Industrial Automation Systems: Production Support with Automation Intended to Minimize Costs and Increase Capacity

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ABSTRACT

Automation in production structures are operate within the factory on the bodily product. The carry out operations consisting of processing, meeting, inspection, or material dealing with, in some instances accomplishing greater than one of these operations within the same system. They are called “Automation” because they carry out their operations with a reduced stage of human participation in comparison with the corresponding guide method. In some fantastically automated systems, there is truly no human participation. The automation in manufacture systems consisting of automated machine tools that technique parts, transfer strains that perform a series of machining operations, automated meeting structures, production structures that use business robots to perform processing or meeting operations, automatic cloth managing and storage systems to combine manufacturing operations, automated inspection structures for nice control. Production support systems with automation is supposed to minimize the quantity of guide and clerical labour concerned in product design, production making plans and control, and the business functions of the industry.

Keywords: *Industrial Automation Systems, Automation in Manufacturing Systems, Production Support Systems*

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I. INTRODUCTION

1.1. Industrial Automation

Industrial Automation Without industrial automation systems it is hard to assume the production panorama those days. Growing demands for excessive product excellent, coupled with expectations of equally high reliability in excessive extent production, mean that the economic automation scale will preserve to increase. Much of what changed into man-made previously can no longer be achieved in terms of fee and high-quality. The fundamental demanding situations facing present day society are strength efficiency, mobility, and security. Industrial automation merchandise from Infineon meet some of these needs, delivering super reliability & robustness, outstanding pleasant and present days innovation. Rich functionality and sizable integration talents make sure that point to market is simple to layout and quickly. The utility for commercial automation is presented in the following diagram: The pyramid for automation illustrates each the 3 fundamental levels and the intercommunication among them.

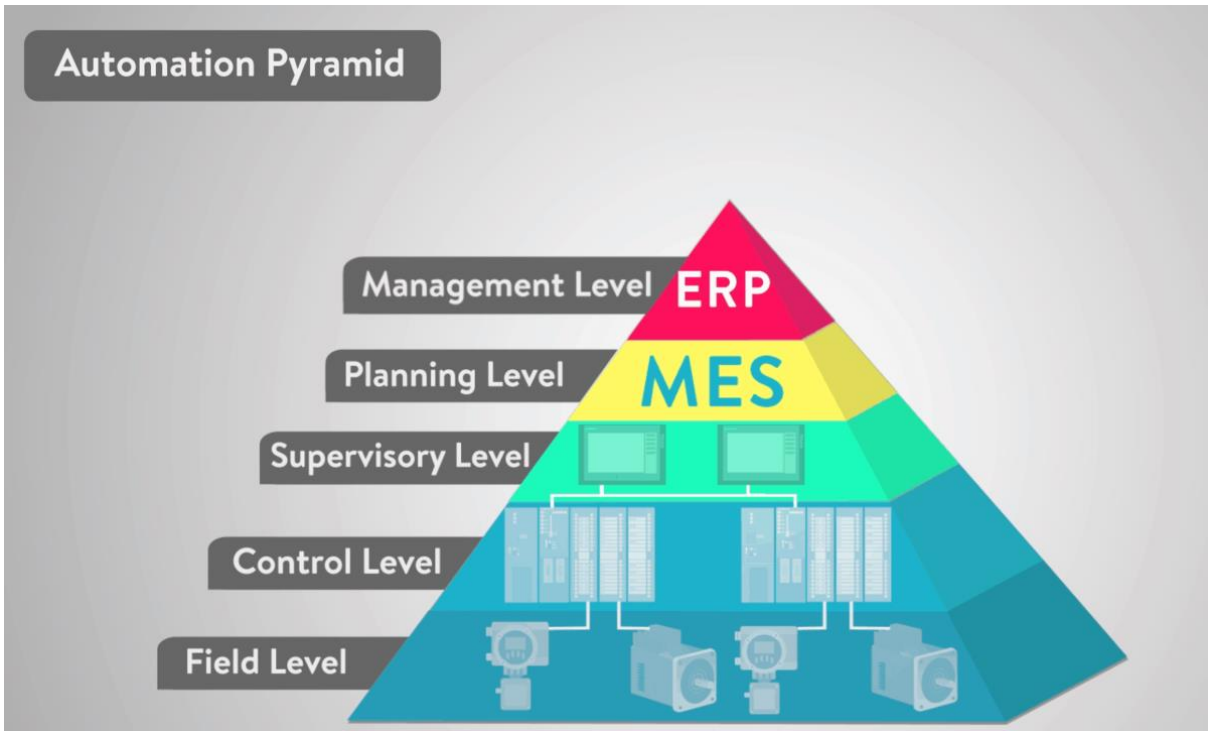

Figure 1.1. Automation Pyramid

In addition, in detail related to the automation pyramid, we introduce for the total automation solution in the parts of application includes the pyramid in Figure 1.2.

