Industry 4.0 Awareness Seminars Reports Template

MS Word File, Font Arial 12 , space 1.5

1.	Date of the Seminar	15 March 2019
2.	Organizers	EEPC India along with FICCI
3.	Title of the seminar	Session on Industry 4.0 – The Indian Perspective
4.	Programme	At Annexure I (enclose a copy in MS Word)
5.	Report: suggested contents (1) Main takeway / good suggestions,	-Key speakers from government & industry -Success stories highlighted by successful companies operating in the domain of I 4.0 in India like Siemens - Global perspective on Industry 4.0 shared by MARii (Malaysian Automotive Robotics and IOT institute.
	(2) Clusters covered,	Engineering, machine tools, foundry, automation, auto parts and components
	(3) Nos attended,	80
	(4) Success stories that need to be compiled / shared	Siemens has successful model for Industry 4.0 replicated in India
6.	List of Speakers with contact details	At Annexure II (enclose a copy in MS Word)

7.	Presentations	Annexure III (enclose copies in MS Word)
8.	Resource persons for providing consultancy, skilling, guidance etc.	As per Annexure II
9.	Photographs	AS per Annexure IV (Jpeg images please)
10.	Learnings from the seminar	1. Connecting SME/MSMEs to digital world is a major task at hand as for them the cost is still higher and many are not aware of the government schemes for support. 2. Emphasis on skill development and safety and standardisation related to Industry 4.0. 3. Digitization will empower the women workforce and prepare them for more challenging tasks. 4. Government funding schemes for Pilot projects at small & medium level enterprises can improve the overall performance. 5. A lot of work at cluster level is required for the adoption of technology. 6. Industry to R&D labs connect needs to be more strategic and strong.

Annexure I: Programme copy

SESSION ON INDUSTRY 4.0 - THE INDIAN PERSPECTIVE

Date   :   15 March 2019

Time   :   1000 hrs

Venue   :   Conference Room E, Hall 2 & 3, Chennai Trade Centre, Chennai

Programme Schedule:

1000 hrs	Registration
1030 hrs	Inaugural Session
1030 hrs	Welcome Address by Shri Rakesh Shah, Chairman (PED), EEPC India
1035 hrs	Keynote Address by Ms. Sukriti Likhi, Joint Secretary, Department of Heavy Industry, Government of India
1050 hrs	Moderator will give introductory remarks and set the tone of the session
1100 hrs	Shri P. J. Mohanram, Senior Advisor, Indian Machine Tools Manufacturers' Association (IMTMA)
1107 hrs	Ms. Uma Balakrishnan, CEO, Axcend Automation & Software Solutions Pvt. Ltd., on Industry 4.0 - Navigator for VUCA world

Technical Talks by Industry 4.0 Technology providers	
1114 hrs	Talk by Dr. Nagahanumaiah, Director, CMTI Bangalore on "Internet of Things for Smart Manufacturing"
1124 hrs	Talk by Mr. Adish Kunhiraman on "Trends in Additive Manufacturing"
Success Stories	
1134 hrs	Shri S. Divakar, General Manager Sales, Southern Region, Siemens Ltd.
1141 hrs	Dato' Madani Sahari, CEO of MARii, Malaysia Automation Robotics & IOT Institute (MARii)
1150 hrs	Panel Discussion Moderated by Shri Rakesh Shah, Chairman (PED), EEPC India
1220 hrs	Concluding Remarks by Shri P R Venkatachalam, WC Member, EEPC India

Annexure II: Speaker list and contact details

Name of organisation	Name of Contact Person	Designation	email	Phone
CMTI	Dr. Nagahanumaiah	Director	director.cmti@nic.in	+91 80 22188263, 80 23372048
		PS To Director	directorate.cmti@nic.in	+91 80 22188227
IMTMA	Mr. P. J. Mohanram	Senior Advisor	imtma@imtma.in; anbu@imtma.in; srikanth@imtma.in; mohanram@imtma.in	9886331677
IIT Delhi	Dr. Sunil Jha	Professor	suniljha@mech.iitd.ac.in	+91-11-26591125, +919958198399
Axcend Automation & Software Solutions Pvt. Ltd.	Ms. Uma Balakrishnan	CEO	uma@axcend.com	9845030363
Siemens Ltd.	Mr. S. Divakar	General Manager Sales, Southern Region	s.divakar@siemens.com	9940647779
MARii (Malaysian Automotive, Robotics & IoT	Dato' Madani Sahari	CEO	madani@marii.my	+60383187742

institute				
ALTEM	Mr. Adish Kunhiraman	Specialist	adish.kunhiraman@altem.com	

Annexure III: Copies of the presentations

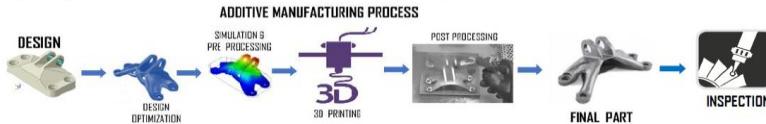## Presentation Copy 1

3D PRINTING AND APPLICATIONS

3D Printing is t...on or addition of material direct...

3D Printing is a process within Additive Manufacturing.

...ve Manufacturing ?

ADDITIVE MANUFACTURING PROCESS

DESIGN → DESIGN OPTIMIZATION → SIMULATION & PRE-PROCESSING → 3D PRINTING → POST PROCESSING → FINAL PART → INSPECTION

Choosing the Correct Design Techniques, Fit for application materials, printing process, pre and post process method defines the success of the job.

Frost & Sullivan: Technology Innovation 2017   India SME 100 2014

PROTOTYPING
50-60%

TOOLING
10-20%

MANUFACTURING
<2-3%

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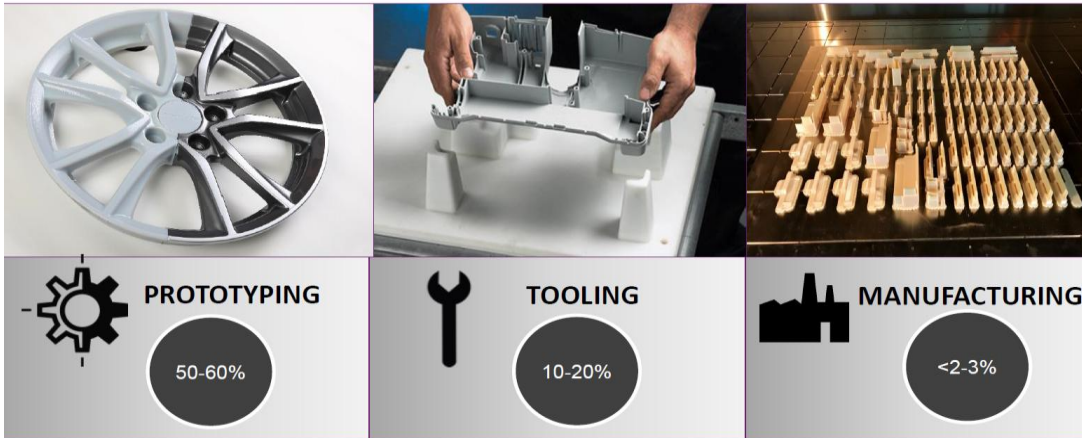
stratasys

Over **30** Technology & Leadership Awards

51% of all industrial units and 28% of all desktop units sold in 2015 were from Stratasys.
Source: Wohler's Report

Head Quartered in
Minnesota, USA & Rehovot, ISRAEL
Over 800 granted / pending patents globally
Publicly traded on NASDAQ (SSYS)

SLM SOLUTIONS

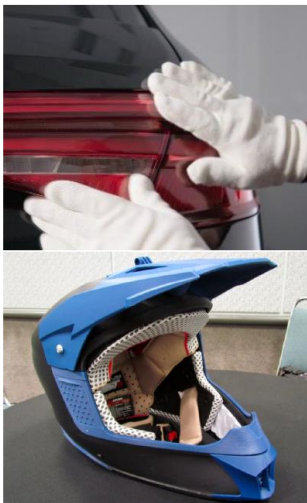Based Lubeck, Germany
Known for High Speed
Open Material Strategy

SLM Solutions

Functionality
Speed
Surface finish
Accuracy
Performance

Rapid Prototyping (Form RPT to Functional Product Realizm)

Rapid Tooling

Rapid Manufacturing

POLYMER AM SOLUTION (FDM AND POLYJET)
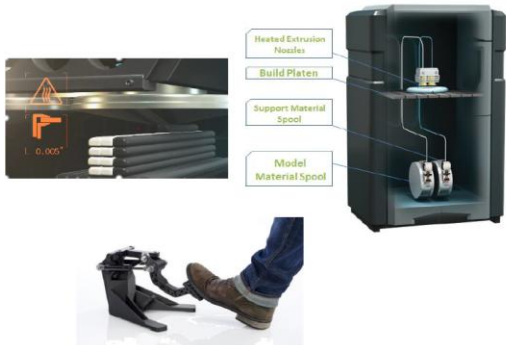
ALTEM TECHNOLOGIES

Fused Deposition Modelling – Polymer AM

Fused Deposition Modeling:

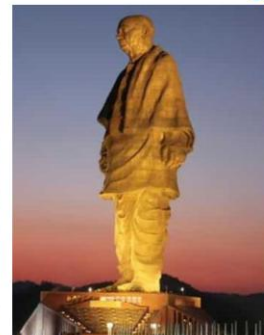Thermoplastic filament is heated to a semi-liquid state and extruded across computer-controlled tool paths to build parts layer-upon-layer.

Heated Extrusion Nozzles
Build Platen
Support Material Spool
Model Material Spool

ALTEM TECHNOLOGIES

Helping Build the Worlds Tallest Statue

TALLEST OF THEM ALL

HOW THE STATUE WILL COMPARE WITH OTHER WORLD MONUMENTS

Statue of Unity INDIA 182

Spring Temple of Buddha CHINA 153

Ushiku Daibutsu JAPAN 120

Statue of Liberty USA 93

Homeland-Mother RUSSIA 85

Christ the Redeemer BRAZIL 38
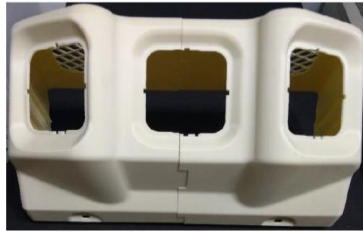
Our Specialized expertise and state of the art modelling tools coupled with complicated models done through Stratasys Printers, let us deliver boundary –pushing innovations and technical challenges unique to tall buildings
- M.S. Prakash , Director – RWDI India

Ashok Leyland- Meeting Critical CMVR Deadlines with AM

Blower Cover Development to meet CMVR Regulation on Time

Conventional Method
~60 DAYS

In-house 3DPrinting

67 hrs.

