
connected
everything.
industrial systems in the digital age
TECHNO-JUNKIE
2021-22
DEPARTMENT OF INSTRUMENTATION ENGINEERING

HOD Message

Dear Technocrats,

It's my pleasure to present this issue of a technical magazine "TECHNO-JUNKIE". The purpose if this magazine is to provide opportunity and platform for the young technocrats to express their talent which will also be beneficial to all others to enhance their technical knowledge.

It is very true that all technocrats must know the basic fundamentals as well as should be able to acquire new knowledge technology quickly for global competition and move demanding engineering required and regulation.

I forward my wishes to the editorial team of this magazine for taking great efforts for the issue of the department .

Hereby I appeal to all budding technocrats to join us an share their knowledge and make the magazine more dynamic, transparent and professional.

Dr. A.A.Shinde

Head OF Department

Instrumentation Engg.

AISSMS IOIT, Pune

Staff Editorial

Dear Readers,

As the saying goes, mind like parachute works best when opened. The enthusiastic write ups of our young writers are indubitably sufficient to hold the interest and admiration of the readers. The inculcation of passion for creative thinking and writing among the students which is one of the major objectives set by our Department.

I am thankful to all the blooming writers who have responded to my call and penned their ideas for **"TECHNO JUNKIE"** magazine which means to showcase the latest trends. I also acknowledge constant hard work of the student editor Vaishnavi Phadtare who proved to be as catalysts in mobilizing the students to write their views and efficiently edited the write ups. I would also like to extend my sincere thanks to our Head of Department Dr. A. A. Shinde for her constant support and guidance through the entire process publication of this magazine.

Finally, from the entire team of "TECHNO-JUNKIE" I wish all the readers a Happy Reading!!!

Mrs. Chitralekha Rananaware

Editorial TECHNO-JUNKIE

Student Editorial

"Technology like art is a soaring exercise of the human imagination." Technology is what makes us think beyond the Imagination. In Technical Section it's never "I failed to run this technology, it's always I have found 100 more ways in which this technology won't work. Technology never fail to upgrade us in each way possible.

I thank all the writers for contributing to the technical section of AAYAM.

I would also like to thank Mrs. Chitralekha Rananaware ma'am for giving us this opportunity and supporting is throughout. Indeed it was a great experience and wonderful learning.

Vaishnavi Suhas Phadtare

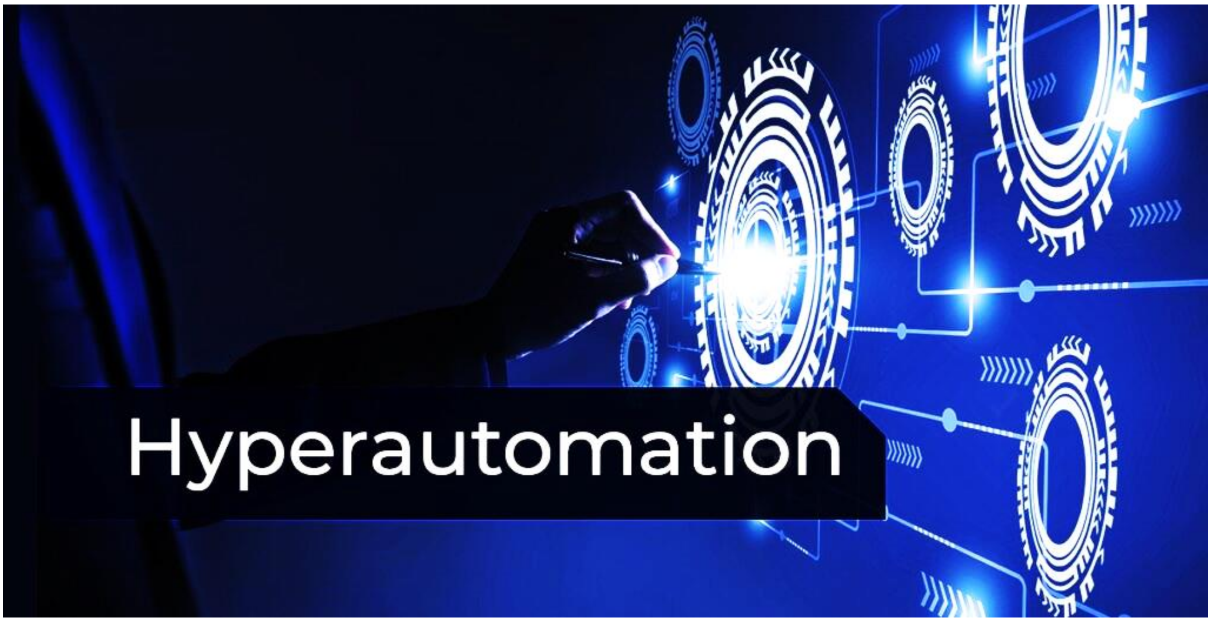
Student Editor T.E. Instrumentation

(Technical Section)

AUTOMATION IN 2022: THE TRENDS AND DEVELOPMENTS IN THE UPCOMING YEAR

Take a look into how the coming year will shape automation for the future.

As the post-pandemic era demands businesses to risk-proof processes and operations, harnessing the benefits of automation technologies is essential to ensure efficiency and sustainability. Hyperautomation brings together several components of process automation, integrating tools and technologies that amplify the ability to automate work, offering opportunities for businesses to achieve scalability, reliability, and efficiency from cost savings and increased delivery speed.

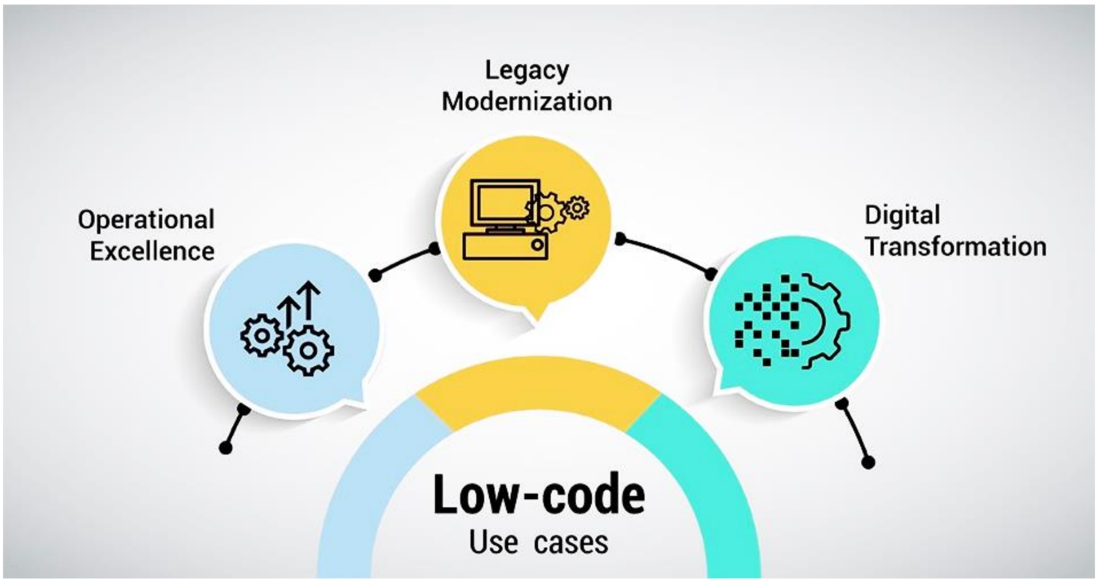


In 2022, as more organizations are leveraging the power of automation as they navigate towards recovery, the significance of the technology is ever increasing. In a recent survey of IT and engineering leaders by Gartner, 74% of respondents said that automation had helped their workforce work more efficiently, with 59% reported cost reduction up to 30%.