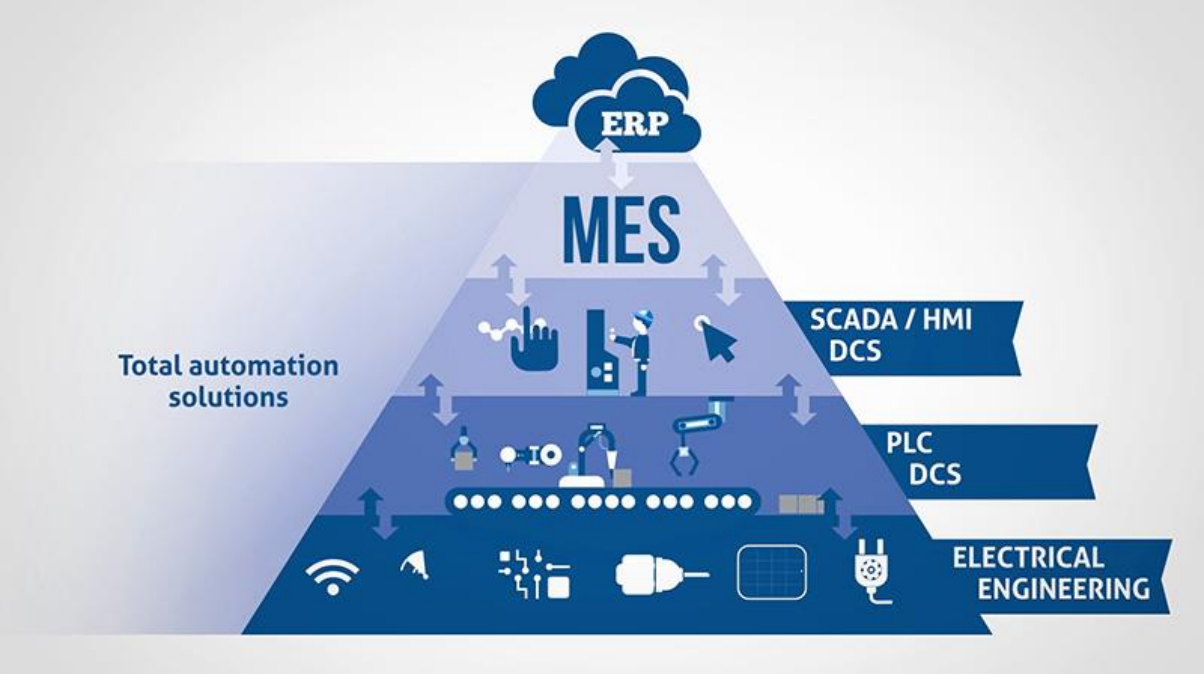

Figure 1.2. Total Automation Solution

1.1.1. Field Level. Beginning on the bottom of the pyramid is what we are able to seek advice from as the "field" degree. These are the devices, actuators, and sensors which you see in the field or at the production ground.

If you suspect of it this way, the sector level is the production floor that does the physical paintings and monitoring. Electric motors, hydraulic and pneumatic actuators to transport machinery, proximity switches used to stumble on that movement or positive materials, photoelectric switches that come across similar matters will all play a part in the subject degree.

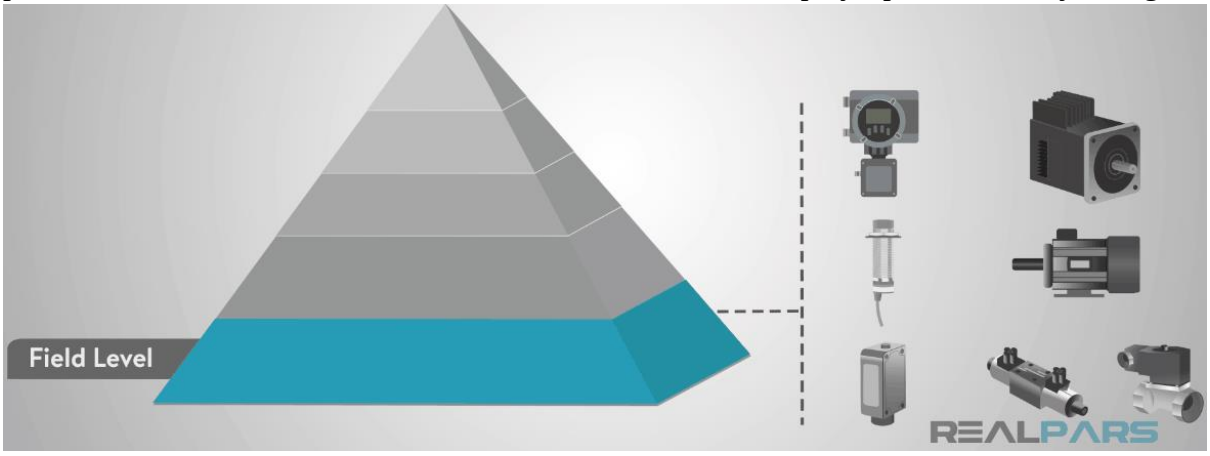

Figure 1.3. Field Level Application

1.1.2. Control Level. This is where the PLC's (Programmable Logic Controller) and PID's are available to play. The manipulate level uses these gadgets to control and "run" the gadgets inside the discipline stage that definitely do the physical work. They take in information from all the sensors, switches, and other input gadgets to make choices on what outputs to show on to finish the programmed task.