Development Time saving (Approx.)

3D Printing - Development Time Savings			
Total Parts Printed	Conventional Method (Days)	3D Printing (Days)	Time Saving (Days)
73	4277	75	4202

"3D Printing helps to develop new concepts quickly and reduces the development time significantly."

Ashok Leyland

Frost & Sullivan: Technology Innovation 2017   India SME 100 2014

Polyjet Modelling – Polymer AM

Coloured Component Formed by Digital mixing of Opaque Coloured Components

Polyjet Modeling:

Photo polymeric Plastic is jet through a series of nozzles and cured using UV Light.

Connex and J750 Polyjet Series can create Multi material/Multi color parts

Coloured Rubber Like component formed by mixing of elastomeric material with rigid coloured material.

Rubber Like component: Shore Hardness of 27-90 can be achieved

Frost & Sullivan: Technology Innovation 2017   India SME 100 2014

Polyjet Materials
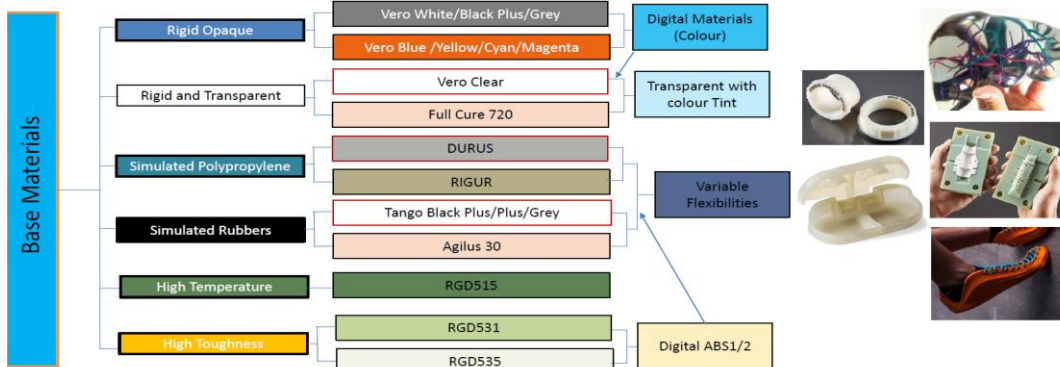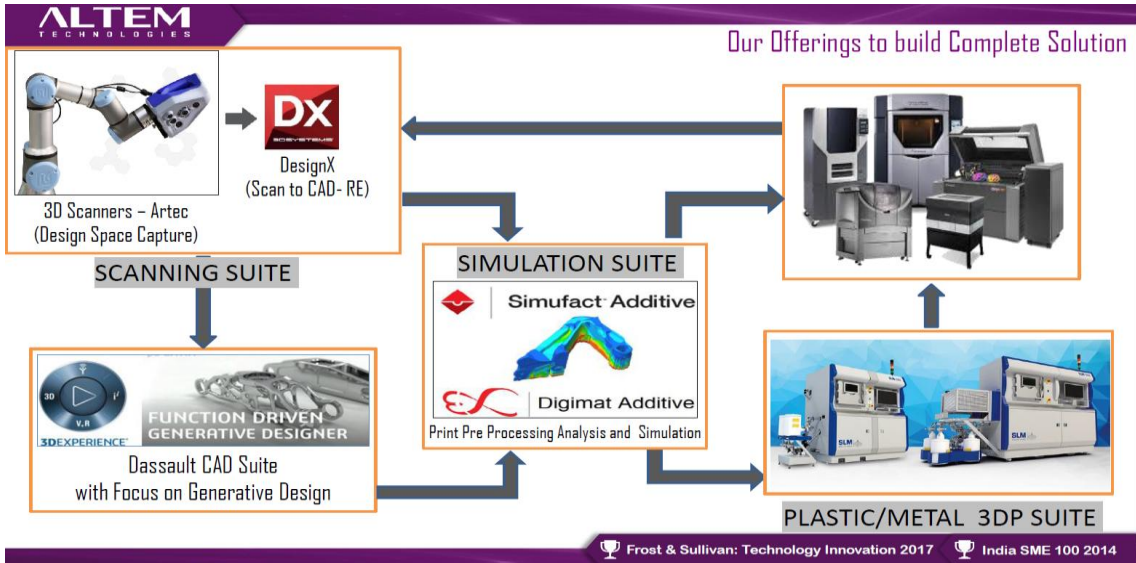
Base Materials			
Rigid Opaque	Vero White/Black Plus/Grey	Digital Materials (Colour)	
	Vero Blue /Yellow/Cyan/Magenta		
Rigid and Transparent	Vero Clear	Transparent with colour Tint	
	Full Cure 720		
Simulated Polypropylene	DURUS		
	RIGUR	Variable Flexibilities	
Simulated Rubbers	Tango Black Plus/Plus/Grey		
	Agilus 30		
High Temperature	RGD515		
High Toughness	RGD531	Digital ABS1/2	
	RGD535		

Frost & Sullivan: Technology Innovation 2017   India SME 100 2014

Presentation Copy 2

Digitalization Concept –Industry 4.0

Efficiency driving Qualitative production

Unrestricted © Siemens AG 2018

**Pace of disruption has increased exponentially
as Digital technologies have a huge reach**

Digital technologies have a huge reach ...

... and are spreading more and more quickly

For every 100 people in the world, there are ...

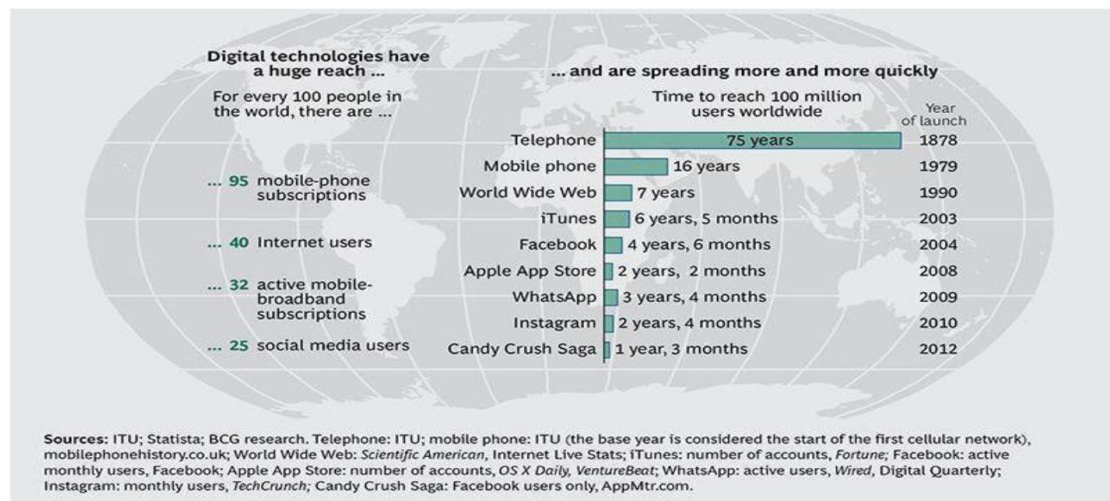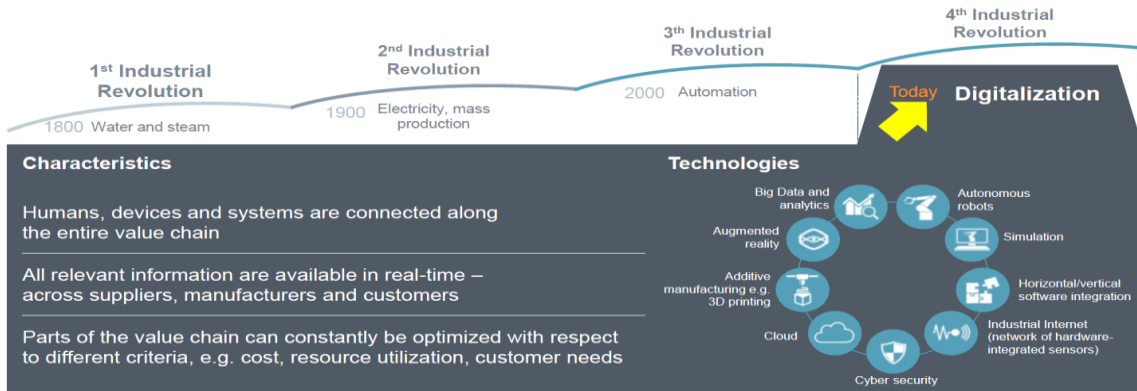|	Time to reach 100 million users worldwide	Year of launch
Telephone	75 years	1878
Mobile phone	16 years	1979
World Wide Web	7 years	1990
iTunes	6 years, 5 months	2003
Facebook	4 years, 6 months	2004
Apple App Store	2 years, 2 months	2008
WhatsApp	3 years, 4 months	2009
Instagram	2 years, 4 months	2010
Candy Crush Saga	1 year, 3 months	2012

... 95 mobile-phone subscriptions

... 40 Internet users

... 32 active mobile-broadband subscriptions

... 25 social media users

Sources: ITU; Statista; BCG research. Telephone: ITU; mobile phone: ITU (the base year is considered the start of the first cellular network), mobilephonehistory.co.uk; World Wide Web: *Scientific American*, Internet Live Stats; iTunes: number of accounts, *Fortune*; Facebook: active monthly users, Facebook; Apple App Store: number of accounts, *OS X Daily*, *VentureBeat*; WhatsApp: active users, *Wired, Digital Quarterly*; Instagram: monthly users, *TechCrunch*; Candy Crush Saga: Facebook users only, AppMtr.com.

