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A STUDY ON IOT 4.0 APPLICABILITY FOR AUTOCOMPONENT MANUFACTURING SETUP

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Abstract

IOT 4.0 is a powerful strategy having wide application in the manufacturing industry. High volume manufacturing is skewed towards the transportation industry and in particular the automotive industry which is cost sensitive without compromise on quality. This paper focuses on a study of the application of IOT 4.0 specifically to auto component manufacturing citing industry challenges, manufacturing, strategies, technology fit and derived benefits.

Keywords: *IOT 4.0, manufacturing industry, applications of IOT 4.0, metrology ,sensors, actuators*.

1. Introduction

The Internet of Things is the model of connecting manufacturing machines and facilities to the Internet and also with other manufacturing systems. It is a connected network where people and manufacturing facilities are seamlessly connected. The information is shared between the environment and the devices.IoT plays a major role which is used to connect everyday objects in life which are operational with microcontrollers and transceivers for digital communication. The Internet of Things represents a vision in which the Internet extends into the real world embracing everyday objects. Physical items are no longer disconnected from the virtual world, but can be controlled remotely and can act as physical access points to Internet services. Finally, the innovative information and communication technologies (ICT) enable humans as smart operators to control and supervise activities.. This paper discusses about the application of IOT 4.0 specifically to auto component manufacturing citing industry challenges, manufacturing, strategies, technology fit and derived benefits.

2. Challenges in manufacturing industry

Sandvik coromant describes various challenges in manufacturing industry in Figure 1, however does not detail the impact at the automotive industry level.

The various challenges (Figure 1) faced in automotive industry are :

2.1 Cost and quality control

Quality and cost are directly proportional to one and another. Automotive manufacturing industries demand six sigma quality level in ensuring the end product meets customer requirement with zero defect. Statistical process control (SPC) monitors and controls quality by tracking production metrics. It helps quality managers identify and solve problems before products leave the facility.

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Increased customization, smaller batches and shorter lead time requirescost traceability and produce the right quality for the customers to be competitive. Manufacturing costs can be divided into materials, labor, and overhead. Each of these areas offers opportunities for cost control. It is important to keep detailed and accurate records about cost control in manufacturing operations.

2.2 Automation

Automotive manufacturing by virtue of size of a product and design reqirements necessitates the need for "POKA YOKE"(mistake proofing)in the manufacturing facilities. This is brought about to automation. In the era of Industry 4.0, automation has been one of the most effective apparatuses driving efficiency for manufacturers .To be competitive on the market the customers must increase their level of automation. An automated production line consists of a series of workstations connected by a transfer system to move parts between the stations. Fixed automation, also known as "hard automation," refers to an automated production facility in which the sequence of processing operations is fixed by the equipment configuration. Programmable automation is a form of automation for producing products in batches. The products are made in batch quantities ranging from several dozen to several thousand units at a time

2.3 Skills gap

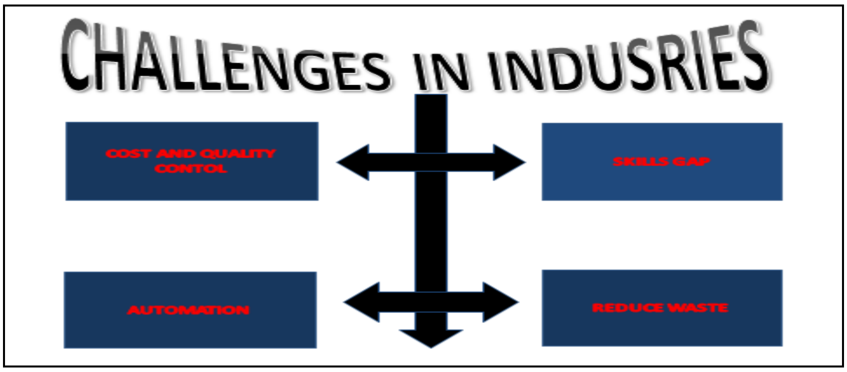
It refers to the misalignment between the skills extant in the workforce and the skills demanded by the labor market. More advanced machines and programming strategies exhibit difficulty in sourcing competitive talent. The concern was that a misalignment between the skills needed by employers and those available in the workforce would hold back employment growth.

2.4 Reduce waste

A manufacturing activity like inspection , inventory, material movement and other indirect activities which provide NIL value to the customer and contributes nothing to your bottom line, but definitely has a cost can be classified as waste. Waste reduction, time reduction, resource, consumable and to get it right from the first component makes the customers competitive in the global market.