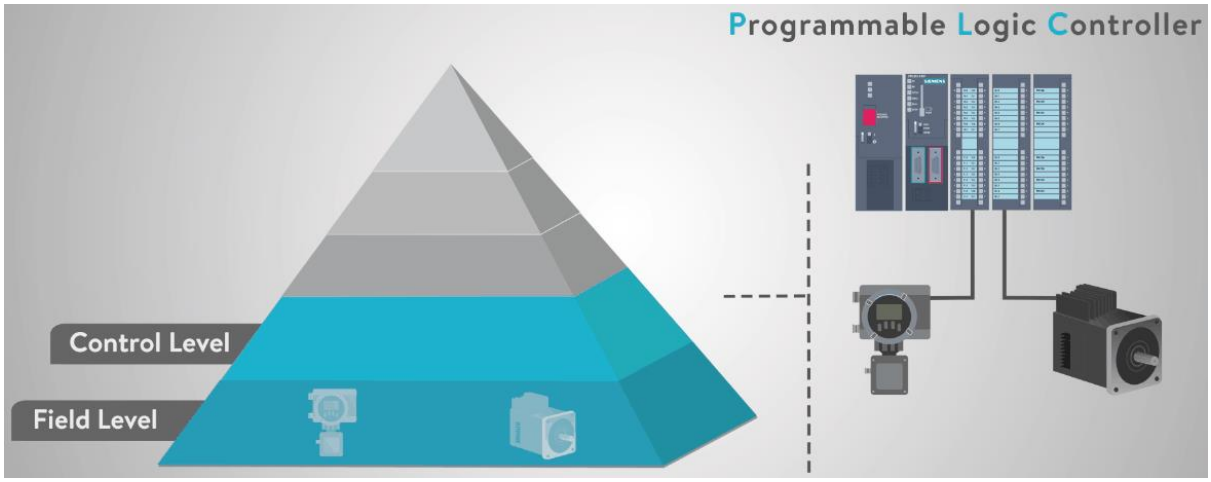

Figure 1.4. Control Level Application

1.1.3. Supervisory Level. The third level of the automation pyramid is referred to as the supervisory degree. Where the preceding degree utilizes PLCs, this level makes use of SCADA (Supervisory Control and Data Acquisition). SCADA is short for supervisory manipulate and statistics acquisition. SCADA is largely the combination of the previous degrees used to access information and control systems from a single location. Plus, it usually provides a graphical person interface, or an HMI (Human-Machine Interface), to manipulate features remotely. Water flowers will often appoint this technology to manipulate remote water pumps in their systems.

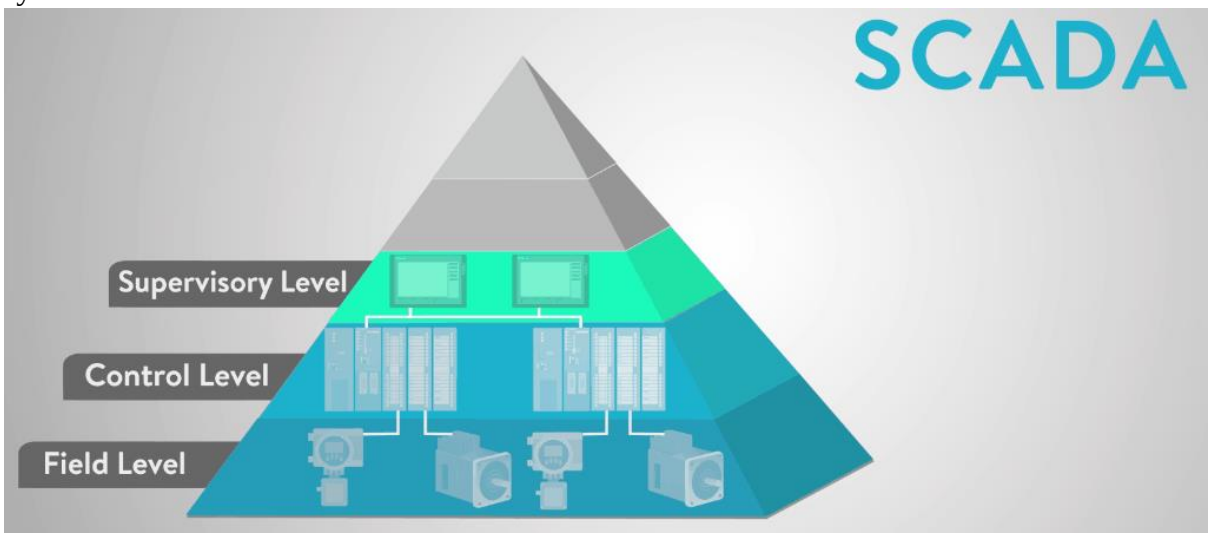

Figure 1.5. Supervisory Level Application

1.1.4. Planning Level. The fourth level of the automation pyramid is called the making plans level. This level utilizes a computer management system known as MES (Manufacturing Execution System). MES monitors the whole manufacturing manner in a plant or manufacturing facility from the raw materials to the finished product. This lets in management to see exactly what is happening and allows them to make decisions based totally on that information. They can regulate raw fabric orders or shipment plans based on real information acquired from the systems we talked about earlier.

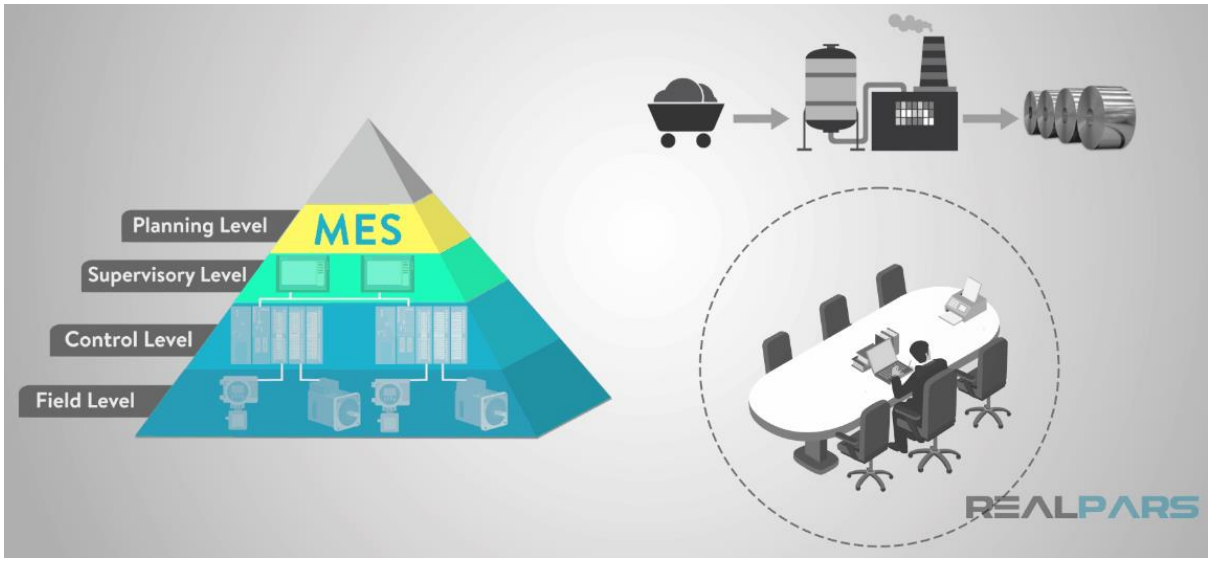

Figure 1.6. Planning Level Application

1.1.5. Management Level. The pinnacle of the pyramid is what is referred to as the control stage. This level uses the organizations integrated management machine which is referred to as the ERP (Enterprise Resource Planning). This is where a business enterprise's top management can see and manage their operations. ERP is usually a suite of different computer applications that can see the whole lot happening internal a corporation. It utilizes all of the previous degree generation plus some greater software to accomplish this stage of integration. This allows the business for you to screen all stages of the enterprise from manufacturing, to sales, to purchasing, to finance and payroll, plus many others. The integration of the ERP promotes performance and transparency within a company by keeping every person in the same page.