Unrestricted © Siemens AG 2018

Industry 4.0 – The next level of manufacturing towards driving the Digital Transformation

SIEMENS
Ingenuity for life

1st Industrial Revolution
2nd Industrial Revolution
3th Industrial Revolution
4th Industrial Revolution

2000 Automation
Today **Digitalization**

1900 Electricity, mass production

1800 Water and steam

Characteristics

Humans, devices and systems are connected along the entire value chain

All relevant information are available in real-time – across suppliers, manufacturers and customers

Parts of the value chain can constantly be optimized with respect to different criteria, e.g. cost, resource utilization, customer needs

Technologies

- Big Data and analytics
- Augmented reality
- Additive manufacturing e.g. 3D printing
- Cloud
- Autonomous robots
- Simulation
- Horizontal/vertical software integration
- Industrial Internet (network of hardware-integrated sensors)
- Cyber security

Siemens customer survey on digitalization, published on July 21, 2015

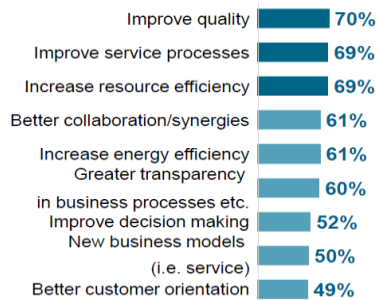**SIEMENS**
Ingenuity for life

What benefits do respondents expect to gain from digitalization?
Digital technologies can transform processes, products, services and also spawn new business models

Majority use digitalization to improve quality, service and resource efficiency

Every second respondent uses digitalization to develop new business models

Benefit	%
Improve quality	70%
Improve service processes	69%
Increase resource efficiency	69%
Better collaboration/synergies	61%
Increase energy efficiency	61%
Greater transparency in business processes etc.	60%
Improve decision making	52%
New business models (i.e. service)	50%
Better customer orientation	49%

Digital barriers
What's holding respondents back from greater implementation of digital technologies?
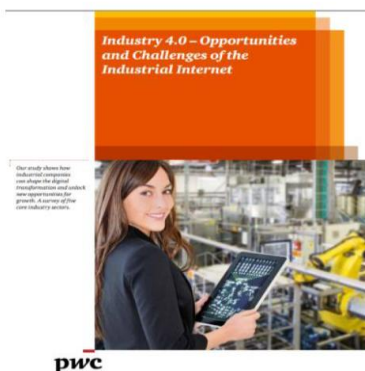
46% Lack of technical standards

41% Unclear benefit

39% Concerns about data security

Industrialized world invests in Digitalization to further increase productivity gap to rest of the world…

SIEMENS
Ingenuity for life

Industry 4.0 – Opportunities and Challenges of the Industrial Internet

pwc

Survey of 235 companies from 5 sectors in Germany

- By 2020, European Industrial companies **will invest €140 billion annually** in Industrial Internet applications
- In 5 years, **> 80% of companies will have digitalized value chain**
- The industrial internet creates better productivity and resource efficiency- **an 18%increase in efficiency within 5 years**
- Digitalized products and services **generate approx. €110 billion of additional revenues per year** for the European industry

The Industrial Internet transforms the entire company and must be part of the CEO agenda

Source: PriceWaterhouseCooper Report

Digitalization addresses core needs of the manufacturing boosting competitiveness and driving growth

Reducing time-to-market
- shorter innovation cycles
- more complex products
- bigger but smarter data volumes

Enhancing flexibility
- customization availability
- diversified market
- highest productivity

Quality
- closed-loop quality processes
- traceable products
- meeting legal requirements
- highest quality standards

Increasing efficiency
- optimal capacity utilization
- efficient resource utilization

Security
- digitalization leads to increasing vulnerability to cyber attacks
- increased need for appropriate security measures

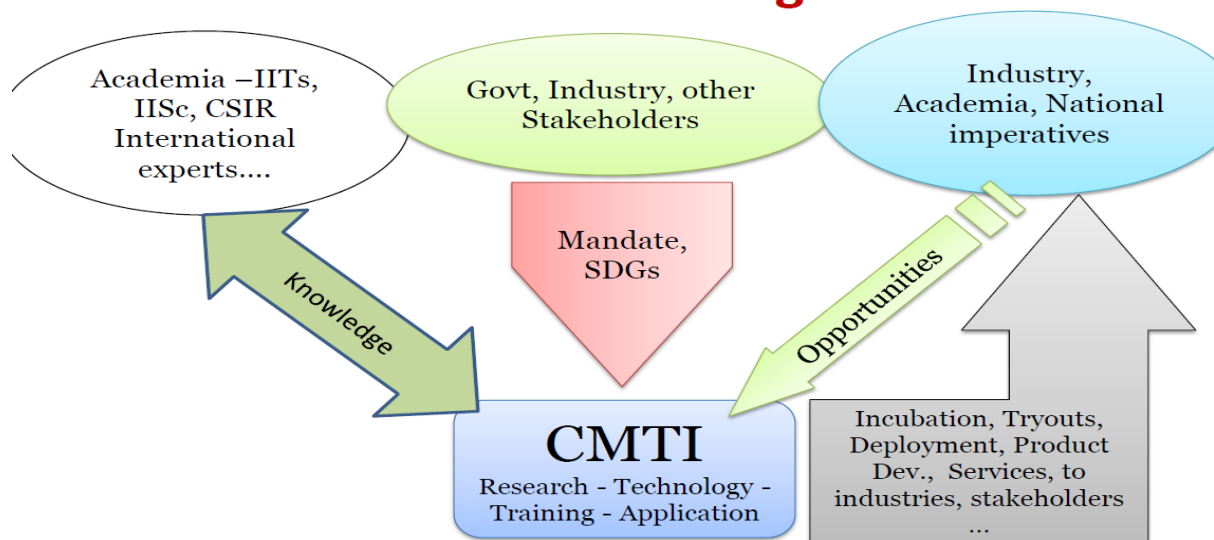# Siemens Ltd. transforms manufacturing process by Digitalization – Today Low Voltage Switchgear @ Kalwa Works

Before Digital Transformation….

>77 product variants manufactured in **3** lines

~21 secs cycle time on **3** different lines

22 Quality parameters check in **60** secs

Local for **Local** market

After Digital Transformation….

>180 product variants manufactured in **1** line

~9 secs cycle time inspite of varied product-mix

68 Quality parameters check in **9** secs
(Including dynamic behavior)

Local for **Local** & **Global** market

Unrestricted © Siemens AG 2018

Presentation copy 3

Internet of Things (IoT) for Manufacturing

Dr. Nagahanumaiah
Director, CMTI

CMTI Focus
Machines and Manufacturing Processes

- Academia –IITs, IISc, CSIR International experts....
- Govt, Industry, other Stakeholders
- Industry, Academia, National imperatives
- Knowledge
- Mandate, SDGs
- Opportunities
- **CMTI** Research - Technology - Training - Application
- Incubation, Tryouts, Deployment, Product Dev., Services, to industries, stakeholders ...

Research-Technology-Training-Application

What CMTI Would Offer

We Undertake Research, Develop Technologies and Machines,
Train Manpower and Deploy into Industrial Applications

Ultra Precision Machine Tools
Special Purpose Machines
Sensors and Controllers
Textile Machinery
Aircraft LRUs and Test Rigs
Precision Metrology
Smart Manufacturing and Industry 4.0
Additive Manufacturing
Industry Employable Manpower (Skilling & Reskilling)
Technology Transfer and Incubation

MADE – IN – INDIA

Smart Machines & Aggregates -Metal Cutting

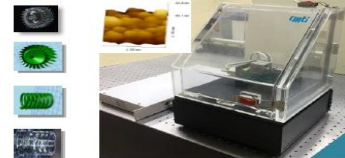Intelligent Ultra Precision Turning Machine

Ultra Stiff Ultra Precision Diamond Turning Machine
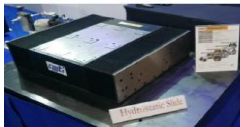
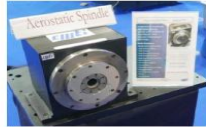Projection Microstereo lithography

Scanning Tunnelling Microscope

Ultra Precision Machine Tool Sub-Systems

Hydrostatic Slide

Aerostatic Spindle

Spindle Error Analyzer

Nano Finishing

Abrasive Flow Finishing Machine

Manufacturing & Fabrication Solutions

Micro Mold & Needle y

Micro machining & spiral grooving of special alloy components

Surface Engineering

DLC coated germanium lens, cutting tools and surgical blades

Design & Development-SPMs

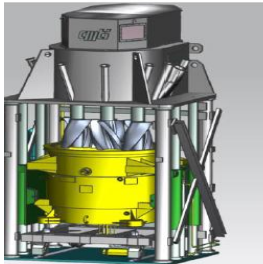Centreless grinding machine for Automobile industry

Perch on facing & boring machine for ship building industry

Flexible multi gauging inspection system

Parallel Kinematics Machine

Vertical Planetary Mixing Machines - upto 5 ton

Single and double cutter head Centerless Bar Turning Machine

Performance Test Rig for Pumps

Product Development

High Speed Rapier Loom - 450
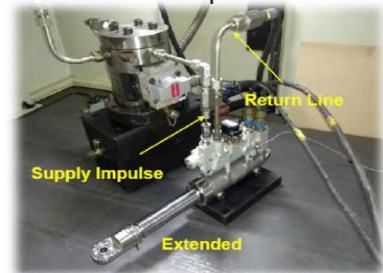
Twin Screw Continuous

Hydraulic Filters

Battery operated hydraulic system to charge parking brake accumulator of aircraft
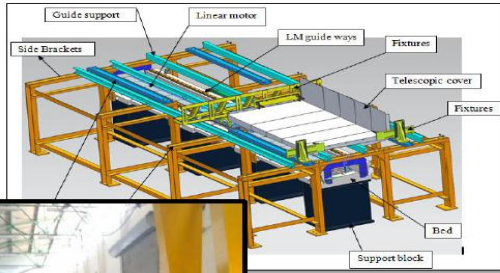
Pressure Endurance tester

Pressure Impulse Test

Test Rigs for Machine Tool Testing

CMTI
www.cmti-india.net

Telescopic Cover Test Rig performance evaluation of telescopic covers of machine tool slides

Electro Hydraulic Force Exciter Dynamic behaviour study of machine tools and structures

Spindle Test Rig for performance testing

Vision Based Solutions

CMTI

MEDICAL INDUSTRY	AUTOMOTIVE INDUSTRY
AUTOMATED INSPECTION OF SURGICAL SCREW FOR M/S ADLER MEDIEQUIP PVT LTD	**AUTOMATED INSPECTION OF RETAINING BUSH FOR M/S FINE TOOLS INDIA PVT LTD**

➢Dimensional Measurements 636 sizes of 30 features each
➢Inspection Accuracy: 5-7 μm.