Automation enables enterprises with highly focused solutions to tackle complex workloads, challenges, and processes, adding efficiency and profitability. Let us dig deeper into how the coming year will shape an automation-enabled future.

Low Code Will Continue Its Domination

Low-code allows the development of applications using a graphical user interface instead of the traditional approach that allows faster deployment, reduces costs and saves time. Low-code emerged out of necessity as it can effectively modernize and optimize business processes and dramatically reduce the time and cost to create and deploy applications. The benefits of low-code include improved agility to address diverse challenges, operational flexibility, higher productivity, better customer experience while addressing a series of challenges.



The flexibility and diversity of its application will result in more industries leveraging low-code solutions, expanding the technology's scope and applications. Low-code is taking the IT landscape by storm due to its capabilities in unlocking simplicity and speeding up software creation.

A recent study by Gartner has predicted that 75% of large enterprises would use at least four low-code development tools. This trend will continue to accelerate in 2022 and will reach its pinnacle in 2024 as, by that year, 65% of all app development functions will be accomplished using a low-code approach.

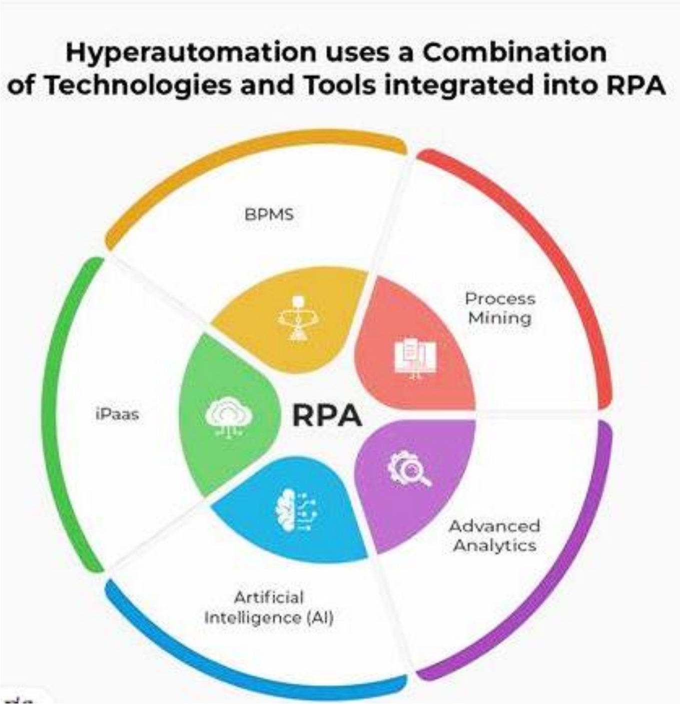
Citizen Development & Self-Service would be BIG

What more would businesses ask for when they can build applications that will suit their needs on their own? The low-code revolution has empowered enterprises to create highly customizable user interfaces, data models, forms, business rules, user workspaces, and such intricate applications with no prior experience in bulky coding.

The emergence of low-code will expedite the process of self-created application development, especially in the years to come. 2022 will mark the beginning of development platforms shifting away from core developers and their monopoly on complex application creation. The recent developments predict that half of all new low-code clients will come from business buyers outside the IT organization by year-end 2025.

RPA will Witness Widespread Adoption

In this decade, the recent developments will allow the Robotic Process Automation (RPA) technology to reach its fullest potential and redefine how businesses handle core business processes. Ensuring business processes and operations are carried out around the clock without further investments, RPA will witness widespread adoption, often helping industries address the labor shortages and maximizing output. In 2020, the RPA service segment accounted for more than 61% of the market share, which is projected growth at the highest CAGR from 2021 to 2028.



The year 2022 will witness a boom in the RPA market as the economy is recovering from the economic impact of the pandemic. If you are looking for core RPA (the no-frills rules-based RPA) without any need for intelligence, 2022 can be a great year.

The Convergence of Hyperautomation Vendors

RPA will ultimately push businesses to Hyperautomation, resulting in 65% of organizations that deployed Robotic Process Automation to introduce Artificial Intelligence, including Machine Learning and Natural Language Processing algorithms, by 2022.

To optimize everyday processes and with intelligent technologies, hyperautomation is a must-have solution. It does not stop automating repetitive tasks; it goes beyond that by interpreting anomalies, learning patterns, and capturing vast quantities of hidden business insights. With the infusion of artificial intelligence tools, 2022 will be the year that modernizes the business landscape.

More and more vendors will offer the hyperautomation suite of technologies in 2022 and beyond.

Low-Code And AI/ML: Forging A New Future

With its strong capability to simulate human intelligence, AI will equip businesses to move processes from humans to technology.

To take it further, in 2022, when applications developed using a low-code approach are integrated with AI and ML technologies, it will profoundly impact business processes. In the coming years, AI and ML will lead to 75 percent cost savings on repetitive tasks compared to human performance.

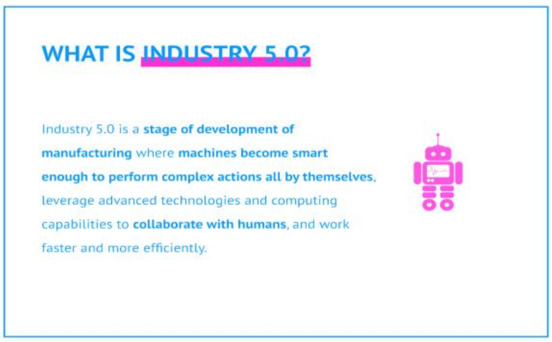
While the constantly evolving phases of the pandemic challenge organizations across industries to transform business processes, automation will be an integral part of organizations. It will carve the path for connected experiences and the digital transformation of businesses bringing a significant shift in how they operate, support their employees, and serve their customers**.**

Industry 5.0: Intelligent Automation of Manufacturing

We are on the brink of the 5th industrial revolution. It wasn't all that long ago that humanity was impressed by the potential of steam power and electricity, and now we are building fully automated robots, smart machines, and networks of smart devices.

What is Industry 5.0?

Industry 5.0 is a stage of development in manufacturing where machines become smart enough to perform complex actions all by themselves, leverage advanced technologies and computing capabilities to collaborate withhumans,and work faster and moreefficiently.



To understand Industry 5.0 better, we need to examine how manufacturing has developed over the past few centuries.

Industry 1.0 refers to the first industrial revolution. Back in the 18th century, the development of steam power began the mechanization of production.

This led to an increase of up to 8 times in volume and productivity.Industry 2.0, the second industrial revolution of the late 19th and early 20th century, was triggered by the implementation of electricity in production and the invention of the assembly line.

Henry Ford successfully used assembly line production in his automobile assembly facility, which drastically enhanced the ability to churn out mass numbers of cars.