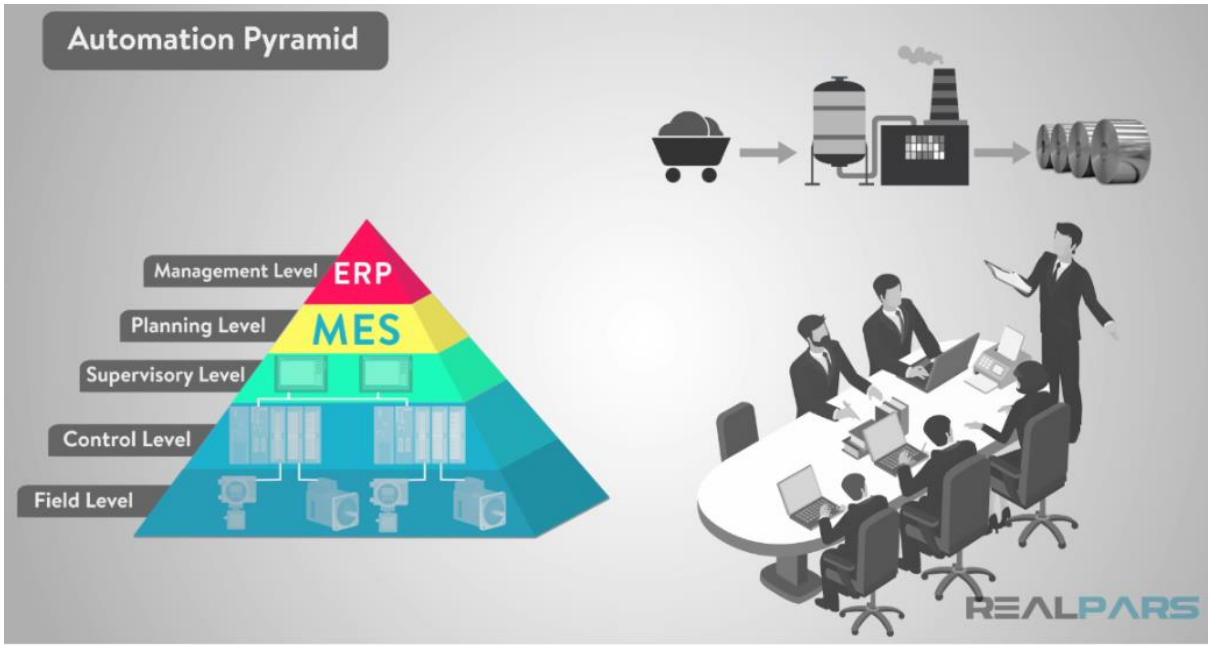

Figure 1.7. Management Level Application

1.2. The Technological Changes

Production ground are entering a time of first-rate transformation. This involves enhancements in nee wishes in manufactured merchandise and processes, production sites, and production workers. Changing needs in manufactured items and strategies replicate urgent necessities for producing greater advanced, more compact, brilliant products associated with Connected (linked vehicles), Autonomous (independent vehicles), Shared (shared vehicles), Electric (electric vehicles), 5 G, and other modifications in industry. Trade friction among the United States and China has affected converting wishes at production locations. These exchange frictions result in accelerated local production and consumption, requiring widespread product best from worldwide disbursed production sites and quicker expansion of producing facilities. Changing needs within the manufacturing employees reflect rising fees for personnel and an getting old society. Every manufacturer is very suffering with a serious employee shortage on the manufacturing ground and professional technicians. Those needs are increasing hastily as time moves. Meanwhile, the pace of innovation for AI, IoT, robotics and other technological improvements and adjustments in seeds is accelerating. These fast technology changes will prove a tailwind in highlighting the converting needs of production floors.

1.3. Reasons for Automation Implementations

Companies undertake projects for a whole lot of good motives in manufacturing automation and computer-included fabrication. The following are some of the motives used to justify the automation:

1. *To increase labor productivity.* Automating a manufacturing operation commonly will increase the charge of manufacturing and the productivity of labour. That means more output consistent with paintings input hour.

2. To reduce labor cost. The ever-increasing exertions charges had been and remain the fashion in industrialized societies around the world. Higher funding in automation has thus come to be economically justifiable as a replacement for manual operations. Machines are being more and more replaced with human labor to lessen the fee of unit product.

3. *To mitigate the effects of labor shortages.* In many superior nations there is a popular exertions shortage, and this has inspired the improvement of automated operations as a substitute for labour.

4. *To reduce or eliminate routine manual and clerical tasks.* An argument can be recommendation that routine, boring, fatiguing, and in all likelihood irksome, social cost exists in automating operations. Automating such tasks serves the motive of enhancing overall running conditions.

5. *To improve worker safety.* The painting is made safer by means of automating a given operation and shifting the worker from active participation inside the technique into a supervisory role. With the 1970 enactment of the Occupational Safety and Health Act (OSHA), the worker's protection and bodily well-being have become a national target. That has given an impetus to automation.

6. *To improve product quality.* Not only does automation lead to higher production costs than manual operations; it also performs the producing manner with greater uniformity and

compliance with excellent specifications. Reducing the rate of fraction defects is one among automation's leader benefits.