Defects identified in injection mould component
  ➢ Flash
  ➢ Cracks
  ➢ Black spots
  ➢ Color variation
  ➢ Missing feature
➢Inspection rate of 3 p/ sec

AGRO INDUSTRY

AUTOMATED INSPECTION OF DRIPPERS FOR M/S UDYOGI INDUSTRIES
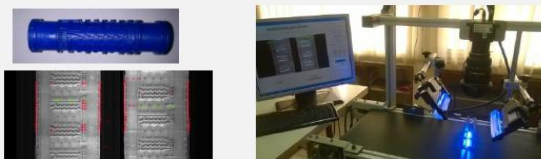
➢Detection of blocked holes, root flash & collar flash, broken edges, circularity of top and bottom sections
➢Inspection rate of 600 p/ min

ENGRAVED LABEL INSPECTION ON SCOOTER FRAME AND BARREL COMPONENT

M/s Forbes India (P) Ltd   M/s Mico Bosch (P) Ltd

Additive Manufacturing

CMTI
www.cmti-india.net

Remanufacturing of Turbocharger for M/s Cummins Pune

Remanufacturing of Pump Gear Shaft for HAL Engine Div. Bangalore

Bi-metallic parts deposition (Steel on Al-Bronze) by DMD

Mould for Ball Bearing Retainer

Mould for Ball Bearing Retainer

Material: Steel

Built time : 4 hr

Honey Comb type Orifice (DMLS)

Honey Comb Orifice Plate for fluid flow control in Nuclear application

Material: Steel

Built time : 9 hr

Model of Aircraft by Direct laser metal sintering

Made in India

Need:
- Bridging the Technology Gap
- Factoring Sectorial developments into Mfg.
- Adoption of latest technologies
- Driving Innovation
- Game changing
- Sustainable / Green Mfg.
- Skill development

Transformation:
- Support for Capital Goods Sector
- Support for Strategic Sector
- Embracing futuristic Technologies
- Enhancing scientific & technical expertise
- Augmentation & upgradation of facilities
- Up scaling of operations

Research –Technology Development – Training (Machine and Manufacturing Processes)

Micro & Nano
Manufacturing Innovation

Design
Innovation

Smart
Manufacturing

Fluid Power Test Rig & Product
Development

CMTI

Additive
Manufacturing

Skill
Development

Automation & Machine Vision
for Advanced Mfg

Sensor Technology

Improvement to Infrastructure (II&AA)

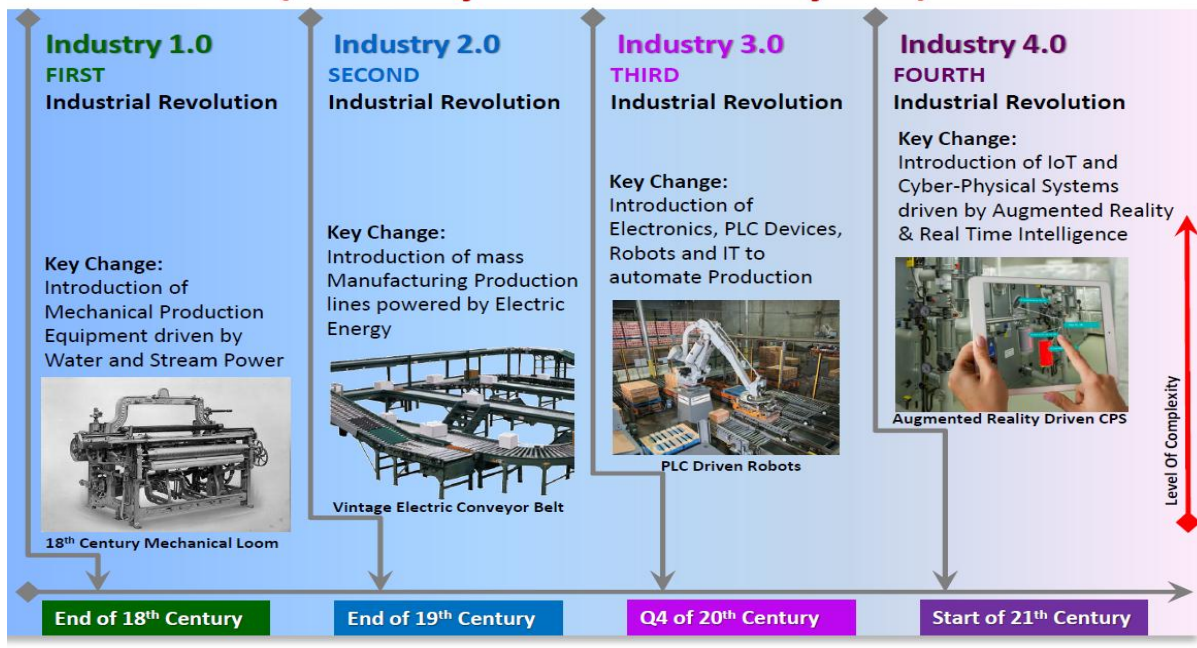Outreach
Programmes

2017-2018-2019-2020-2021-2022-2024....

Key Initiatives 2018-2024

- Smart Manufacturing Design and Demonstration Center

- Center of Excellence for Textile Machinery

- Indian Institute of Innovative Manufacturing (I^{3}M)

- Design Innovation and Manufacturing Excellence

![CMTI logo](www.cmti-india.net)

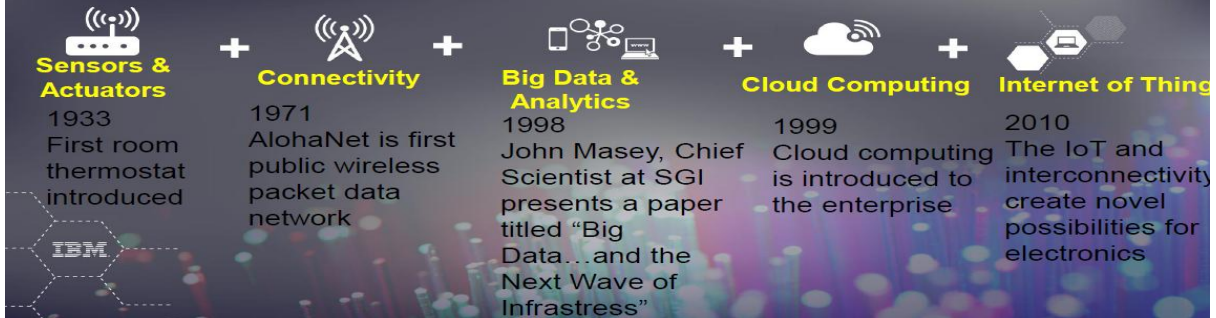# IoT – IIoT – Smart Manufacturing – Smart Factory
(The Manufacturing Revolution)

Competitive Advantage in Market

Innovation; Responsiveness; Cost Effective; First to Market

Smart Enterprises
Predict – Digitize and Share – Analytics – Automate

Manufacturing Revolution
(Industry 1.0 to Industry 4.0)

![CMTI logo](www.cmti-india.net)

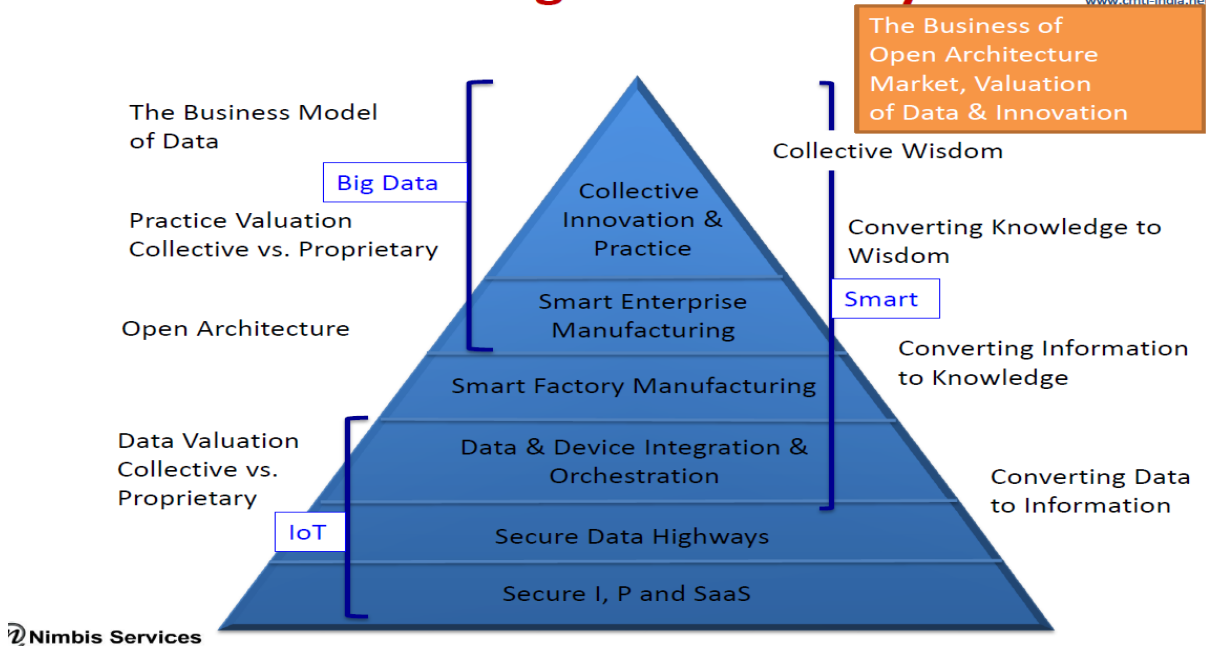| Industry 1.0 FIRST Industrial Revolution	Industry 2.0 SECOND Industrial Revolution	Industry 3.0 THIRD Industrial Revolution	Industry 4.0 FOURTH Industrial Revolution
			Key Change: Introduction of IoT and Cyber-Physical Systems driven by Augmented Reality & Real Time Intelligence
		Key Change: Introduction of Electronics, PLC Devices, Robots and IT to automate Production	
Key Change: Introduction of Mechanical Production Equipment driven by Water and Stream Power	Key Change: Introduction of mass Manufacturing Production lines powered by Electric Energy		Augmented Reality Driven CPS
		PLC Driven Robots	
18th Century Mechanical Loom	Vintage Electric Conveyor Belt		
End of 18th Century	End of 19th Century	Q4 of 20th Century	Start of 21th Century

Level Of Complexity

Electronics Innovation
IoT - IIoT – Smart Mfg. – Smart Factory

These "smart, connected products"—made possible by vast improvements in processing power and device miniaturization and by the network benefits of ubiquitous wireless connectivity—have unleashed a new era of competition."