FIGURE 1

Challenges in manufacturing industry



Source: Sandvik seminar on iot 4.0

3. The role of IOT 4.0 as a technology fit in autocomponent manufacturing

IOT 4.0 interfaces with various elements of autocomponent manufacturing industry like machine tools, toolings, CAM(Computer Aided Machining), metrology equipments, sensors and actuators used in fixtures and other automation elements of the machines, intelligent electronic devices to name a few represented in figure 2.Automotive companies and related businesses can no longer afford to ignore the significance of IOT in automotive manufacturing.

3.1 Machine tools

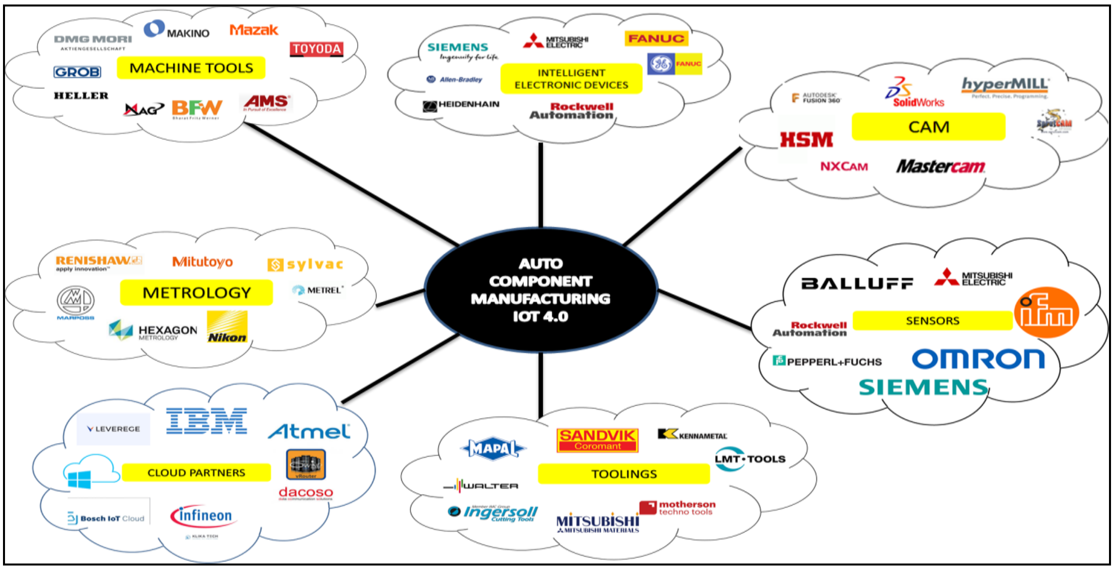
A machine tool is a machine for handling or machining metal or other rigid materials, usually by cutting, boring, grinding, shearing, or other forms of deformation. The major 5C`s(Cylinder block, Cylinder head, Cam shaft, Crank shaft, Connecting rod) used in engine manufacturing, gears, shafts and housings used in gearbox manufacturing, axle arm and axle beam are generally machined in inside factory premises of major automotive companies. Machining may be accomplished with either a milling or turning process or a combination of both. Material is removed from the work piece in order to generate desired shape. Machine tool is used to directly or indirectly make every auto components constituting a automobile.

3.2 Intelligent Electronic Device(IED)

An intelligent electronic is a device that is added to industrial control systems (ICS) to enable advanced power automation.The ability of an IED is to perform all the functions of protection, control, monitoring, and upper level communications independently without the aid of other devices like an Remote Terminal Unit (RTU) or communications processor. Examples of IED are CNC machine controllers, PLC`s, I/O modules, VFD(Variable Frequency Drive).

FIGURE 2

The role of IOT 4.0 in auto component manufacturing



Source:Abhijit

3.3 CAM partners

CAM refers to Computer Aided Manufacturing software used to create simulated part programs and other complicated machining strategies virtually before deploying in machines. CAM`s generally function hand in glove with machine control system manufacturers. These are mostly partners for IOT Intelligence and gives factory operators the ability to automate the tracking and monitoring of the location, condition, state, and utilization of connected assets from a single consolidated view. It collects and analyzes information from the devices. CAM partners extract costs from the manufacturing business through managing by exception and increasing productivity. Detect and prevent loss through combined security surveillance, sensor alerts, alarms, and policies.

3.4 Actuators

An actuator is a part of a device that helps to achieve physical movements by converting electrical, air, or hydraulic energies into mechanical force. It is the component in any machine that enables movement.Actuators in IoT systems take electrical signals and convert them into physical output.

3.5 Sensors

Sensors are sophisticated devices that are frequently used to detect and respond to electrical or optical signals. A Sensor converts the physical parameter into a signal which can be measured electrically. It can also sense the objects and calculate the distance between them. Sensors should be sensitive to the phenomenon that it measures. Sensors most commonly used in the IOT are Temperature Sensor, Pressure Sensor, Proximity Sensor, Accelerometer, Gyroscope Sensor, IR Sensor, Optical Sensor, Gas Sensor and Smoke Sensor.