7. *To reduce manufacturing lead time.* Automation facilitates to reduce the time elapsed between patron order and product delivery, thus presenting the producer an aggressive benefit for destiny orders. The manufacturer also reduces the range of work-in-process inventories by using decreasing the production lead time.

8. *To accomplish processes that cannot be done manually.* Certain operations can't be finished without the assist of a machine. These processes have requirements for precision, miniaturization, or geometry complexity which can't be manually achieved. Examples consist of some incorporated circuit production operations, speedy prototyping procedures primarily based on computer graphics (CAD) models, and the machining of complex, mathematically defined surfaces the usage of numerical pc control. Only laptop-controlled structures can perform those strategies.

9. *To avoid the high cost of not automating.* There is a sizable competitive advantage in automating a fabrication plant. The gain can't be easily confirmed on the challenge authorization shape of a company. The benefits of automation regularly appear in surprising and intangible ways, inclusive of improved quality, better sales, higher hard work relations, and a higher image of the business. Unautomated businesses are probably to be at a competitive downside with their customers, their personnel and the general public.

II. LITERATURE REVEW

2.1. Automation Technology Aims

Automation is the generation that executes a method or system with minimum human assistance. Automation or automatic manage is the use of multiple input systems for operating equipment, such as machinery, strategies in factories, boilers and heat-treating ovens, switching on phone networks, steering and maintaining ships, aircraft and other packages and automobiles with minimum or minimal intervention by humans.

Automation covers applications starting from a heater-controlled family thermostat, to a big industrial manipulate machine with tens of lots of enter measurements and output manipulate signals. It can range in control complexity from easy on-off manage to high-level multi-variable algorithms.

A controller compares a measured cost of a technique with a desired set value in the only form of an automatic control loop and tactics the ensuing error sign to exchange some enter to the system in such a manner that despite disturbances the system remains at its set point. This closed-loop control is a negative remark implemented to a device. The mathematical foundation of control idea was commenced inside the 18th century, and rapidly advanced inside the 20th.

Automation was finished by using diverse means, normally in combination, including mechanical, hydraulic, pneumatic, electrical, digital devices, and computers. Complicated structures, inclusive of modern factories, plane, and ships, usually use all of these strategies together. Automation benefits include employment savings, electricity cost savings, material price savings, and upgrades in quality, precision and accuracy.

2.2. The Ten Strategies for Automation and Production Systems

If automation seems to be a feasible answer for improving productiveness, excellent, or other performance measurement, then the following ten techniques provide a street map to look for these improvements. We seek advice from them as automation and production structures strategies because some of them relate, whether or not the process is a candidate for automation or just for simplification.

1. *Specialization of operations.* The first method involves the use of special-motive equipment designed with the greatest possible performance to perform one operation. This is analogous to the concept of labor specialism, used to improve the productiveness of hard work.

2. *Combined operations.* Production happens as operational sequence. Complex elements may additionally require dozens or even hundreds of processing steps. Combined operations approach includes reducing the variety of distinct manufacturing machines or workstations to direction the part via. This is performed by means of carrying out multiple operation on a given system, thereby reducing the variety of separate machines required. Because each gadget normally includes setup, setup time can typically be saved due to this method. Material dealing with effort is also decreased as is non-operation time. Producing lead time for better customer support is reduced.

3. *Simultaneous operations.* A logical extension of the blended operations strategy is to perform the operations which might be combined at one workstation simultaneously. In effect, two or more processing (or assembly) operations are carried out concurrently on the same work piece, thereby reducing overall processing time.

4. *Integration of operations.* Another approach is to link multiple workstations into single incorporated mechanism, the usage of automated paintings coping with gadgets to transfer parts among stations. In effect, this reduces the wide variety of separate machines thru which the product should be scheduled. Multiple parts may be processed concurrently with multiple workstation, according increasing the general output of the system.

5. *Increased flexibility.* This strategy seeks to maximize the usage of device for job keep and medium volume situations by way of the use of the identical gadget for quite a few components or products. It includes the usage of the flexible concept of automation. Primary dreams are to reduce manufacturing gadget setup time and programming time. This normally interprets into decrease lead time in production and much less in-method paintings.

6. *Improved material handling and storage.* The use of automated fabric handling and storage structures presents a super opportunity to reduce unproductive time. Typical blessings consist of decreased paintings-in-system and shorter lead times in production.

7. *Online inspection.* Traditionally, fine of labor inspection is done after completion of the method. This approach that any product of poor high-quality has been produced by using the time it is inspected. Incorporating inspection into the manufacturing process lets in for system corrections because the product is being produced. That reduces scrap and brings the overall product excellent towards the designer's nominal specifications.

8. *Process control and optimization.* This consists of a wide range of manipulate schemes aimed at greater efficient operation of the individual tactics and associated device. This approach can lessen the character technique times and improve product satisfactory.

9. *Plant operations control.* Whereas the previous approach concerned manage of the man or woman production process, manipulate on the plant level issues this method. It tries to extra efficaciously manipulate and coordinate the combination operations within the plant. Its implementation commonly entails a high stage of in-fabric pc networking.

10. *Computer-integrated manufacturing* (CIM). Taking the previous approach one stage higher, we have factory operations incorporated with engineering design and the firm's enterprise functions. CIM entails the considerable use of enterprise-wide computer applications, pc databases and laptop networking.

2.3. Automation Migration Concept

Due to competitive market pressures, a agency regularly wishes to introduce a brand new product in as brief a time as possible. As referred to earlier, designing a manual production method the usage of a chain of workstations working independently is the very best and least expensive way to perform this aim. The tooling for a manual method may be manufactured fast and at low cost. If, as is regularly the case, more than one set of workstations are required to make the product in enough quantities, then the guide cellular is replicated as usually as vital to satisfy call for. If the product turns out to be successful, and predicted high destiny demand, then automating production makes sense for the enterprise. Often, the improvements are made

in phases. Many businesses have a approach of automation migration, that is, a formalized plan to evolve the manufacturing systems used to provide new products as call for increases. A typical strategy for the automation migration is as follows:

Phase 1: Manual production using single station manned cells running independently. For motives already mentioned, that is used to introduce the brand of new product: speedy and low-cost tooling to start.