Sensors & Actuators
1933
First room thermostat introduced

+

Connectivity
1971
AlohaNet is first public wireless packet data network

+

Big Data & Analytics
1998
John Masey, Chief Scientist at SGI presents a paper titled "Big Data…and the Next Wave of Infrastress"

+

Cloud Computing
1999
Cloud computing is introduced to the enterprise

+

Internet of Thing
2010
The IoT and interconnectivity create novel possibilities for electronics

IBM

Smart Manufacturing Sustainability

The Business of Open Architecture Market, Valuation of Data & Innovation

The Business Model of Data

Big Data

Practice Valuation Collective vs. Proprietary

Open Architecture

Data Valuation Collective vs. Proprietary

IoT

Pyramid (top to bottom):
- Collective Innovation & Practice
- Smart Enterprise Manufacturing
- Smart Factory Manufacturing
- Data & Device Integration & Orchestration
- Secure Data Highways
- Secure I, P and SaaS

Collective Wisdom

Converting Knowledge to Wisdom

Smart

Converting Information to Knowledge

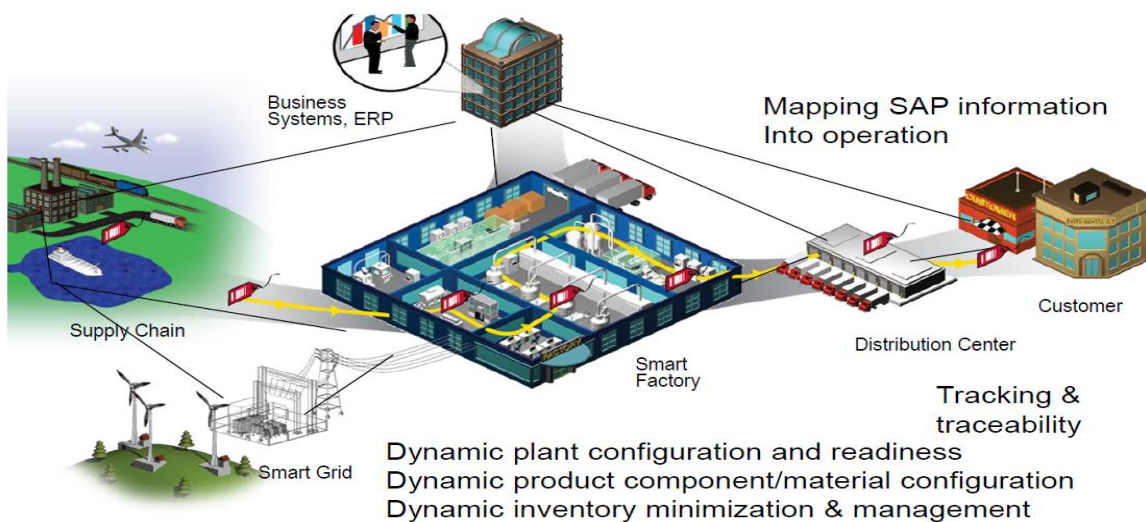Converting Data to Information

Nimbis Services

IoT + Big Data = IIoT

- **Internet of Things (IoT):** Devices with electronics and sensors connected to public telecome network and internet

- **Big Data:** Large data sets that may be analyzed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions.

- **Industrial Internet of Things:** A network of physical objects, systems, platforms and applications that contain embedded technology to communicate and share intelligence with each other, the external environment and with people.

- **IoT + Big Data = Industrial Internet**
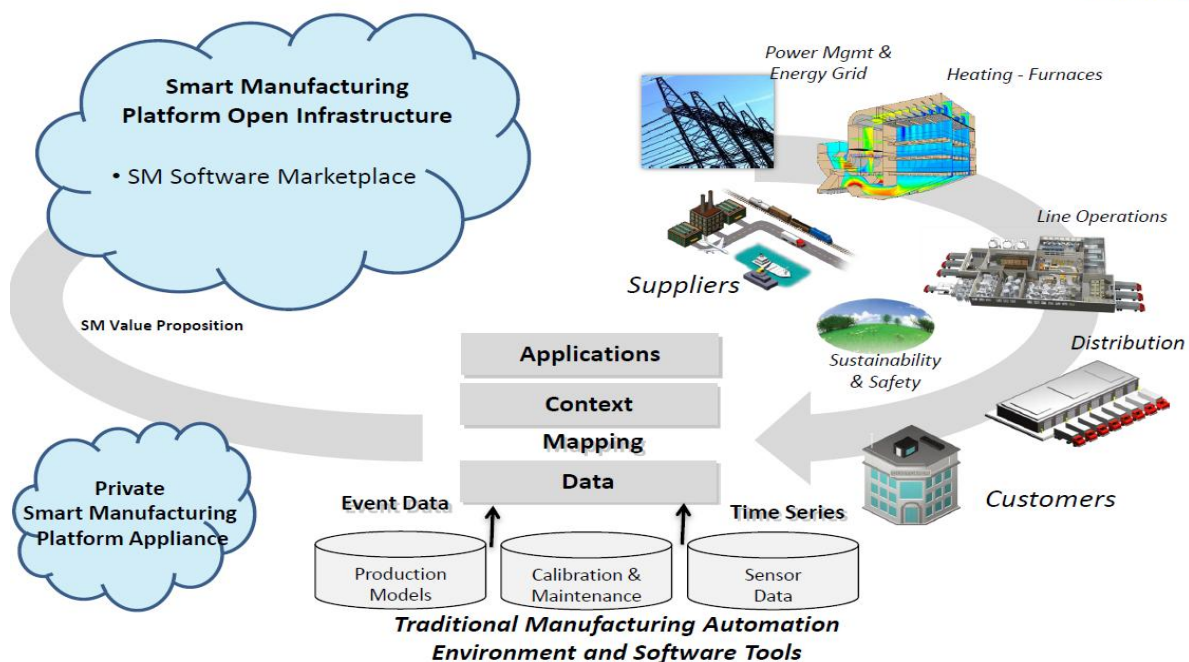
What is Smart Manufacturing?
Value Chain Network Based Manufacturing

Business Systems, ERP

Mapping SAP information Into operation

Supply Chain

Smart Grid

Smart Factory

Distribution Center

Customer

Tracking & traceability

Dynamic plant configuration and readiness
Dynamic product component/material configuration
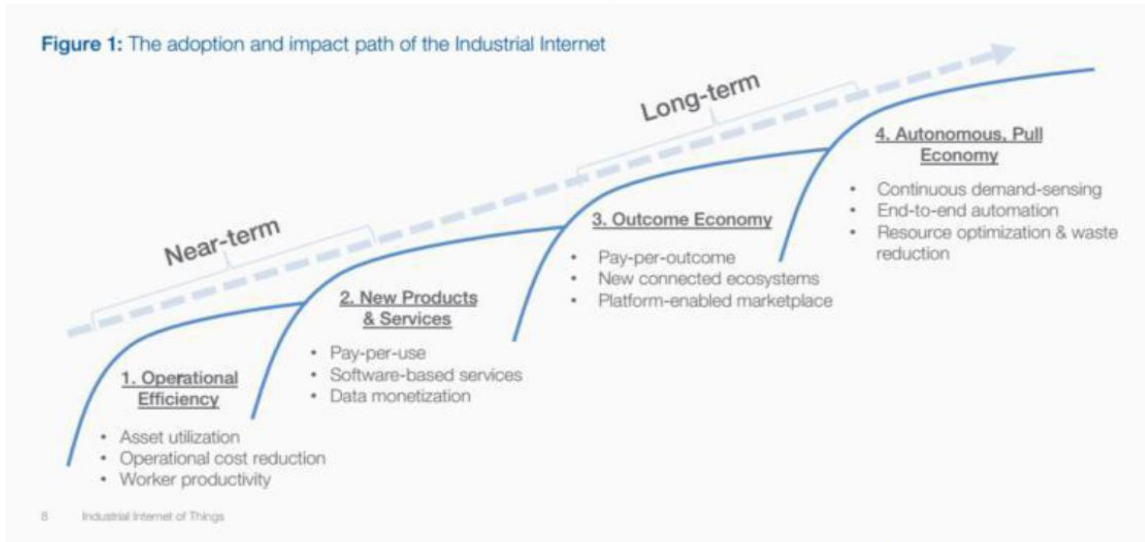Dynamic inventory minimization & management

Smartness in Manufacturing Value Chain

- **Smart Manufacturing Intelligence**
  - Deeper understanding of the manufacturing process through modeling and analysis
  - New capacity to observe and take action on integrated patterns of operation through networked data, information, analytics, and metrics
  - Dynamic management of energy and material resources

- **Smart Manufacturing Practice**
  - Generating and orchestrating the use of sensor-based, data-driven manufacturing intelligence
  - Applying integrated performance metrics constructed for real-time action
  - Reusing, scaling and repurposing integrated practice using a common infrastructure

- **Smart Manufacturing Execution**
  - Dynamic orchestration of decision/action workflows in heterogeneous environments without losing control of state
    - across different time constants and seams, including supply chain
    - multi-vendor discrete, continuous, operational and human/social applications
  - Applications that can share data and data that can share
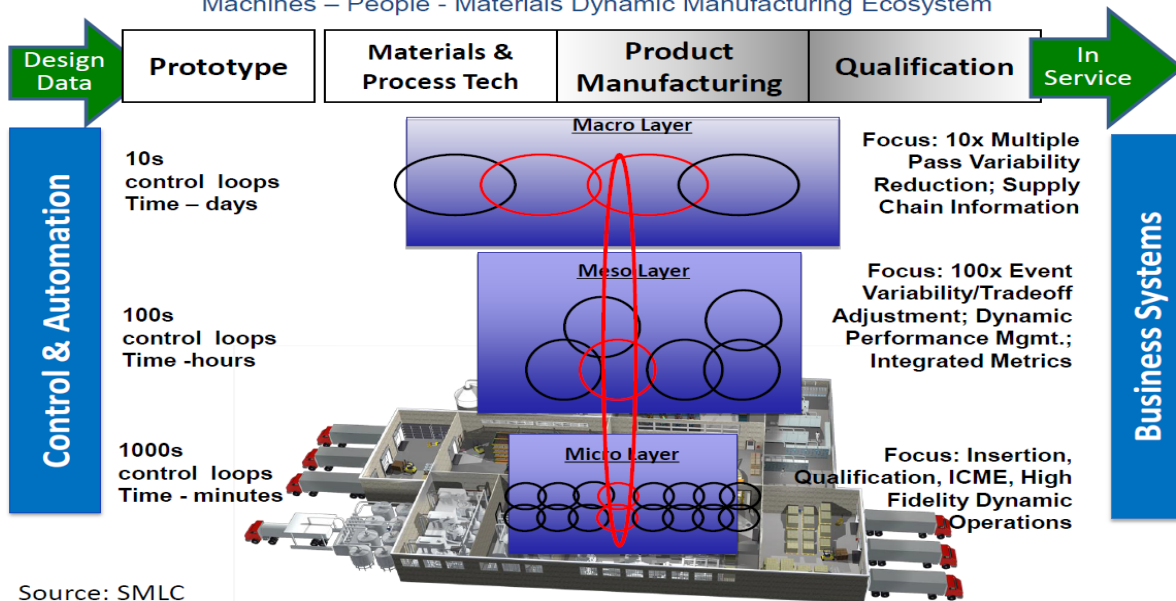
Smart Manufacturing Ecosystem