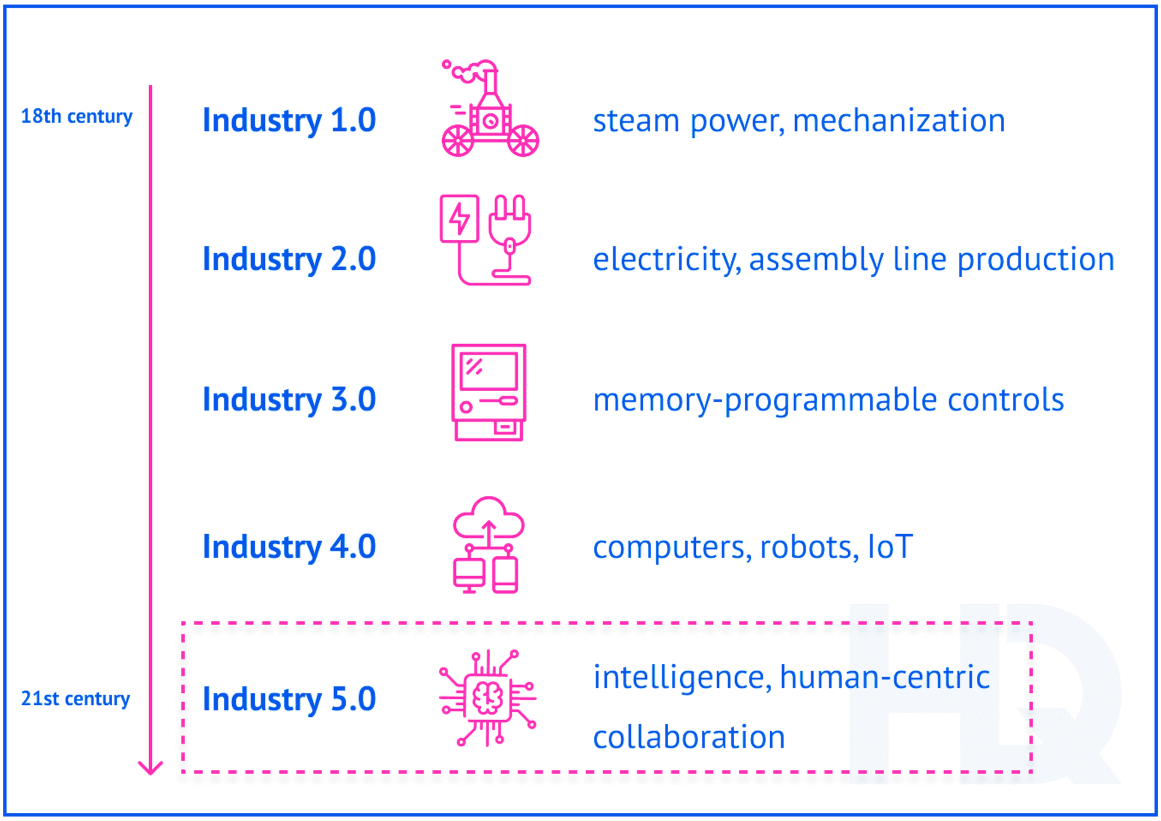
Industry 3.0 began in the 1970s. The third industrial revolution saw production activities increasingly becoming automated with the help of new memory-programmable controls.

This was the era in which computers became an integral part of production, making possible the partial automation of certain manufacturing processes.

Industry 4.0 is our current state: the application of increasingly sophisticated computers, robots, and communication technologies to industrial processes.Processes that have been automated and performed by robots are now interconnected with a network of devices that share and analyze data, also known as IoT (Internet of Things) networks.The whole production line is nearly autonomous; cyber-physical production systems collaborate with people via the network. The only thing missing is advanced intelligence and Data Analytics.

Industry 5.0 fills the gap and adds the missing ingredient — intelligence.

This allows us to blend the power of smart, precise, accurate machinery with human creativity and ingenuity.



The history of industrial revolutions from Industry 1.0 to Industry 5.0.

The goal of Industry 5.0 is to find the right balance between robotization and humans. But this type of collaboration is already reaping some benefits. We'll look at those next.

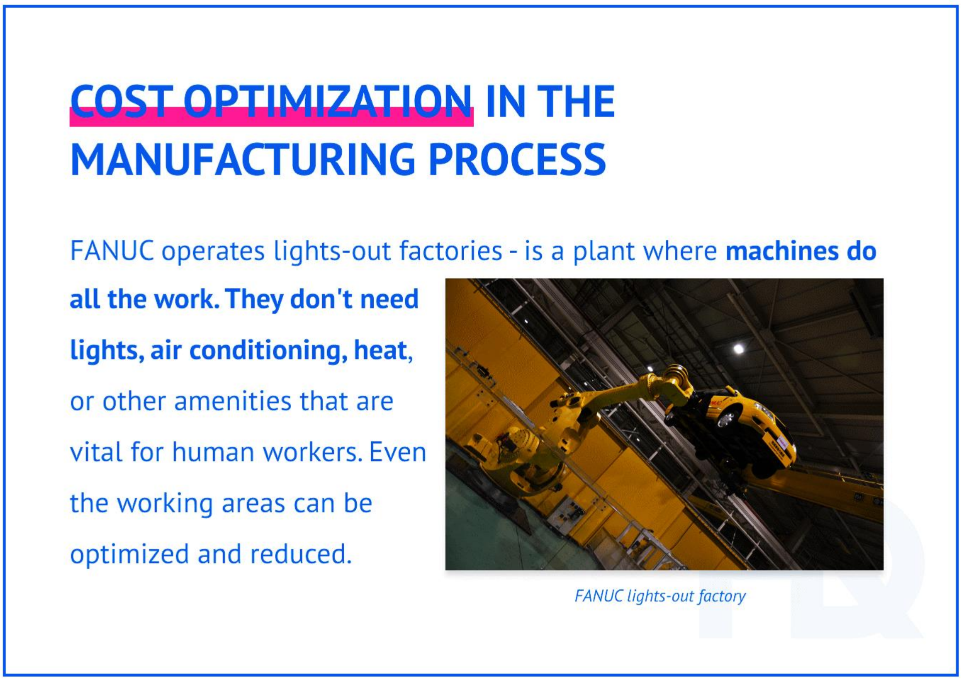
Benefits of Industry 5.0

All industrial advancements aim to bring as many benefits as possible while eliminating drawbacks. Industry 5.0 technologies are no exception.

Here are some of the benefits of intelligent process automation.

Cost optimization in the manufacturing process

A lights-out factory is a plant where machines do all the work. They don't need lights, air conditioning, heat, or other amenities that are vital for human workers. Even working areas can be optimized for reduced energy use and cost.Such intelligent automation in manufacturing incorporates effective processes that require fewer resources and less human involvement, helping the business save money.



Reduction of human-factor failures

In manufacturing, there are two main approaches to analyzing and managing process failures caused by the human factor:

- Proactive: What could possibly happen because of the workers' actions?
- Reactive: What has already happened?

Industry 5.0 technologies make it possible to avoid accidents caused by human error. Workers are not involved in the production process at all, or perform only monitoring roles.

An Industry 5.0 plant is a machine-operated factory, with all actions automated. It can even control and analyze what it does by itself, performing far more calculations than a human can.

Reduction of human-factor failures in Industry 5.0.

Environment-friendly manufacturing

In addition to obvious environmental benefits, such as less resource consumption and therefore less atmospheric emissions, some other advantages to Industry 5.0 are that it:

- Facilitates adherence to new government regulations and international manufacturing requirements.
- Allows for sustainable policies for automated and controlled waste generation.
- Requires fewer resources to be spent on ensuring proper working conditions for workers.
- Industry 4.0 gave the healthcare industry a better means of treating diabetes: today patients can use a special medical device to substitute for a failing pancreas.
- This artificial pancreas system, worn externally, regularly checks the diabetic patient's blood glucose through a skin patch, which communicates wirelessly with an insulin pump that delivers the precise amount of insulin needed.
- This is a fully automated solution that nevertheless lacks advanced analysis of a patient's health condition. Patients with diabetes have different metabolic rates and

some other body parameters that are not taken into account by the pancreas substitution.

- If we move this solution to Industry 5.0, it will gain intelligence: users will get an app where they can add data about themselves and see analytical data about the pancreas system's performance.

- Personalized solutions with Industry 5.0.
- Applying Artificial Intelligence and Data Analytics technologies, the app will define patterns about how the patient's body performs and tweak the system so that it becomes more tailor-made for the patient.
- It seems that we are ready for Industry 5.0. So let's take a look at what's needed to implement it.
- What is required for Industry 5.0?
- Apart from technological progress, here are some things that need to happen during Industry 5.0.
- **Adopting AI with a human-centric approach**
- All those disaster movies in which smart robots eventually become evil and destroy humanity display a depressing perspective.

- You might think the movie industry is right, and humans should beware of letting robots develop their own intelligence.