Phase 2: Automated production automatic cells working independently from one single station. As demand for the product increases, and it turns into apparent that automation may be justified, then the single stations are automated to reduce exertions and increase the rate of production. Working devices are nevertheless manually moved between workstation.

Phase 3: Automated integrated production Use of an automated multi-station gadget with serial operations and automated switch of work gadgets among stations. If the company is sure that the product can be synthetic in mass quantities and for numerous years, then integration of automatic single-station cells is warranted to further reduce labor and increase the price of production.

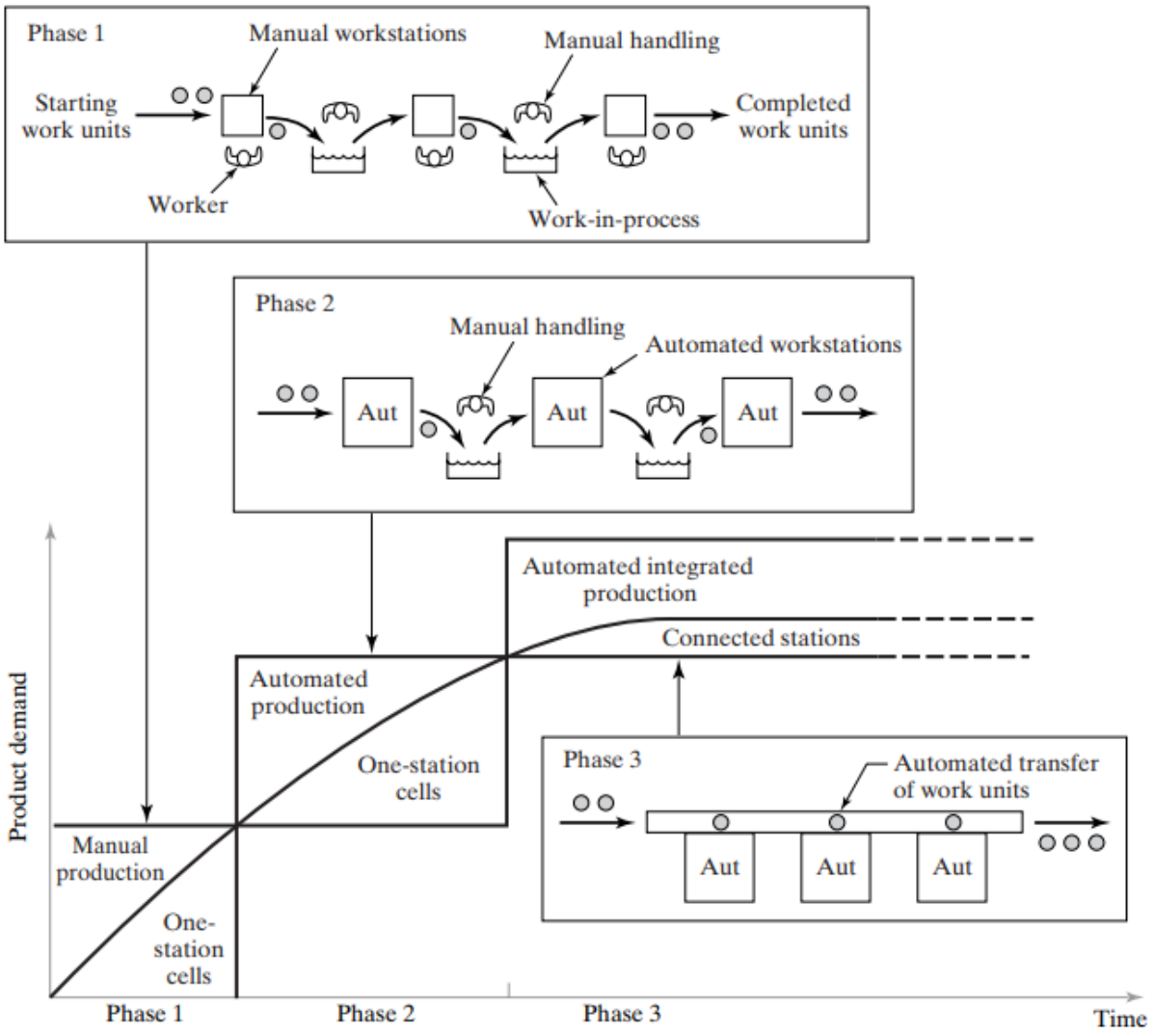

Figure 2.1. A typical automation migration concept.

2.4. Automation Support in Production Systems

Some factors of the company's manufacturing gadget will possibly be automated while others may be manually or clerically operated. Automation can be defined for our functions right here as a generation involved with the application of mechanical, electronic, and computer-primarily based systems for production operations and control.

The automated factors of the manufacturing device can be separated into classes: (1) manufacturing structures automation inside the factory, and (2) manufacturing help systems computerization. The two categories overlap to a degree in modern production systems, because the automated manufacturing systems working at the factory floor are frequently implemented through computer systems themselves and related to the automated manufacturing assist systems and management information device running at the plant and corporation level. This huge use of computer systems in production systems is indicated by using the term computer-included manufacturing. The two classes of automation are proven in Figure 2.2.