Smart Manufacturing Platform Open Infrastructure

- SM Software Marketplace

SM Value Proposition

Private Smart Manufacturing Platform Appliance

Power Mgmt & Energy Grid

Heating - Furnaces

Suppliers

Line Operations

Sustainability & Safety

Distribution

Customers

Applications

Context

Mapping

Data

Event Data

Time Series

Production Models

Calibration & Maintenance

Sensor Data

Traditional Manufacturing Automation Environment and Software Tools

IIoT Integration

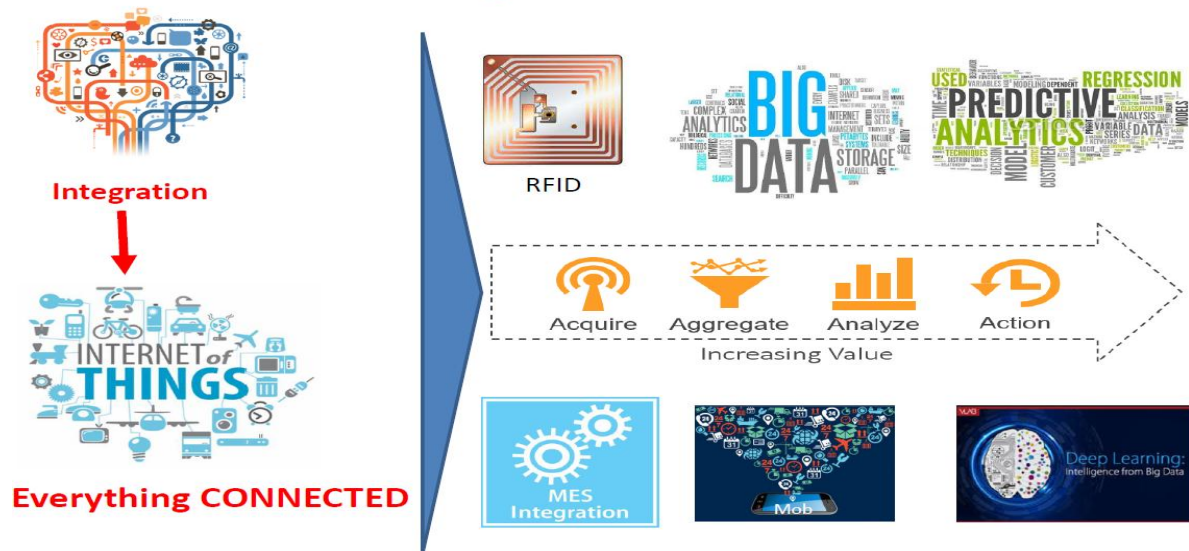**Figure 1:** The adoption and impact path of the Industrial Internet

World Economic Forum Agenda 2015, Accenture. Industrial Internet of Things: Unleashing the Potential of Connected Products and Services. January 2015

Smart Manufacturing: Multi-Layered Seams, Time, Data & Action

Machines – People - Materials Dynamic Manufacturing Ecosystem

Source: SMLC

IIoT Integration means...

Integration

Everything CONNECTED

RFID

BIG DATA

PREDICTIVE ANALYTICS

Acquire   Aggregate   Analyze   Action

Increasing Value

MES Integration

Mob

Deep Learning: Intelligence from Big Data

SMART Foundry 2020 (2016–2020)

Sustainable Metalcasting by Advanced Research and Technology

Goal: Ultra-compact SMART Foundry, for sensor-driven automatic and economic production of small intricate metal parts with high quality

DST Sanction = Rs. 8,25,15,160   Industry Contribution = Rs. 1,25,00,000

PIs:
Dr. Savithri, NIIST, Trivandrum
Dr. Sudip Kr. Samanta, CMERI, Durgapur
Dr. A.M. Kuthe, VNIT, Nagpur
Dr. G. Sutradhar, Jadavpur Univ, Kolkata

Industry:
3D Foundry Tech Pvt Ltd., Mumbai
Atomberg Technologies Pvt. Ltd., Mumbai
Aha 3D Pvt. Ltd., Jaipur
Marcopolo Products Pvt. Ltd., Kolkata
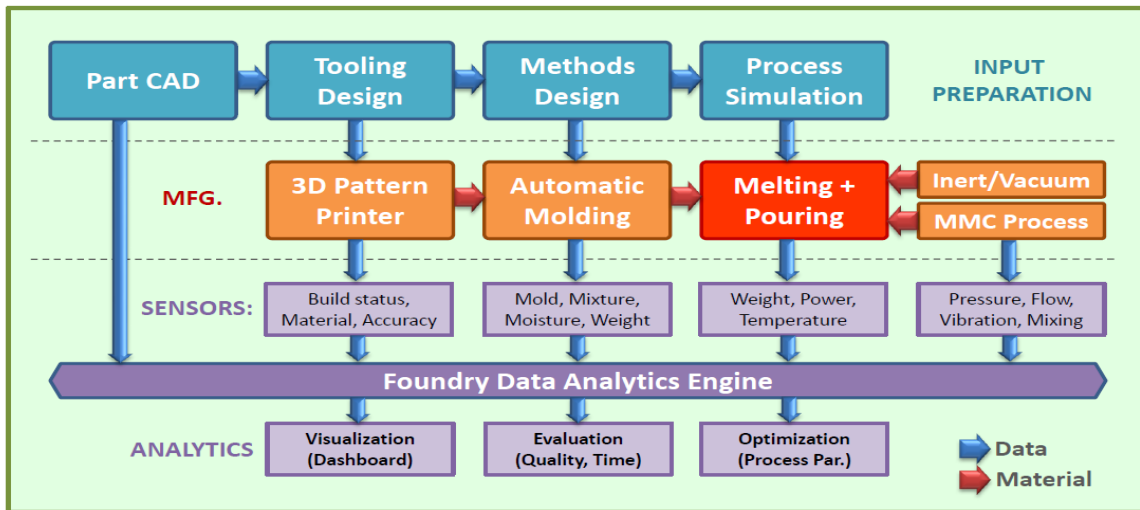TREELabs Foundation, Mumbai

Co-PIs:
Dr. Arati V. Mulay, College of Engg., Pune
Dr. Amit Sata, MEF College, Rajkot
Dr. Atul Sharma, IIT Bombay, Mumbai
Dr. Elizabeth Jacob, NIIST, Trivandrum
Dr. J.V.L. Venkatesh, SGGS Inst., Nanded
Dr. Mayur Sutaria, CHARUSAT, Anand
Dr. Shyam Karagadde, IIT Bombay, Mumbai
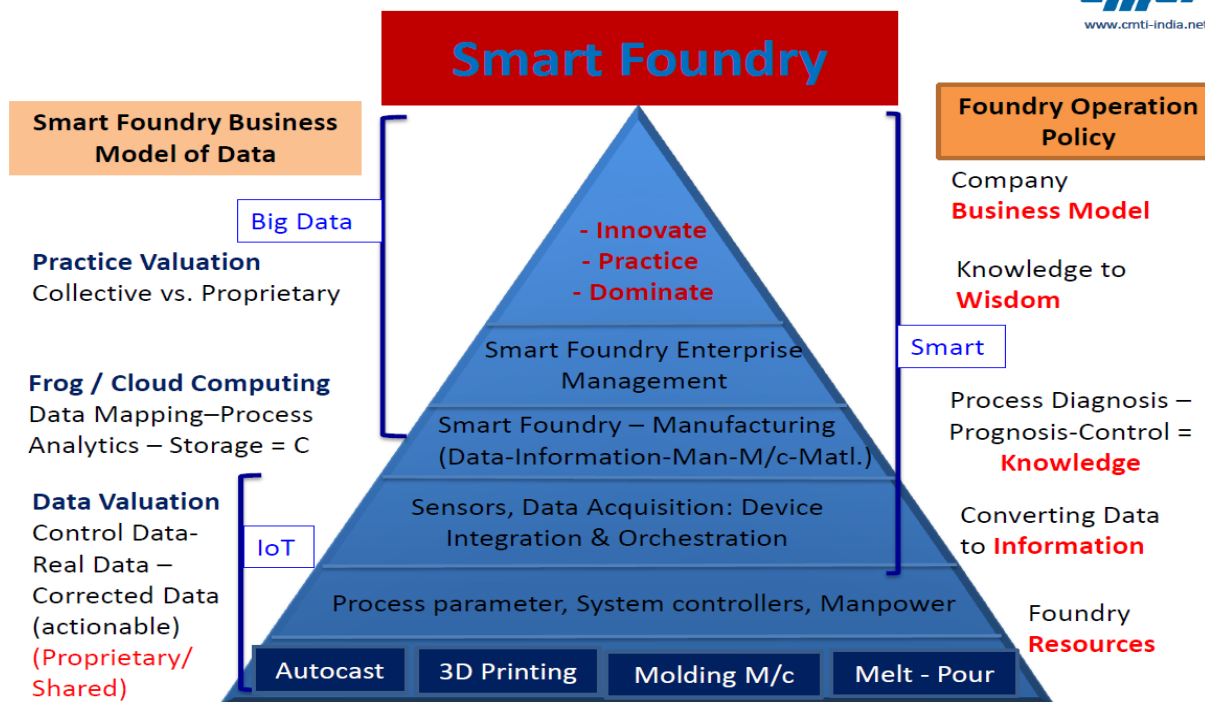Dr. Vasudev Shinde, DKTE TEI, Ichalkaranji

