Existing conventional machines for IOT.
- Increase in productivity.
- Managed information flow.
- Increased individual efficiency.
RECKERS MECHATRONICS PVT LTD

and many more...
Thank You
Achieving Success in the VUCA world

Embracing the Potential of Cyber Physical Intelligence

Anup Wadhwa
Director
Automation Industry Association
What we are used to…

Operators and partly automated Machines

Mechanized Operations

Improved productivity over Manual operations

Vital Process parameter control

Quality can not be predicted

Data Analysis is not a key skill set

Safety standards are soft
What we have to be conscious about...

• GDP per person hour worked in India is about $1/5^{th}$ of Germany
  – Means we are doing the lowest end jobs
  – And that too, most inefficiently
• “The world is dangerously open”. Innovators and R&D teams need to be mindful of technology obsolescence.
• High technology execution demands having smooth control of parameters like
  – Throughput
  – Quality
  – Consistency
  – Predictability
  – Rate of improvement of above
  – Getting everything RIGHT faster than before
Future of low wage is UNCERTAIN

- **Non-Reliable**: Did you check? By my eyes Sir!
- **Uneven**: OK! OK...
- **Overlook**: See, I didn't see.
- **Dangerous**: My eyes hurt.
- **Fatigue**: Simple Constant Repetitive Operations
- **Low Productivity**: Wow! I'm giddy.
COMPLEX Challenges

- Awareness and Relevant Use Cases
- Economic Risk of Small Scale
- Budget, Funds, Subsidies
- Knowledge to go into Measurements and Beyond
- Competence to Manage Automation and Scaling Up
- Culture of Delegation and Transparency
Winners Embrace Smart Ways

Remote sensing of objects and environment

In a plant, it’s not just about data... INTEGRATED CONTROL & INFORMATION MATTERS

Subscribe to my status updates

My yield will meet today’s production needs

Cameras deployed for monitoring and security

Just plug me in! I am online and ready for configuration with the line. Here is my configuration

Everything has a URL

Clean me next shift

7100kWh of energy used today
It is a DIFFERENT TERRAIN

- VIDEO 1
- VIDEO 2

The NEW GAME is very aspirational and requires new competencies
Interplay of Technologies

Industrial IoT and Cyber Physical System

Collaborative Robots

Smart Sensors, Actuators & Controllers

Rapid Prototyping and Tooling

Augmented Reality

Advance Simulation, Digital Twin

Analytics, Mfg Ops Mgmt

Remote Maintenance

Wireless Instrumentation

Industrial Safety

Cyber Security, Mobility
Connect and Collaborate

The CEFC at FSM supports and facilitates Users, Digital Business Architects, Digital Manufacturing Integrators & Master Trainers
IITD-AIA Foundation for Smart Manufacturing

It’s For You!

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