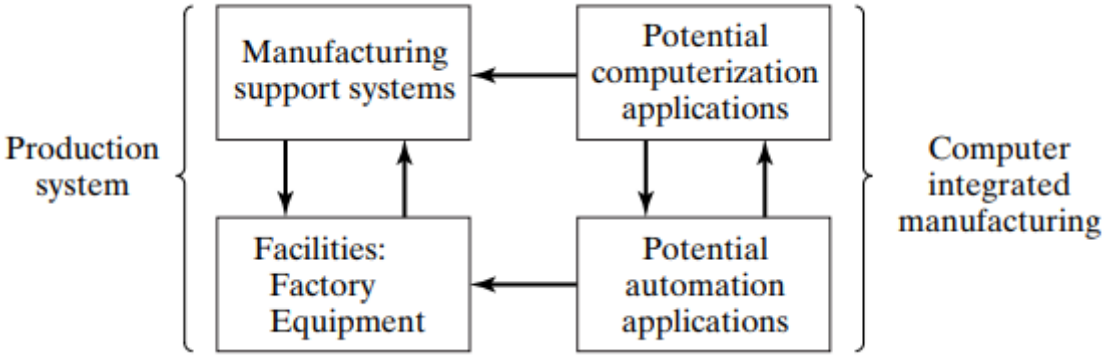

Figure 2.2. Opportunities of automation and computerization in a production system.

2.4.1. Automated Manufacturing Systems

Automated manufacturing systems operate on the bodily product inside the factory. They carry out processing, meeting, inspection, or fabric dealing with operations, in some cases appearing greater than this kind of operations inside the same system. Compared with the corresponding guide system, they're known as computerized because they perform their operations with a discounted level of human participation. There is surely no human involvement on some fantastically computerized systems. Examples of automated fabrication structures consist of:

- automatic machine equipment that manner components
- transfer traces that carry out a chain of machining operations
- computerized meeting structures
- manufacturing structures that use industrial robots to perform processing or assembly operations
- automated cloth dealing with and storage structures to combine production operations
- automatic inspection systems for excellent control

It is possible to categorise computerized manufacturing systems into 3 simple types: (1) constant automation, (2) programmable automation, and (3) flexible automation.

(1) *Fixed Automation.* Fixed automation is a machine wherein the configuration of the gadget determines the collection of processing (or assembling) operations. Each of the sequence operations is normally simple, possibly regarding a plain linear or rotational motion, or an uncomplicated aggregate of the two; for example, feeding a rotating spindle. Typical functions of constant automation are:

- high initial investment for custom-engineered gadget
- high production charges
- relatively rigid in accommodating product variety

In products which might be produced in very large quantities and at excessive manufacturing rates, the financial justification for fixed automation is found. The initial excessive price of the system can be un-fold over a very large range of units, according make the cost of the unit attractive as compared to alternative production methods. Examples of constant automation encompass switch line machining and automatic meeting.

(2) *Programmable Automation.* The manufacturing system is designed in programmable automation with the potential to trade the series of operations to accommodate extraordinary product configurations. The sequence of operations is controlled with the aid of an application which is a fixed of coded commands so that they can be study and interpreted through the system. New programs can be organized to produce new merchandise and entered into the device. Certain functions characterizing programmable automation consist of:

- high investment in general cause device
- decrease manufacturing fees than constant automation
- flexibility to deal with versions and adjustments in product configuration
- most suitable for batch manufacturing

In low and medium volume manufacturing programmable computerized manufacturing structures are used. Typically, the components or the products are made in lots. The machine has to be reprogrammed with the set of gadget instructions which correspond to the new brand product so that it will produce every new batch of an exceptional product. The device's bodily setup has additionally to be changed:

Tools have to be loaded, fixtures should be connected to the system desk and the necessary machine settings should be entered. It takes time for that changeover procedure. The traditional cycle for a given product consequently includes a period during which the set-up and reprogramming take place, followed via a period in the course of which the batch is produced. Examples of programmable automation include numerically controlled (NC) device tools, business robots, and programmable logic controllers (PLC).

(3) *Flexible Automation.* Flexible automation is an extension of programmable automation. A bendy computerized device is capable of producing a whole lot of components (or products) from a part fashion to the subsequent with truly no time misplaced to change. While reprogramming the gadget and changing the bodily setup (tooling, fixtures, gadget settings) there's no lost production time. Consequently, the machine can produce one of a kind combinations and schedules of parts or products as opposed to requiring them to be made in batches. What makes bendy automation feasible is that there are no good size differences

among the processed elements. It is a soft variety case, so the quantity of switching required among styles is minimal. The features of flexible automation can be summarized as follows:

- excessive funding for a custom-engineered gadget
- non-stop manufacturing of variable mixtures of merchandise
- medium production charges
- flexibility to address product design versions

The bendy manufacturing structures for appearing machining operations dating returned to the late Sixties are examples of flexible automation.

The relative positions of the three kinds of automation for one of a kind production volumes and product sorts are depicted in Figure 2.3.

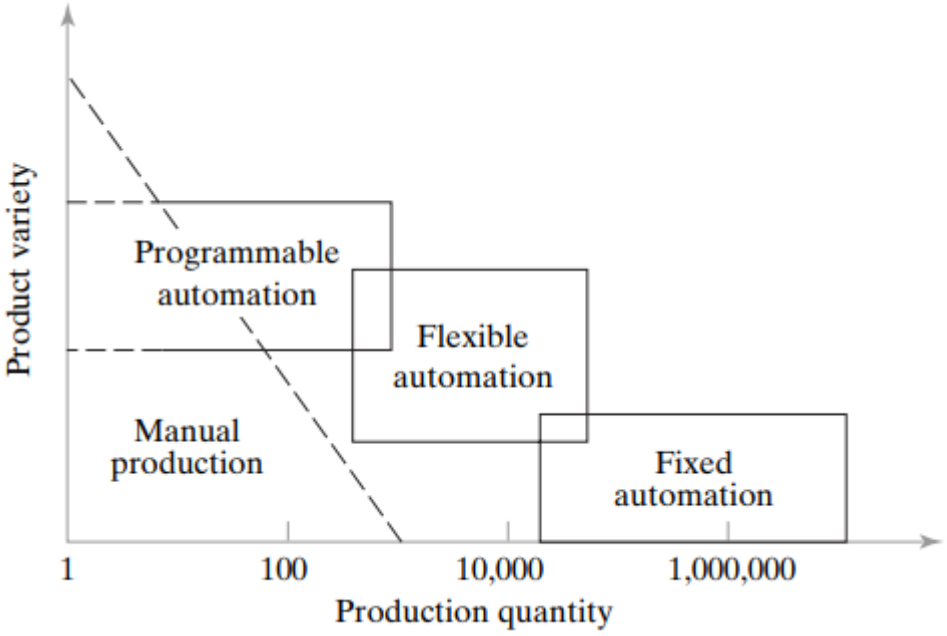

Figure 2.3. Three types of automation relative to production quantity and product variety.