Mentors: Prof. B. Ravi, IIT Bombay
Dr. Nagahanumaiah, CMTI Bangalore
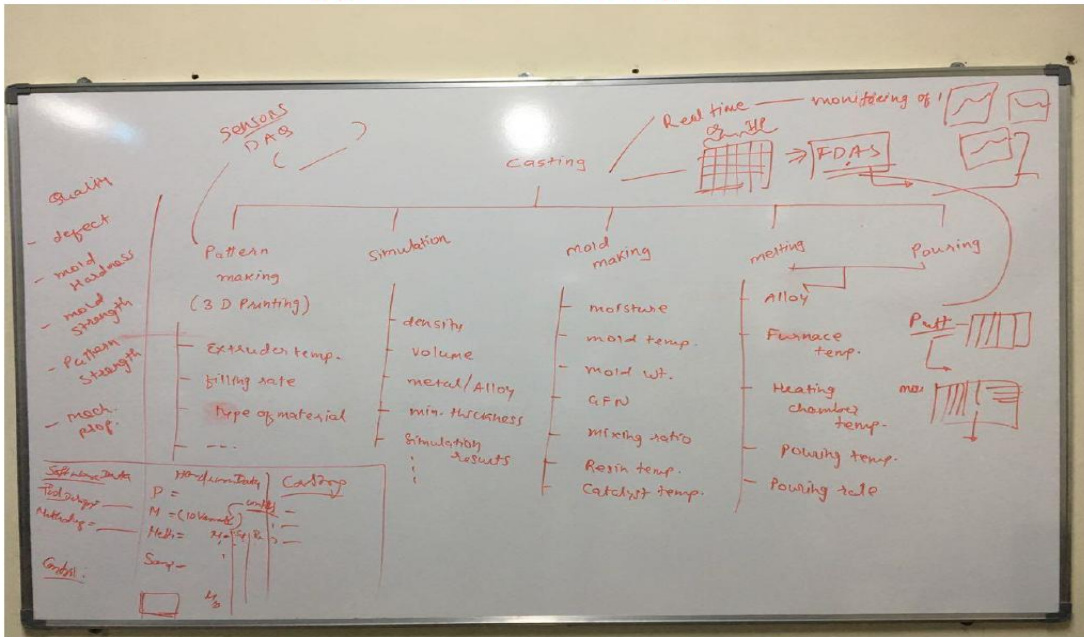
Proposed SMART Foundry 2020

CMTI
www.cmti-india.net

Sustainable Metalcasting by Advanced Research and Technology

Part CAD	→	Tooling Design	→	Methods Design	→	Process Simulation	INPUT PREPARATION

MFG.

3D Pattern Printer	→	Automatic Molding	→	Melting + Pouring	←	Inert/Vacuum
					←	MMC Process

SENSORS:

Build status, Material, Accuracy	Mold, Mixture, Moisture, Weight	Weight, Power, Temperature	Pressure, Flow, Vibration, Mixing

Foundry Data Analytics Engine

ANALYTICS

Visualization (Dashboard)	Evaluation (Quality, Time)	Optimization (Process Par.)

→ Data
→ Material

Adding intelligence to manufacturing using Cloud, Big Data (from sensors) and Analytics

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CMTI
www.cmti-india.net

Smart Foundry

Smart Foundry Business Model of Data

Big Data

Practice Valuation
Collective vs. Proprietary

Frog / Cloud Computing
Data Mapping—Process
Analytics — Storage = C

Data Valuation
Control Data-
Real Data —
Corrected Data
(actionable)
(Proprietary/
Shared)

IoT

- Innovate
- Practice
- Dominate

Smart Foundry Enterprise Management

Smart Foundry — Manufacturing
(Data-Information-Man-M/c-Matl.)

Sensors, Data Acquisition: Device
Integration & Orchestration

Process parameter, System controllers, Manpower

Autocast	3D Printing	Molding M/c	Melt - Pour

Foundry Operation Policy

Company
Business Model

Knowledge to
Wisdom

Smart

Process Diagnosis —
Prognosis-Control =
Knowledge

Converting Data
to **Information**

Foundry
Resources

Typical Foundry Data

Example: Automatic Molding Machine

Investor / Board

Customers

Manager

Software: Module -A
- Mold design data
- Pattern design
- Methoding results

Material Data
- Sand test data
- Resin properties
- Hardner property

Regularities

Machine & Controller

Melting & Pouring

Fettling & Sand Reclaim

Process Data Analytics

3D Printing Module –B1
- Pattern Actual data
- Pattern Material
- Non-functional data

Resources Machine Plant Utility

Machine Data Module –B2
- Working (Spec.) limits
- Operation data
- Real (Sensor) data

Smart Foundry Operation Version -1

cmti
www.cmti-india.net

Process Display Unit

SMART Foundry
Pattern Reached
Melt Ready
Temp.: 450
Level: 12

Fettling & Finishing

Melting and Gravity Casting

Castings with gates

Finished Casting

Sand Molds

Plastic Patterns

Design & Process Simulation

Methoding data

Tool design data

3D Printing of patterns

Smart Foundry Operation – V2

cmti
www.cmti-india.net

Casting Design & Methoding
(SS @ Trivendurm)

Board
(BR @ Mumbai)

Regularities
(@ New Delhi)

Process Data Analytics
Pre-production - (EJ @ Triv.)
Post production: (AS @ Gj)

Cloud

Sand Reclaimer & Quality Manager
(VS @ Kollhapur)

3D Printing of Pattern
(SS @ Trivendurm)

Mold Making
(CMERI @ Durgapur)

Melting casting
(Mayur @ Anand)

SAMARTH Udyog Bharat 4.0 Platform

A CEFC Under the Scheme on Enhancement of Competitiveness in
Indian Capital Goods Sector

www.samarthudyog-i40.in

- Smart Manufacturing Demo & Development Cell at CMTI
- IITD-AIA Foundation for Smart Manufacturing
- I4.0 India at IISc Factory R & D Platform
- Kirloskar Centre for Learning in Industry 4.0

DHI Sponsored Industry 4.0 Awareness Program
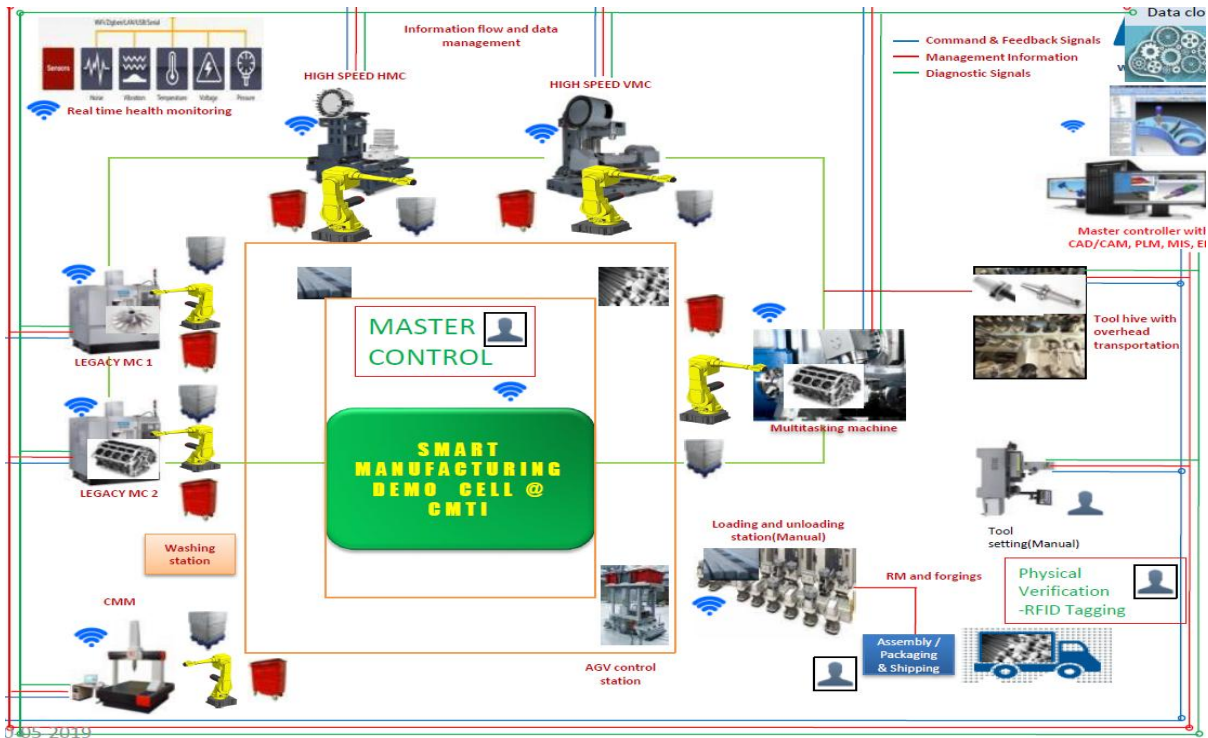
Smart Building Blocks for Legacy Machines - Mazak H400N – Legacy Machine

www.cmti-india.net

MAZAK H400N

MAKE	MAZAK
MODEL	H400N
Year of Manufacture	1996
Machine Type	4 Axis HMC
Control System	Siemens 828D

Sensors are plugged to Legacy Machine → Sensor data is sent to the IO Master → DATA is sent to Cloud and for further Analytics

Legacy Machine + IoT Gateway + Performance Manager

Scope : Smart Energy Management
Key Outcomes
➤Monitoring of Energy consumption
➤Distinguishing Idle energy and production energy
➤Power quality(Harmonic analysis done to ensure machine internal electrical health)
➤Cycle time analysis based on power signature
➤KPI such as Energy per piece and identify optimization potential through analytics to build a business case

➤Energy Monitoring
➤Spindle Health Monitoring
➤Machine Vibration Monitoring
➤Hydraulic unit Monitoring

➤Machine Cabinet Temp. Monitoring
➤Coolant pH and Refractive index Monitoring
➤Overall Machine Performance-OEE

IOT Enabled SMART Metal Cutting Machine

www.cmti-india.net

Empower a Legacy Machine with Smart features to improve process efficiency

Sensor Modules

- Temperature : spindle coolant Temp.
- Pressure : Spindle coolant pressure
- Vibration : Machine health
- Evaluate TcP (tool center point) drift
- Energy : Downtime of the machine
- Vision : In-situ inspection / Quality