Environment-friendly manufacturing is possible in Industry 5.0.

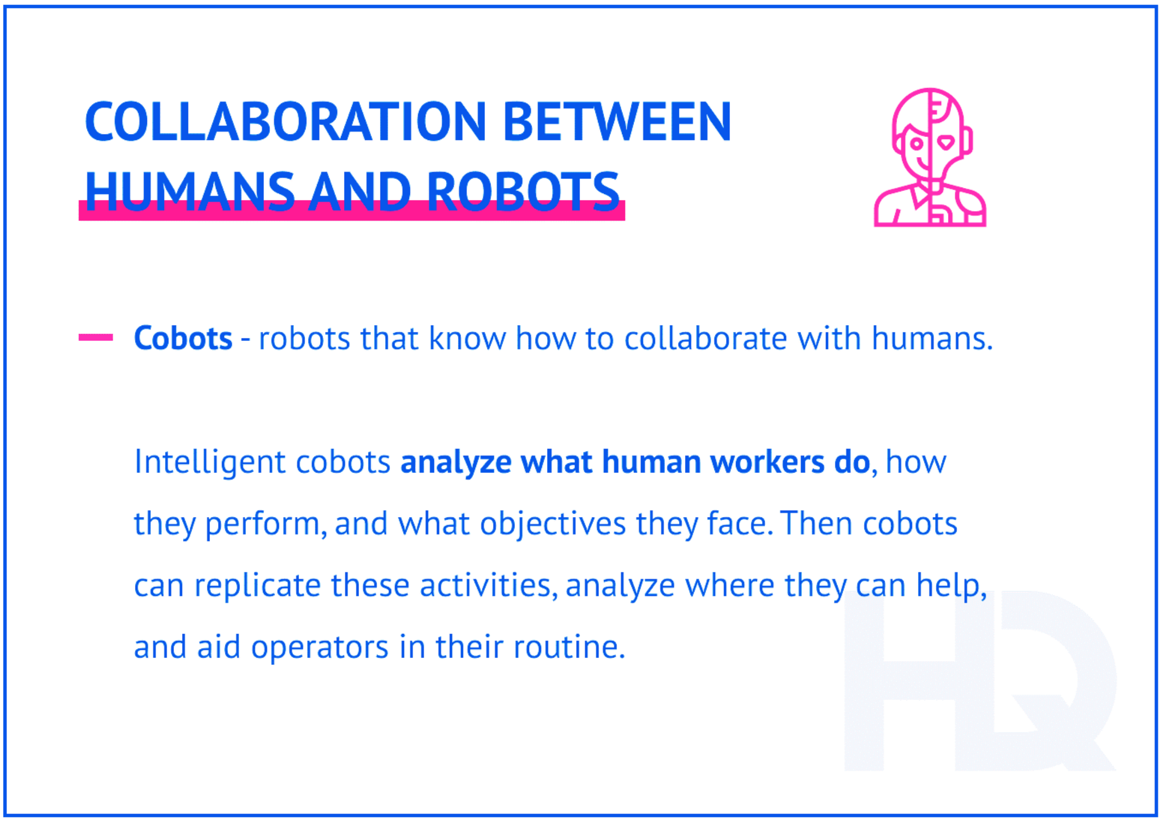
Collaboration between humans and robots

In addition to helping people do their jobs better, robots equipped with AI should be able to collaborate.

Robots designed specifically to collaborate with humans have been called "cobots" in terms of Industry 5.0 development.

Cobots are designed to build simple interactions with humans. At the same time, the goal of intelligent process automation is to help cobots set both production goals and industrial-plant safety mechanisms.

Intelligent cobots analyze what human workers do, how they perform, and what objectives they face. The cobots can then replicate these activities, analyze where they can help, and aid operators in their routine.



Smart factory solutions in use now

Here are some existing "smart factory" solutions, which will only develop further with the expansion of Industry 5.0.

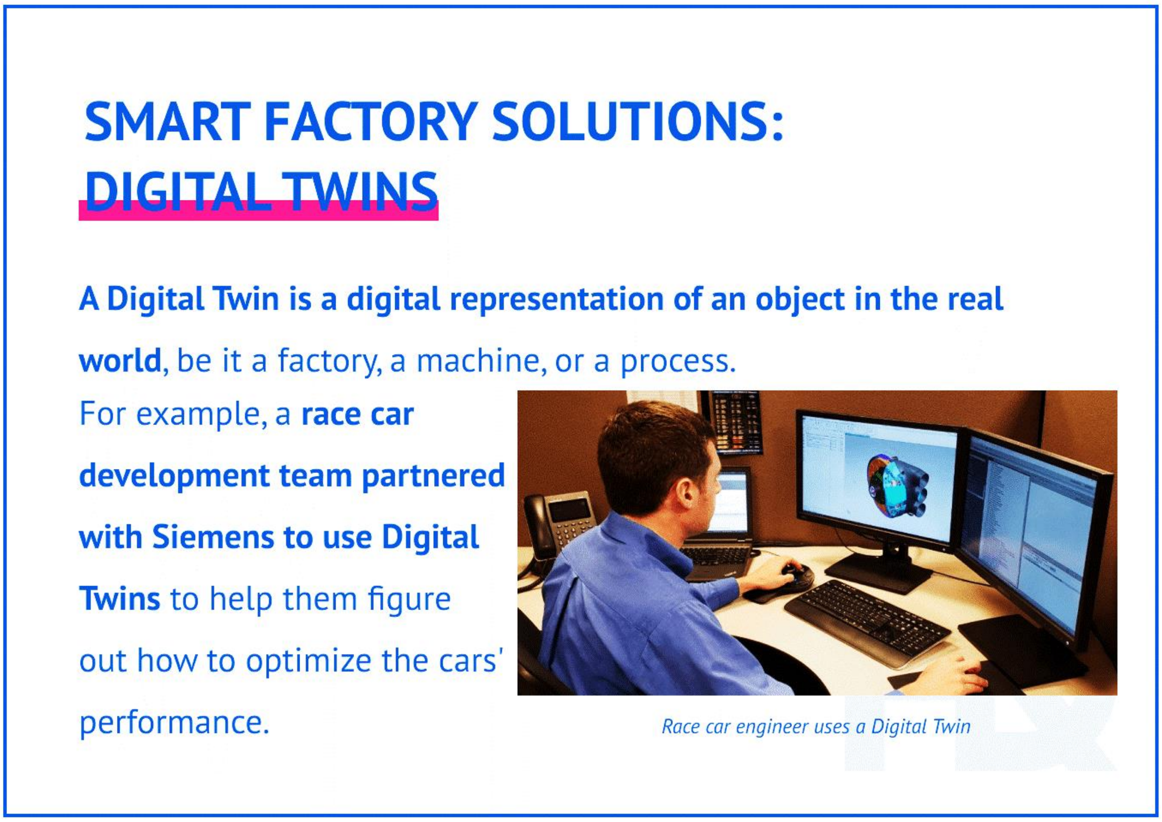
Digital Twins

A Digital Twin is a digital representation of an object in the real world, be it a factory, a machine, or a process.

This Industry 5.0 technology allows for testing machines and optimizing the performance of systems without actually interrupting or altering the real thing. All tests and changes are first carried out in a simulation — a Digital Twin.

Industries already using Digital Twins include aerospace, automotive, and heavy machinery. It's much easier, cheaper, and safer to conduct tests and experiments on online simulations than on real machines or processes.

For example, a race car development team partnered with Siemens to use Digital Twins to help them figure out how to optimize the cars' performance.



Smart factory solutions: Digital Twins.

Driverless transport

Vehicles that operate without human intervention appear not only on the streets but also at production facilities.

Driverless transport vehicles, or DTV, can transport required components or tools from station to station, choosing the most optimized route by themselves.

