IndAC-SM

Industry Academia Consortia for Smart Manufacturing
Every solution provider has his version of Smart Manufacturing / Industry 4.0

Very few large scale implementations in India.

Those who have started, are in the process of getting there.

Lack of frameworks to evaluate applicability of Smart Mfg / Ind 4.0 concepts for one’s own business.

Uncertainty about ROI.
Next Gen Business

GTAI, Germany
EFFRA, EU
SMLC, US
NIST, US
The Govt Office for Science, UK
Institute for Manufacturing, UK
EPSRC, UK
The Japan Business Federation

Siemens
Beckhoff
Bosch
GE

Capgemini
Mckinsey
PWC

- Focus on customer experience
- Co-creating products and services.
- Servitization
- Mass customization
- Sustainability: Product upgrades instead of throw away, Reverse logistics.
Embedded systems
Cyber Physical Systems
IOT
Smart sensors
Computer vision
COBOTs
Cloud computing
Edge analytics
Additive Mfg
Asset Admin Shells
Big data analytics
AI/ML
AR/VR
Intelligent HMIs
Blockchain
Need: Customization

Function: Production

Technology:
Smart Workpiece,
Networked Production
Smart Manufacturing

Smart Decision Making

- Visibility of Asset
- Descriptive analytics
- Predictive analytics
- Prescriptive analytics

What's it made up of and what are the current values of monitored variables?

What is the current condition/situation?

When will a particular event occur?

What decision should be taken?
1. Have a unique identification
2. Have high interoperability
3. Actively interact with the user and other products
Machine Parameter Extraction Algorithms

Raw Data

GUI

MTConnect Adapter

MTConnect Agent

Local File Format

Third party Applications

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Characteristics of Smart Products

1. Have a unique identification
2. Have high interoperability
3. Actively interact with the user and other products
4. Can store data about itself and learn
5. Deploy a language to display its features
6. Self assessment of health condition
7. Are capable of participating in or making decisions
8. Help in executing an action
Characteristics of Smart Processes

A self aware process that can observe its own execution and optimize its behavior around a user’s or application’s needs.
Shift to Shift
Machine to Machine,
Spindle to Spindle
Operator to Operator
### Day 1

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Possible Causes
Possible Locations
Avg

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M
SP
OP

Descriptive analytics

Visibility of Asset
Visibility into Asset
Predictive analytics
Prescriptive analytics

When will a particular event occur?
What is the current condition/situation?
What decision should be taken?

What’s it made up of and what are the current values of monitored variables?

AVERAGE
0
2
4
6
8
10
12
14
S1 S2 S3 M1 M2 M3 M4 SP1 SP2 OP1 OP2 OP3 OP4

Improvement Opportunity
Characteristics of Smart Systems

Real Time Production Control

Disruption 1  Disruption 2  ...  Disruption n

Reaction 1  Reaction 2  ...  Reaction n

Proactive Algorithm  Reactive Algorithm
Characteristics of Smart Systems

Disruption 1  
Disruption 2  
...  
Disruption n

Proactive Algorithm

Reactive Algorithm

Problem Set
Please refer to the Problem pdf to know about the scheduling problems

Format Set
Please refer to the format pdf to know about the way you have to upload the excel sheet

Upload for Schedule Calculation
Please upload the excel file for schedule
- Choose File: No file chosen
- Submit

Upload for Due-date Calculation
Please upload the excel file for Due-date calculation
- Choose File: No file chosen
- Submit
Visibility into Asset

Descriptive analytics

Predictive analytics

Prescriptive analytics

What's it made up of and what are the current values of monitored variables?

What is the current condition/situation?

When will a particular event occur?

What decision should be taken?