Benefits

- IOT enabled connected machine
- Remote access of machine health and process data
- Real time Machine health monitoring
- Predictive machine maintenance
- Energy monitoring
- Better process control
- Improved part quality
- Reduced machine down time

Implementation Scheme

Machine

RTD PT100 sensors

Thermal Analog

LEM Current Transducer

Current Analog

Accelerometer

Accelerometer Analog

Pressure

Pressure Analog

Computer Vision

RS 232 Dataset

Local Edge Controller

Upload Controller

Serial Communication

Webserver

Cloud Storage

Dashboard
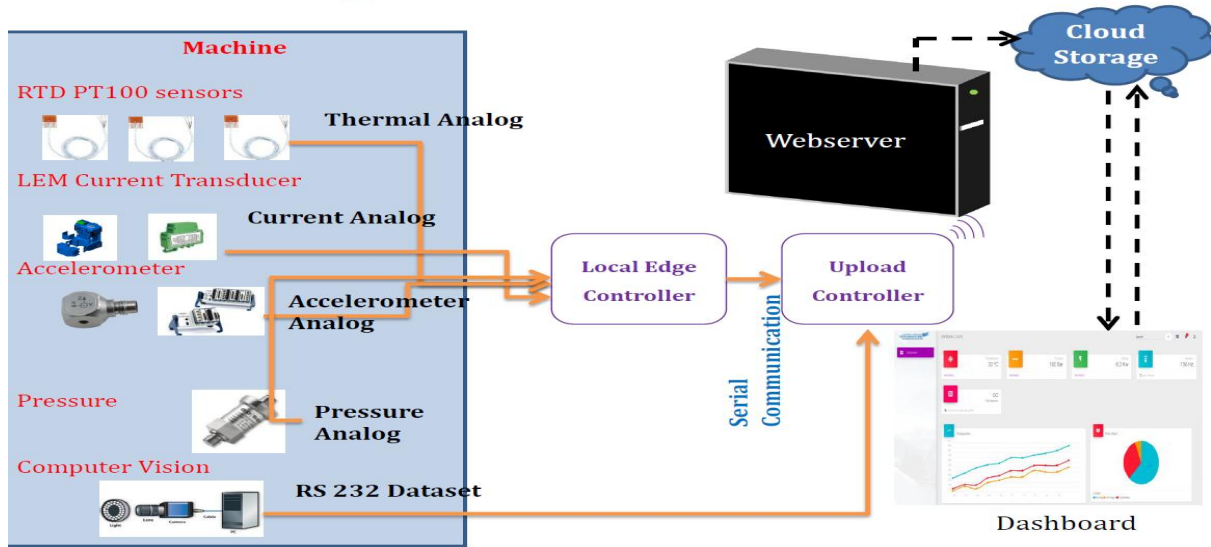
Implementation: For the Demonstration of IOT Enabled Additive Manufacturing
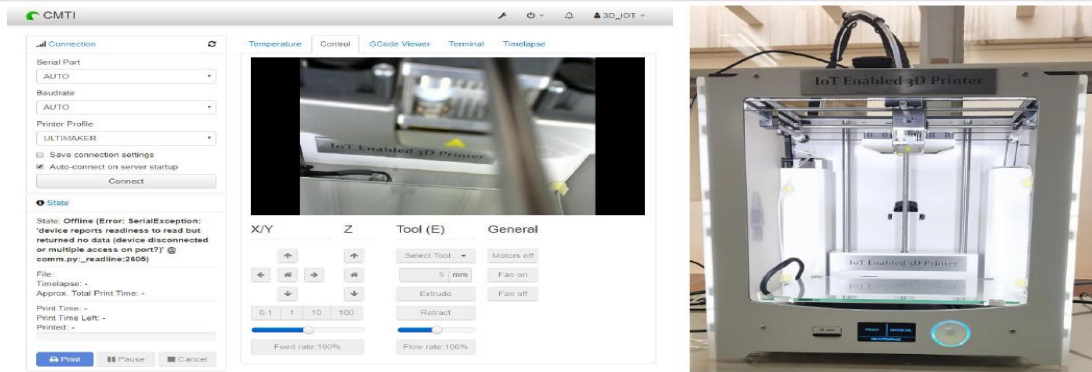
A IOT enabled Control GUI has been developed to control the 3D printer in a closed loop. The following features have been implemented.

➢ Cloud based 3D printing by uploading G-code via Any internet connected device, i.e Mobile Phones & Tablets.

➢ Cloud based closed loop monitoring of process parameters & Temperature signatures of subsystems of 3D printer

➢ A complete live fabrication process can be viewed online via IOT process monitoring camera

IOT Dash Board for Additive Manufacturing Machines
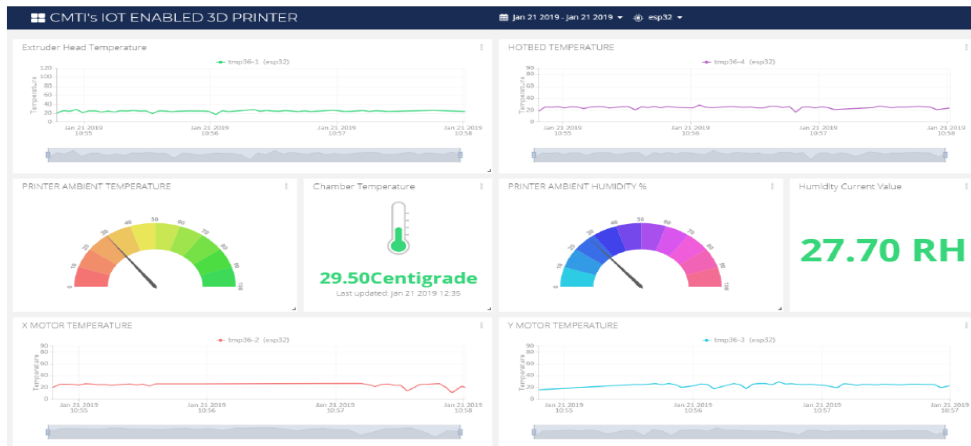
- ➤ A complete IOT based dash board has been developed for process monitoring of an
- ➤ additive manufacturing machine. It monitors temperature of extruder, base plate & motors
- ➤ along with ambient humidity inside the machine & with material feed monitoring.

Summary

- IoT + Big Data = Industrial Internet of Things

- What's Different
  - Cheap hardware
  - Unlimited computing power
  - Internet everywhere

- Product/Service Hybrids
  - Change they way customers buy
  - Rethink your go to market strategy

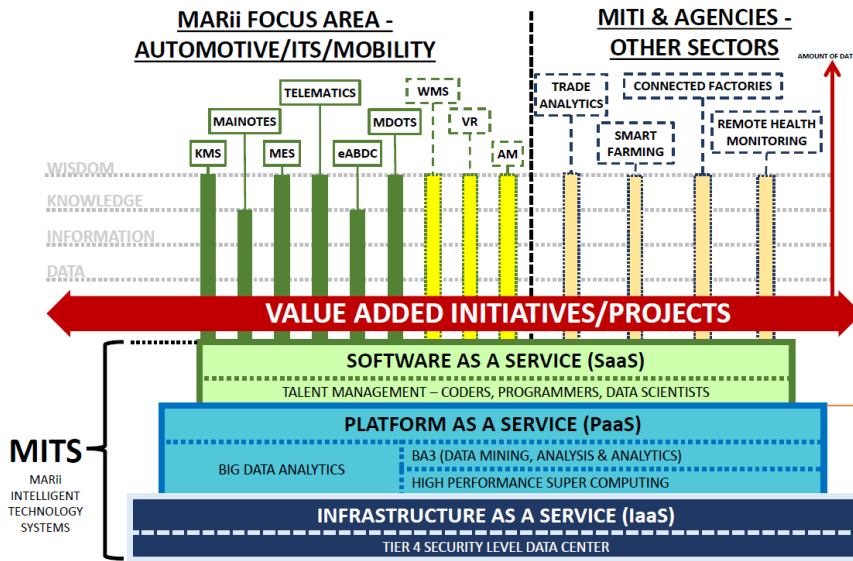- Innovate & Dominate — Capacity Building

Presentation copy 4

Seminar on Industry 4.0
International Engineering Sourcing Show
VIII

Chennai Trade Centre, India
15 March 2019

MARII INDUSTRY 4.0 ARCHITECTURE
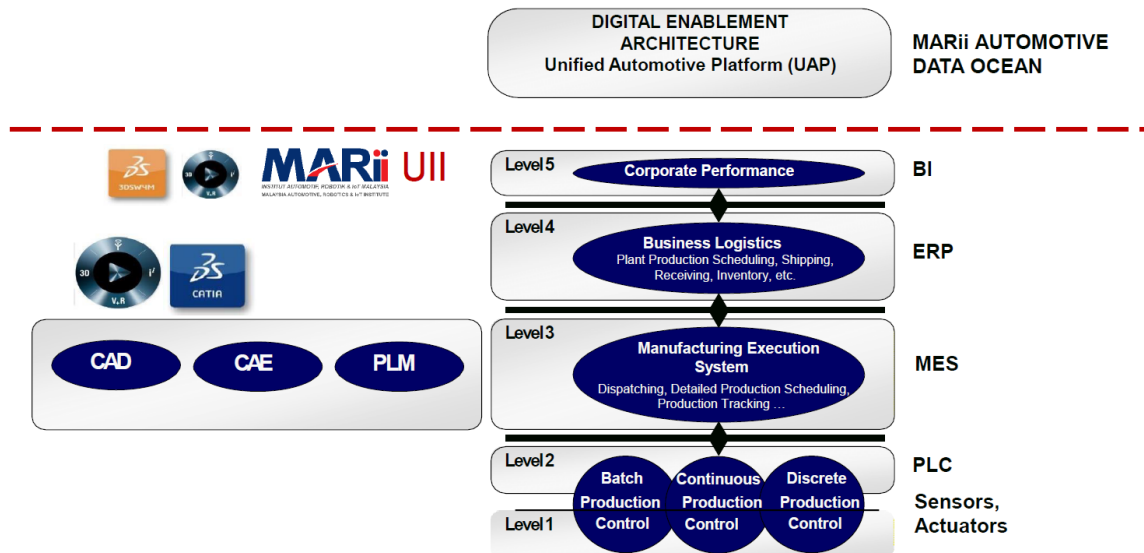
THANK YOU!

Annexure IV: Select photos from the session

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