The vehicle operates in a sensor-based environment and fetches maps and directions from the cloud. This is how we get a networked logistics solution.

See how Fetch Robotics has applied such a system.

This company has developed Autonomous Mobile Robots that easily operate inside production facilities. They pick objects and transfer them to the required place while moving seamlessly around workers and machines.

With the help of Industry 5.0 technologies, such robots will become even more autonomous, productive, and intelligent.

Smart factory solutions: driverless transport.

Augmented Reality

There is huge unrealized potential for AR adoption in manufacturing processes.

Augmented Reality allows for connecting physical and virtual worlds by overlaying data onto a physical object. This requires only simple, affordable devices such as smartphones and tablets to view data.

AR can support other technologies, such as Digital Twins, or act as an independent tool. For example, AR helps with machine maintenance: experiences using AR can show technicians how to perform service on machines in real-time. This is widely applied at General Electric right now.

Another application is in the surgical field.

Smart factory solutions: Augmented Reality.

A surgeon can use AR glasses during an operation to see overlaid data from a patient's profile, such as MRI or blood test results.

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Because of the increasing advances in technology, smart systems are increasingly being used. These systems allow technicians, administrators, and managers to monitor and control the performance of devices from a safe distance. The monitoring system is very important when working in the field of three phase systems; some users and companies use smart monitoring software

REVIEW ON IOT BASED INDUSTRIAL PARAMETERS MONITORING AND CONTROLING SYSTEM

[1]Kajal Vijay Talele, [2]Anis Iqbal Mullani, [3]Suraj Shesherao Shelke, [4]Prof. C. D. Rananaware
Department of Instrumentation & Control
AISSMS Institute of Information Technology,
Pune-411006, India

Abstract: Real-Time monitoring is the effective way to observe factual data. Internet of things based online monitoring is useful to access data remotely. IoT is the network of physical objects embedded with electronics, software and sensors that enable to collect and exchange data. IoT enables the flexibility and liberty to access the machine placed in a remote area access to keep a continuous track of the machine behavior in real time. Application of this technology in electrical engineering is beneficial to observe different parameters which are not easy to access. Electrical equipment performance can be monitored on a real time basis to improve the operating span. This is carried out using online monitoring system. IoT is used to observe different parameters on real time scale. This helps to measure and sense various parameters like energy, voltage, current, temperature, power factor and frequency of any given electrical equipment. This paper reviews suitability of IoT based online monitoring system for electrical equipment.

***Index Terms* - Online monitoring, IOT**

I. Introduction

Electrical power systems are widely divided into manufacturing, transmission, distribution and utilization.In every field of power system, there is a use of electrical machine, so proper monitoring of electrical machine must be done. Electrical Machines have transformed the industrial growth from their inception. Every part of a power system from generation of power to its final utilization at the consumer end requires extensive use of various electrical machines, especially Induction Motors which form the backbone of all industrial processes. As a result, proper monitoring and its maintenance has been a topic of great interest for industries around the world. It is imperative that importance that must be given to the proper monitoring of the operation of those machines are not just from technical perspective, but also from commercial perspective, as it will reduce the losses. Furthermore, proper monitoring of machines helps to determine the performance of the and thus, proper maintenance can be done as and when required. This demands for a system capable of making those necessary observations for monitoring machine parameters and making the data accessible remotely.

Because of the increasing advances in technology, smart systems are increasingly being used. These systems allow technicians, administrators, and managers to monitor and control the performance of devices from a safe distance. The monitoring system is very important when working in the field of three phase systems; some users and companies use smart monitoring software programs. These programs are installed on the user's smartphone or company computers to allow employers to make decisions if there is an error.

The proper monitoring of the electrical machine helps us to determine the performance of the machine and thus proper maintenance can be determined. So, there is a necessity of measuring the electrical parameters of electrical machine. The paper composes a system that is capable to perform various tasks at a time. The proposed system is a bridge between the sensing of electrical parameters and IOT cloud computing. The hardware prototype includes sensing of electrical parameters like current, voltage, temperature, power factor and frequency. Measurement of current is done using non-invasive current sensor and voltage through using a step-down transformer. Only phase voltages are sensed and then using a level shifter, a dc shift is given to output of sensing circuit which will be fed to the MSP430 controller. By using algorithm, the frequency and power factor are calculated and obtained data is transferred to node MCU by serial communication through MSP430. This data is stored in cloud and it helps to fetch data from cloud to any device.

The Term Industry 4.0 stands for fourth Industrial Revolution which is nothing but Smart Industry that adapts cyber-physical changes and improves the Productivity.

- The Main reason why Industries can see considerable growth is because Data Driven Approach towards business

  systematic analysis of data proves beneficial in many ways such as predictive maintenance, achieving goals as per the targets etc.
- We chose this topic as we can clearly see the industry adapting and evolving successfully to industry 4.0 and there is a lot of scope of expansion that we can contribute as emerging engineers.
- We are focused on Energy efficiency part and production monitoring part which naturally reflects in the top line and bottom line of balance sheet i.e., turnover and profits of the industry
- Our Focus is to minimize the Power Consumption and Machinery Damage and Monitor the

Production rate which directly contributes to Profit of the Company.

The aim of this work was to design and implement a low cost and safe three phase measuring system and to design a smartphone application to monitor the data received from the three-phase measuring system. The Project has been designed to measure three phase voltages and currents for all three phase systems that have a line to ground voltage of less than 250 VAC with a current value of less than 30 A. The rest of the is organized as follows: Literature review, project definition, objectives, proposed methodology, working of the project, software and hardware used, implementation, conclusion, reference.

II. NEED FOR INDUTRIAL MONITORING AND CONTROLLING

In present industrial processes are manually monitored. It leads to the accidents due to excessive temperature, current and voltage. Thus, there is need of industrial monitoring and controlling system.

So, proper controlling and monitoring system have following steps.

1. Sensors controlling monitors voltage, current etc.
2. Compare this value with threshold value.
3. Avoids manual interface.

III. Block Diagram

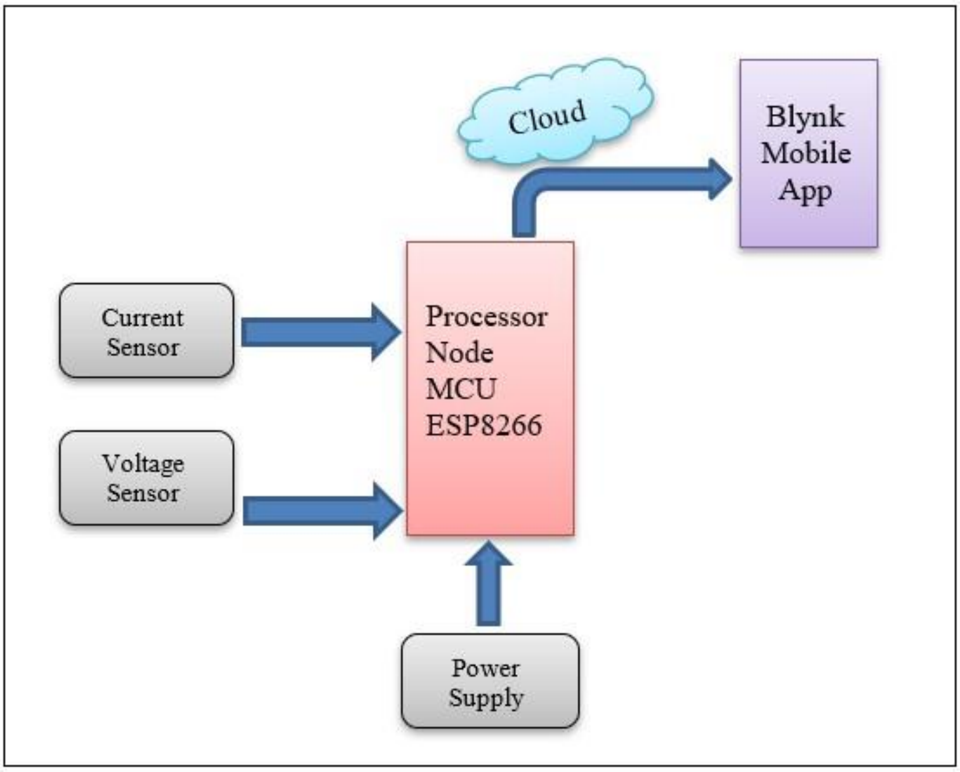

Figure 1: Block Diagram

The IOT based industrial monitoring and controlling system is divided into three units

1. Sensing and monitoring unit
2. Controlling unit
3. Alert unit

The sensing and monitoring unit consist of sensor module which includes current, Voltage sensors. These sensors are interfaced with microcontroller. The current and voltage sensor continually measures the industrial parameter at regular intervals. These measured values are sent to the microcontroller. The microcontroller is programed such that it checks measured value of sensor with threshold values. Whenever the measured value exceeds the threshold limit an alert system is activated and the controlling action is performed.