Level 1

Level 2

Level 3

Level 4

Level 5

Preparatory Levels
Visibility of Asset

Metadata:

Unique identification:

Location:

Physical Characteristics:
No. of axis
Max length of job,
Max dia of job
Max weight of job
Max torque available
Max spindle speed
Tool changer capacity
Controller type

Capability:
Feature types that can be machined
Feature sizes that can be machined
s/c finish achievable
Tolerances achievable
Visibility into Asset:

Part library:

Parameters monitored:

Threshold values of parameters:

Current values of parameters:

Maintenance Schedule:

Pending maintenance activities:

Current job being processed:

Jobs in queue:

Current tools in tool changer:

Spares available:

Operating manuals:

Maintenance manuals:

Instructional videos:
Descriptive Analytics

Descriptive Analytics:
- Health status of monitored machine parts:
- Health status of monitored tools:
- Expected completion time of jobs in queue:
- Average no. of jobs in queue:
- Average waiting time of jobs in queue:
- OEE

Jobwise analytics
- Control charts:
- Cp/Cpk:
- % value added time:
- Power consumption cost per hr
Smart Processes

TS-MRM
Process Parameter Specifications

Mold Temperature Range: 85 to 104 °C

Material Temperature Range: 401 to 445 °C

Injection Pressure: 1010 to 1190 psi

To ensure enhanced traceability, we need to capture data at a higher granularity

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Predictive Analytics

Level 1: Visibility of Asset
Level 2: Visibility into Asset
Level 3: Descriptive analytics
Level 4: Predictive analytics
Level 5: Prescriptive analytics

Preparatory Levels

What's it made up of and what are the current values of monitored variables?
What is the current condition/situation?
When will a particular event occur?
What decision should be taken?

Visibility into Asset
Descriptive analytics
Predictive analytics
Prescriptive analytics

Detecting a shift in signal
Tracking the progress
Predicting the future
Maintenance Planning

- **REACT**
  
  "fix it when it's broke"

- **PREDICT**
  
  "Know when it's going to fail"

- **PREVENT**
  
  "Reduce the probability of failure"

- **RECOMMEND**
  
  "Recommend appropriate maintenance action"

**Selective Maintainance**

**Opportunistic Maintenance**
Smart Machine: Advanced (under development)

Sense, think, Act, Learn
System for Operations, Health and Usage Monitoring
Digital Twins

A Digital Twin is the current representation of a product or system, i.e., mimicking machines, controls, workflows etc.
Domain Models

Petri Nets

Discrete Event Simulation

Markov/Semi Markov Models

Bayesian Networks

FE Models

Neural Networks
Digital twins: Wipro
Digital twins: Wipro
Who are the consumers of data?
What will they do with this data?
How will it help?

- **m/c tool**
- **Production Planning**
- **Quality control**
- **m/c tool**
- **Maintenance**

- **m/c tool service**
- **manufacturer**
- **Consumable supplier**
- **Customer**

- **Real time Quality Monitoring**
- **Predictive maintenance**
- **JIT Spares parts inventory**
- **Lower Maintenance Costs**

- **Cp, Cpk, FTR**
- **Real time Quality Monitoring**

- **Production Planning**
- **Production Control**

- **Remote monitoring**
- **Breakdown services**

- **Kanbans and dispatching rules**
- **Optimized and just in time consumable supply**
- **Real time production status and process monitoring**

- **Controlled throughput, Small lead times**
- **Lower consumable cost**
- **Better synchronization**

- **On-time delivery, Low inventory cost**
- **Controlled throughput, Small lead times**
- **Lower consumable cost**
- **Better synchronization**

- **Optimized and just in time consumable supply**
- **Real time production status and process monitoring**
- **Higher Availability**
- **Lower consumable cost**
- **Better synchronization**

- **Kanbans and dispatching rules**
- **Consumable supplier**
- **Customer**

- **Real-time sequencing and inventory control**

- **Cp, Cpk, FTR**
- **Real time Quality Monitoring**
- **Predictive maintenance**
- **JIT Spares parts inventory**
- **Lower Maintenance Costs**

- **Optimized and just in time consumable supply**
- **Real time production status and process monitoring**
- **Kanbans and dispatching rules**
- **Consumable supplier**
- **Customer**

- **On-time delivery, Low inventory cost**
- **Controlled throughput, Small lead times**
- **Lower consumable cost**
- **Better synchronization**

- **Real-time sequencing and inventory control**
- **Production Planning**
- **Production Control**

- **Remote monitoring**
- **Breakdown services**
- **Kanbans and dispatching rules**

- **Optimized and just in time consumable supply**
- **Real time production status and process monitoring**
- **Kanbans and dispatching rules**
- **Consumable supplier**
- **Customer**
A **technology roadmap** typically outlines when, why, and what **technology** solutions will be implemented to help the organization move forward.
QA