3.6 Metrology

Metrology is the science of measurement that is crucial for manufacturing technologies. It establishes a common understanding of units, crucial to human activity. Metrology ensures the quality of the product.Examples of metrology are coordinate measuring machines, digital internal and external dimension measuring devices like bore dial, vernier caliper, micrometer,digital diaphragm type pneumatic measurement gauges, transducer , LVDT, optical measuring instruments.

3.7 Cloud partners

Cloud is a metaphor for a group of networked elements providing services not restricted to or managed by users, however provide suite of hardware and software residing in internal or external virtual environment. Largescale cloud service providers are cisco ,detechtion, Microsoft, google.

4. Manufacturing lifecycle

The manufacturing lifecycle(Figure 3) starts from design ->process planning->operation planning ->tools, fixture->production logistics->machining->verification->supply to customer

4.1 Design

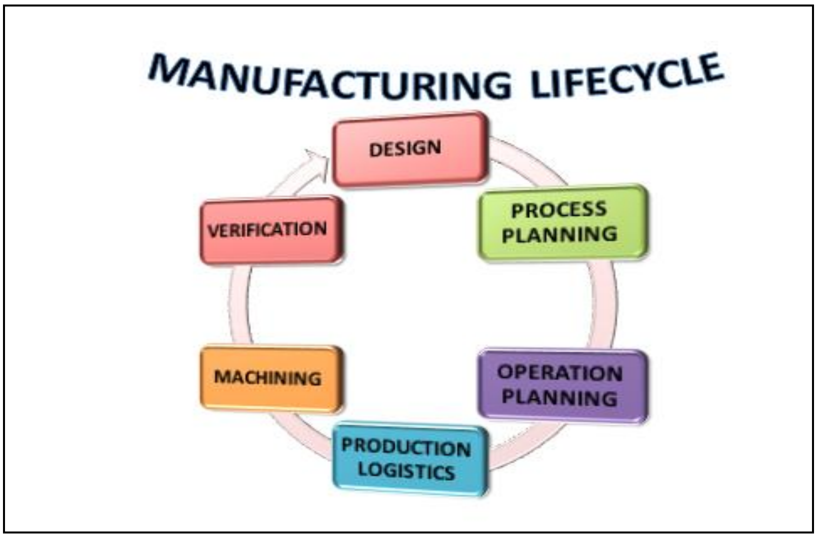
Design for Manufacturing is the process of designing parts, components or products for ease of manufacturing with an end goal of making a better product at a lower cost. This is done by simplifying, optimizing and refining the product design. The goal is to design a product that is easily and economically manufactured. The importance of designing for manufacturing is by the fact that about 70% of manufacturing costs of a product (cost of materials, processing, and assembly) are determined by design decisions.

4.2 Process planning

Process planning is a preparatory step before manufacturing, which determines the sequence of operations or processes needed to produce a part or an assembly. This step is more important in automotive industry, where high volume products are manufactured using costly machines and facilities. Process Planning provides a single, scalable and secure source of manufacturing data that supports lifecycle processes from engineering through production. With a fully managed, single source of knowledge for products, processes, resources and plants, automotive companies can increase manufacturing's influence on product innovation to drastically improve profitability, time-to-market and quality as indicated in figure 4

FIGURE 3

Manufacturing lifecycle



Source: Abhijit

4.3 Operation planning

An operational plan is a document that lays out the basic structures and practices of a Automotive manufacturing lifecycle. An operational plan for automotive manufacturing should detail the metrics and operational status of all facilities and equipment. It should take into account geographical locations, floor space, operational purposes and floor plans of the facilities. It should also describe the various types of manufacturing equipment that the facilities employ, giving information regarding their purpose and their state of repair.