The controlling unit comes into action when the measured sensor value is greater than the threshold values. Here, the threshold value is set according to industrial safety measures. In this system, current is monitored as well as controlled. An alert unit gives an alert msg. in the form of SMS and e-mail to the user when the measured value exceeds the threshold limits.

IV. **Algorithm**

Algorithm: - Industrial monitoring and controlling operation.

Inputs: - Measured sensor values

O/P: - Alert msg. to the workers.

V. **LITURATURE SURVEY**

1. Shashank Kumar, the term of Industry 4.0 (German Industry 4.0), commonly recognized nowadays, occurred in the public domain in 2011 at the Hanover Trade Fair as the name for the common initiative of the representatives of business, policy and science promoting the idea of strengthening the competitiveness of the German industry (Müller et al., 2018; Rao and Prasad,
2018). The German federal government liked the idea so much that they decided to make Industry 4.0 an integral part of the government initiative "High-Tech Strategy for Germany 2020”, whose objective is to promote Germany as a global leader of technological innovation (Pereira and Romero, 2017; Zhou et al., 2015; Jabber et al., 2018; Androdiecious, 2017a).

2. Beata Ślusarczyk., Paper selected for this section has discussed the production process and some advanced design of shop floor in the manufacturing industry by using cyber-physical system (CPS) and smart object. Majority of papers discussed about the internet of things (IoT) and their implication part. S. Wang et al., (2015) in his paper explained smart object-based shop floor. Shop floor with the smart agent and the advanced tool that converted the simple system into the self-organizing system has discussed. IoT and CPS are used to make all the machines and tools smart. CPS and IoT enabled various agents are then classified into different agents for the easiness of collecting the big data feedback and facilitate coordination among them. For better coordination, an intelligent negotiation mechanism has presented by Wang et al. To get the significant visualization of co-ordination of smart objects, virtual engineering object (VEO) technology has introduced by S. Shafiq et al., (2015).

3. Bozena Gajdzik 1, Sandra Grabowska 2, and Sebastian Saniuk 3, The first step of literature review was used the bibliometric analysis [36]. The following keywords were selected in the bibliographic analysis: "Pathway to Industry 4.0", "Implementation of Industry 4.0", "Application of Industry 4.0", "Roadmap (to) for Industry 4.0" and "For Industry 4.0". framework".The choice of keywords was consistent with the adoption research objective, which was to find the answer to the question: Industry 4.0, how to implement step-by-step? The period of analysis was 2011–2020. From 2011 on, the popularization of industry 4.0 begins and continues for years to come. Analyzing the results of a scientific database review of adopted keywords, it was found that most of the publications were in the database for keywords: "Implementation of Industry 4.0

4. Priyanka Verma, Priyanka Verma, Jyoti Kushwaha, Cyber-Physical Systems: The Cyber-Physical System (CPS) concept is defined as a technique where artificial and biological systems for processing, information exchange and feedback processing are integrated into physical and cyberspace (Bagheri et al. al. 2015). Network systems control and monitor physical processes with the help of embedded (cyber) subsystems through network systems. Various devices such as sensing, computing and communication (often wireless) capabilities are used to create a physical system. These physical devices can be identified with the help of physical characteristics or data sensing systems, for example, radio frequency identification (RFID) or (infrared sensors), and can then be connected with networking systems, mostly the Internet.

5. Eren KAMBER, Gulin Idil SONMEZTURK BOLATAN, announcing its name at the Hannover Fair in Germany for the first time in 2011, Industry 4.0 has been a considered subject. Kagermann (2013) defines Industry 4.0 as a new trend for automation and data transfer in manufacturing technologies.

Cyber physical systems (CPS), internet of things (IoT), cloud systems and smart factories are the main components that make up the concept of Industry 4.0. To summarize the industry 4.0 system briefly; by using cyber physical systems in smart factories, digital copies of real objects are created in the virtual world. Also, they are coordinated.

6. Haradhan Kumar Mahajan, Jaime Ventura and Hans-Joachim Voth had shown that Britain's borrowing boom during IR was beneficial to agricultural reform, the growth of the textile and iron industries, which triggered a structural change of trade and large-scale social change. Vijaya Singh has enlightened on technological advances through machines during the IR [69]. Robert C. He said wages were remarkably high and energy was cheaper in Britain than in other continents. Living standards of Britain rose generally due to economic developments.

VI. LITRATURE REVIEW

The survey includes a number of monitoring devices for electrical machines that already exist. It was noticed that the meter based on IoT is being implemented. A noninvasive current sensor was used because it had the advantage of small size and ability to be used wherever the power is being consumed. It was understood that there are some algorithms that can be implemented to calculate the power factor and frequency in a microcontroller. From this it was realized that MSP430 is low power consuming microcontroller of Texas instruments which can be used for long time running. Also, the mentioned algorithm could be applied on this controller as its sampling rate is high. Here, use GSM module is made for electric machine monitoring but it was realized that the it has some disadvantage which can be overcome by IoT system. From it was realized that ESP8266 is a low cost IoT Wi-Fi module which has a full TCP/IP stack and also possess an onboard microcontroller. We are using Node MCU module which has a Wi-Fi module as well as a microcontroller which help in programming such device easily. For data capture we can use Thing speak, IBM, azure amazon web services etc.

The major challenge in the project lies in proper integration of multiple subsystems and their successful simultaneous operation. All the subsystems like sensors, microcontroller, communication with Wi-Fi module and upload to the cloud, should work in synchronization and should provide the expected result, with a fair and tolerable accuracy. Developing a familiarity with programming of MSP430 microcontrollers is of paramount importance for successful implementation of necessary algorithms and communication.

VII. CONCLUSION

Title of Paper	Publisher	Year of Publishing	Methodology	Conclusion

IOT Based Machine monitoring System	Prof. Puneshkumar Tembhare, Atharva Punde, Arpit Rewatkar, Anshul Raut	2021	1. Sensor Data 2. Node MCU 3. Blynk Cloud 4. Blynk App	The concept of "Industrial parameter Surveillance and fault detection" was chosen with the goal of learning about the many industry variables, tracking their changes, and determining the threshold for the same using Node MCU and sensors.
Smart Factory of Industry 4.0: Key Technologies, Application Case, and Challenges	Baotong Chen; Jiafu Wan; Lei Shu; Peng Li; Mithun Mukherjee; Boxing Yin	2017	1. Device Domain 2. Network Domain 3. Data Domain Application Domain	Industry4.0, as a representative of the future of the Fourth Industrial Revolution, evolved from embedded system to the Cyber Physical System (CPS). Manufacturing will be via the Internet, to achieve Internal and external network integration,

				toward the intelligent direction. Layer, and the data application layer in the smart factory are analysed, and some application cases were discussed to explore potential solutions for key technologies.
Industry 4.0: Towards future industrial opportunities and challenges	Keliang Zhou; Taigang Liu; Lifeng Zhou	2015	1. Physical Layer 2. Network Layer 3. Data Layer 4. Cloud Layer 5. Application Layer 6. Enterprise Layer	Industry 4.0 (the fourth industrial revolution) encapsulates future industry development trends to achieve more intelligent manufacturing processes, including reliance on Cyber-Physical Systems (CPS), construction of Cyber-Physical Production Systems (CPPS), and implementation and operation of

				smart factories.
Industry 4.0 Development and Application of Intelligent Manufacturing	Guo-Jian Cheng; Li-Ting Liu; Xin-Jian Qiang	2016		Industry4.0, as a representative of the future of the Fourth Industrial Revolution, evolved from embedded system to the Cyber Physical System (CPS). Manufacturing will be via the Internet, to achieve Internal and external network integration, toward the intelligent direction.

Table 1: Comparison of Review Paper

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2. S. Karakana and N. R. Namburi, "Design and prototype development of a digital instrument for measuring single phase power

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Industrial Internet of Things
Applying IoT in the Industrial Context

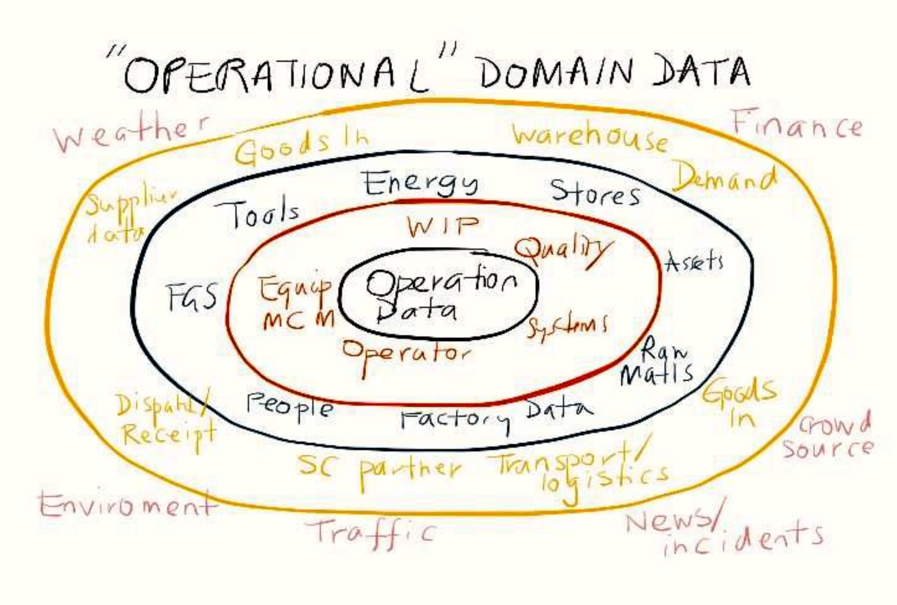
The term industrial Internet of things (IIoT) is often encountered in the manufacturing industries, referring to the industrial subset of the IoT

Uses of Industrial IoT

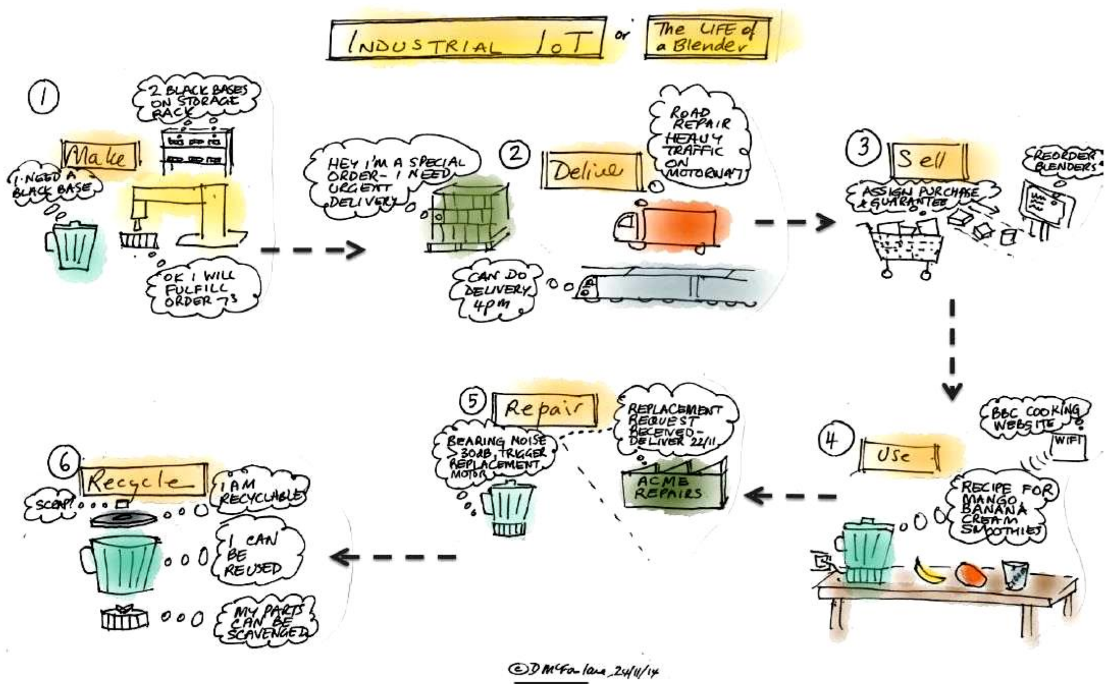
In this section, two specific benefit areas of IoT in an industrial context are raised. These relate to areas of sensing that are not traditionally part of the factory information environment and are hence not typically integrated into production or asset management considerations. In a later section, the differences between existing industrial IT systems and the options that IoT can offer will be discussed.

(i) Collecting Non-Production Data to Improve

Industrial Operations: Industrial operations are extremely efficient at sensing production data to ensure best performance but generally less efficient at integrating data from maintenance, quality control and raw material supplies into considering production planning, scheduling and control issues. Part of the reason is the difficulty of integrating such data into the factory information & control environment. IoT can potentially help address this challenge by making this data accessible – even if it originates from 3rd party data suppliers. Conversely the use of production data for non-production needs (maintenance, quality control etc.) can also be enabled by some of the evolving Industrial IoT offerings. Figure belowillustrates different "layers" of manufacturing data: core production data, peripheral production data, factory wide data, supply chain data and ecosystem data. There is very little interconnection currently between these levels and this is partly because of the different information systems used.



(ii) Collecting Product related Data to Improve Product Life Cycle *Performance:* A second severe limitation of today's sensed data provision relates to product data and product-related process data as a product moves throughout its life cycle. Fragmented information relating to an industrial product lies in databases of suppliers, manufacturers, distributers, retailers and service providers etc. The work of the Auto ID Centre, EPC Global, GS1 and others over the last 15 years has been to create standards for the exchange of product data across multiple organisations. An industrial IoT framework in which product data could be seamlessly gathered and linked to a physical entity as it moves through its life cycle would address many of today's product life cycle management challenges. It might even enable self-managing products, as illustrated in figure below:,



There is at this stage only a very limited, superficial literature on the deployment of IoT in an industrial context and even that coverage is cursory. It is extremely difficult to determine where reported applications have in fact benefited from specific IoT developments and where the reporting is simply that of a sensor application within an industrial context.