4.4 Machine Tools

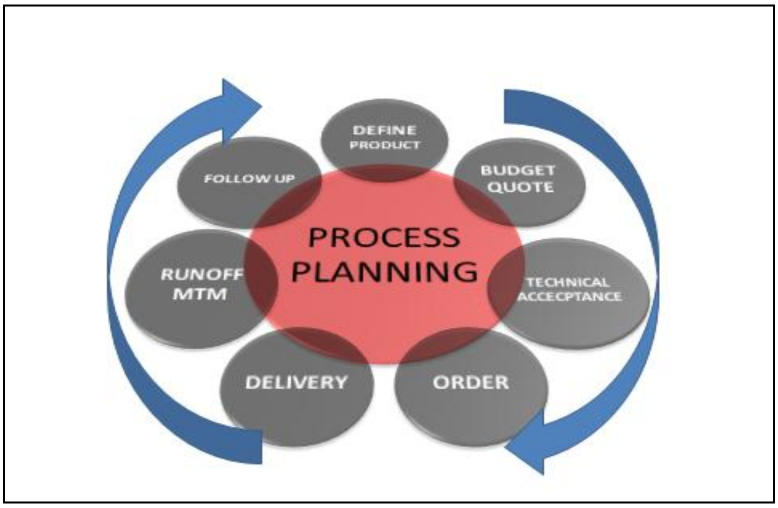
Machine tools in manufacturing are used to achieve a high level of specificity and uniformity. Machining tools can be used to selectively remove or finish a piece of metal or metal-based product. Machine tools are traditionally powered by electricity, additional automation of the machining process can be achieved by employing a CNC machine tool, guided by computer programming. The major benefit of machining tools is exceptional uniformity they deliver when manufacturing numerous products with identical parameters and requirements.

4.5 Production logistics

The purpose of production logistics is to ensure that each machine and workstation is being fed with the right product in the right quantity and quality at the right point in time. Production logistics provides the means to achieve customer response and capital efficiency. They can reduce costs and streamline the processes.It covers all activities connected to the supply of manufacturing operations.

FIGURE 4

Process planning



Source: Abhijit

4.6 Machining

Machining is manufacturing process that involves removing materials using cutting tools from raw material and converting it into finished products fit for assembly. These operations are usually mechanical and involve cutting tools(milling, drilling, hole milling, turning, reaming, tapping), abrasive wheels, and discs. Machining operations are performed using machine tools.

4.7 Verification

Verification plays a role in almost every stage, from initial development to production and upscaling. Many manufacturers perform quality verification to meet standard requirements, but monitoring quality can provide additional benefits as well. Verification is intended to check that a product meets a set of intended design specifications.

4.8 Supply to customers

Companies have real-time data on their products and stock. With an accurate inventory of the products, they can anticipate demand and avoid sending out more products than needed. If they have too much stock in the warehouse, they incur needless costs. On the other hand, if they have too little stock, it can undermine their liquidity position and their relationship with customers. It is really necessary to meet the needs of customer in manufacturing a product.

5. Digital disruption and losses

It can be observed in Traditional machine shops the usage of multiple processing stations discretely functioning in silos. Digital disruptive technologies as per figure 5 enable, mass communication between machines or processing stations,inflow of voluminous datapoints, wastage reduction, analytics enabled efficiency improvement resulting in demand for sustainable businesses.

5.1 Mass connectivity

Mass connectivity is the basic requirement of all Internet of Things (IOT). Mass connectivity is a term defining connection between all the points in the IOT ecosystem, such as machine tools, fixtures, cutting tools, sensors, gateways, routers, applications, platforms and other systems.

5.2 Growth of data

Number of devices connected to the Internet, including the machines, sensors, and cameras that make up the Internet of Things (IoT), continues to grow at a steady pace. A new forecast from International Data Corporation (IDC) estimates that there will be 41.6 billion connected IoT devices, or "things," generating 79.4 zettabytes (ZB) of data in 2025. As the market continues to mature, IOT increasingly becomes the fabric enabling the exchange of information from things, people, and processes.

5.3 Reduce waste

IOT presents a huge opportunity to reduce waste, lower the operating costs of automotive companies and improve the quality of service that businesses receive.Sensor-enabled and internet-connected machine tools, fixtures and cutting tools can collect information on cutting load, power, peak energy demand, oil consumption and thereby dynamically indicate operation cost providing venues for reducing waste.

FIGURE 5

Digital disruption and losses

Source: Abhijit

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5.4 Demand for sustainable business

Business sustainability, also known as corporate sustainability, is the management and coordination of environmental, social and financial demands and concerns to ensure responsible, ethical and ongoing success. Automotive manufacturing industry is a highly competitive sector, very often under cost pressure. Globally major automotive OEM`s like General Motors have undergone bankruptcy needing government intervention to bail them out. IOT facilitates sustainable businesses through highend analytics.

6. Benefits

The benefits of IOT 4.0 (Figure 6)into manufacturing helps in the following:

- ✓ Consistent quality
- ✓ Well monitored expenditures
- ✓ Tracability of components
- ✓ Machines and facility maintanace at right intervals
- ✓ Reduced proceesing times and resource usage
- ✓ Fact/data based decisions
- ✓ Justified automation

FIGURE 6

Benefits

Source: Abhijit

8. Conclusion

Based on the above study it can be observed that the future of cost competitive auto component manufacturing industry relies heavily on IOT 4.0 and connected digital devices paving the way to digital factory. This study is limited to IOT 4.0 applicability on auto component manufacturingand paves way for future research applicable for other industries.

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