Ignoring this distinction for the moment, applications that report the deployment of Industrial IoT solutions typically cover one of the following themes:

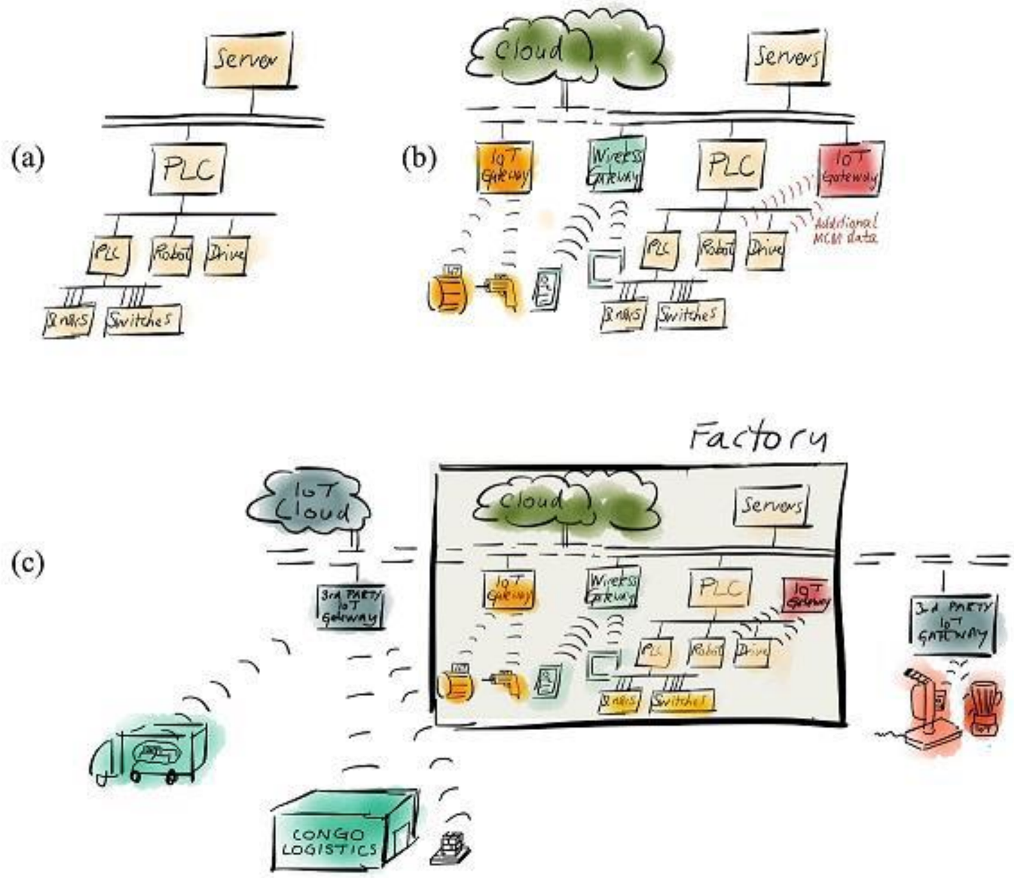
- equipment monitoring – gas turbines & construction equipment
- maintenance – aircraft, wind turbine, elevators
- quality control – beverages
- energy management – manufacturing
- productivity – logistics, machine tools, oilfield production
- safety – rail transport

To summarise, the areas where Industrial IoT might provide the best immediate impact are applications in:

- Integrating data from suppliers, logistics providers, customers
- Introducing data from new technology, peripherals, tools, equipment
- Distributed production requiring addition of new data sources, locations, owners
- Sensors on board raw materials, parts, products, orders passing through organisations

Links to existing Industrial IT

As mentioned above, one of the challenges in articulating the impact IoT can make in the industrial space is to be able to differentiate between existing facilities for linking physical activities to computing via sensing and actuation and those additional capabilities that IoT developments can provide. This is noted for example in an IoT Report by the Digital Catapult. Conventional industrial IT systems – e.g. those based around the so called Computer Integrated Modelling (CIM) principles already allowed for standard data connections between production sensors and devices and data management computers (see Figurea) but IoT gateways integrated into the factory IT environment would allow for a simple integration of production and non-production data (see Figureb) and potentially also allow for third party data from beyond the factory boundary (Figurec) to also be included. Conversely, such extensions will also allow for data from the production environment to be made available for uses elsewhere, for example, making production monitoring data from particular equipment available to the machine supplier or manufacturer or product quality data available to the end customer.



Links to other Industrial paradigms

One of the challenges for both industrial users and academic developers in this area is the lack of distinction between numerous different paradigms.

Industry 4.0: Industry 4.0 is a name for the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of Things, cloud computing and cognitive computing. Industry 4.0 creates what has been called a "smart factory".

Digital Manufacturing: Digital Manufacturing is an integrated approach to manufacturing that is centred on a computer system.

Data Analytics / Big Data: Data analytics refers to qualitative and quantitative techniques and processes used to enhance productivity and business gain. Data is extracted and categorised toidentify and analyse behavioural data and patterns, and techniques vary according to organisational requirements.

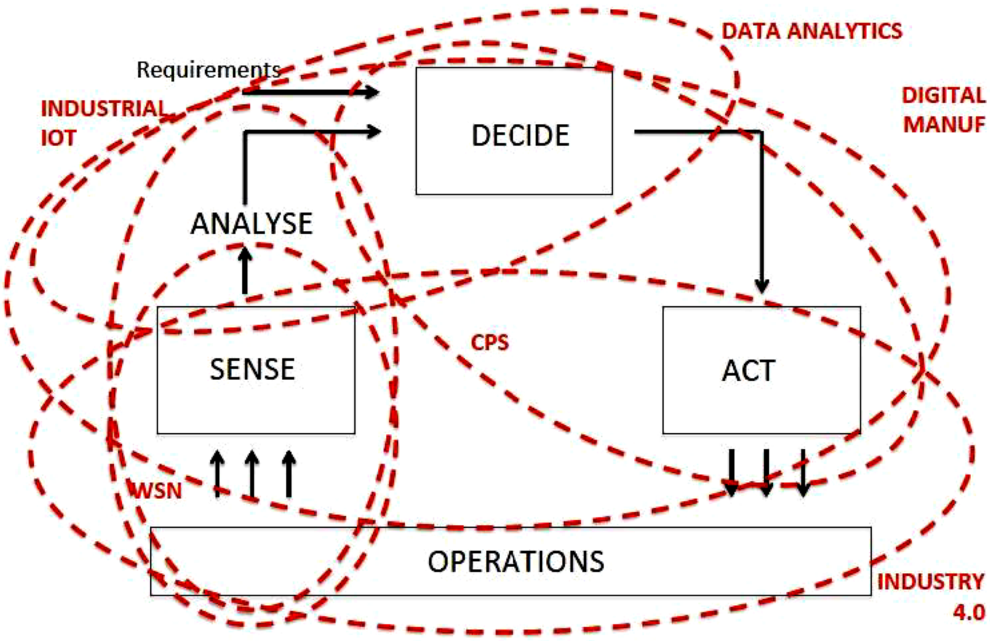
Cyber Physical Systems: A cyber-physical (also styled cyber physical) system (CPS) is a mechanism that is controlled or monitored by computer-based algorithms, tightly integrated with the Internet and its
users.

Wireless Sensor Networks: Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organising the collected data at a central location.

The interaction between these definitions and the overlaps indicated diagrammatically in **Figure 11** highlight the challenge in defining a necessary programme of work in any one of these areas. With this in mind it might be convenient to restrict the definition of IoT in an industrial context to being associated with:
(i) Edge: The development of sensing and actuation devices that attach to or represent properties of industrial equipment, products and materials

(ii) Gateway: connect (edge) devices such as

sensors and actuators to local networks within the industrial organisation, and
(iii) Data Management Systems: the provision of (server or cloud based) systems required to manage and use the data associated with edge devices.



Such a restricted description would clearly provide a distinction from other digital paradigms such as data analytics and cyber physical systems – albeit providing data for the former and infrastructure for the latter. Its role in Digital Manufacturing and Industry 4.0 developments would be substantial but only part of what is required to address digital needs of the manufacturing industry.