2.4.2. Computerized Manufacturing Support Systems

Manufacturing support systems automation goals to reduce the amount of guide and clerical effort in product layout, manufacturing planning and manage and the company's business features. Using computer systems almost all contemporary manufacturing guide systems are implemented. In fact, laptop generation is used to implement automation of the factory production structures as well. The term of Computer Integrated Manufacturing (CIM) refers back to the omnipresent use of laptop structures to layout products, plan production, manage operations, and perform the numerous business-associated functions required by way of a production company. True CIM involves integrating all these capabilities into one device that works across the enterprise. Other terms are used to identify particular CIM-gadget elements. Computer-aided layout (CAD) for instance denotes the use of laptop structures to guide the characteristic of product design. Computer-aided manufacturing (CAM) denotes the use of computer structures to carry out production engineering-associated capabilities inclusive of system planning and element programming of numerical controls. Some laptop structures carry

out both CAD and CAM, meaning that the time period CAD / CAM is used to signify the 2 being integrated into one device. Computer integrated manufacturing includes CAD / CAM however it is usually the production-related business functions of the firm.

Let us try to define the relationship among automation and CIM through growing a production conceptual model. In a manufacturing firm, the physical production sports taking location at the manufacturing facility may be outstanding from the information processing activities, which include product design and production planning, which commonly take vicinity in an office environment. Physical sports include all of the processing, assembly, dealing with of substances, and inspection operations performed at the factory product. During fabrication these operations come into direct contact with the product. Figure shows the relation among the physical activities and the statistics processing activities in our model. Raw materials circulate one manufacturing facility end and finished products waft out to the alternative cease. Inside the manufacturing facility are the physical activities taking area. The records processing sports in our model shape a hoop which surrounds the manufacturing unit, providing the records and knowledge vital for the successful manufacture of the product. Processing activities are carried out for you to implement the four basic manufacturing guide features diagnosed above: (1) business features, (2) product design, (3) production making plans and (4) manufacturing control. These 4 capabilities form a cycle of events that have to accompany the sports of bodily production however do no longer touch without delay on the product.

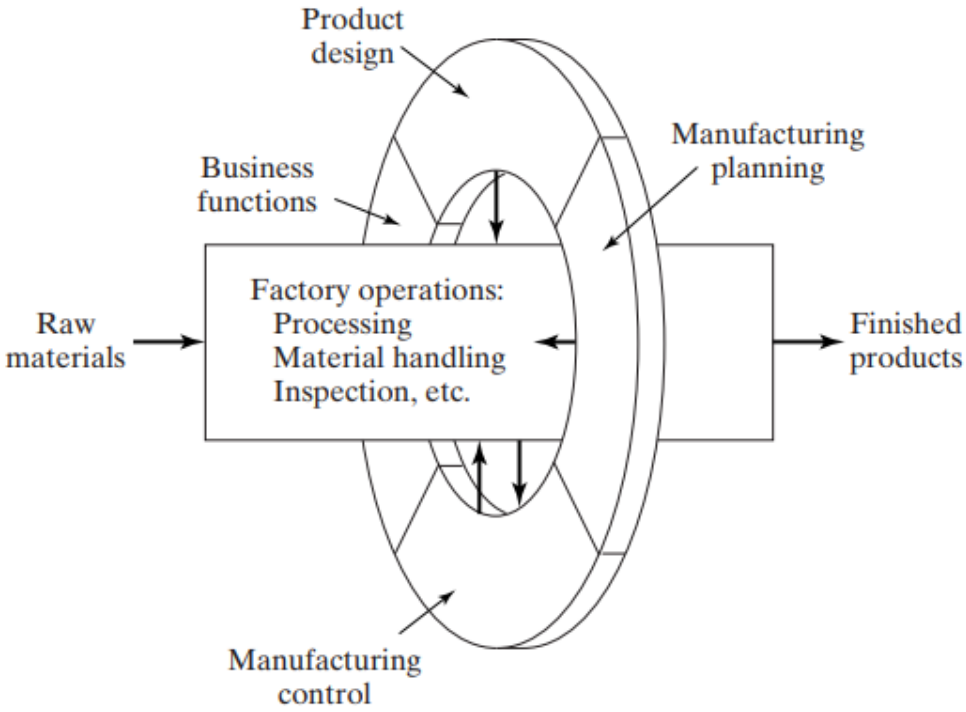

Figure 2.4. Model of manufacturing showing factory operations and the information processing activities for manufacturing support.

2.5. The Genesis of Innovative-Automation

To use innovation in solving production floor issues, in 2016, we came up with the IAB (Industrial Automation Business) value creation concept. This consist the [three "'’i"] of the innovations driving automation on the production floor. These concepts are **integrated** (evolution in control), **intelligent** (intelligence developed through ICT), and **interactive** (new harmonization between humans and machines). This is the intersection of changes in needs, changes in seeds, and OMRON's unique approach. Evolution in control refers to achieving ultra-high-speed and ultra-high-precision machine control. This is a combination between the IAB lineup of the widest range of control devices in the industry and software. Intelligence developed through ICT refers to the incorporation of AI and IoT into all manufacturing control devices, driving machines themselves to learn and evolve. The ultimate goal is to create production lines that experience zero stoppages and create high-quality products with zero defects. A new harmonization between humans and machines means machines that autonomously move, working together with humans. The machine and the human each leverage their own strengths in cooperation, leading to a new reality for production floors.

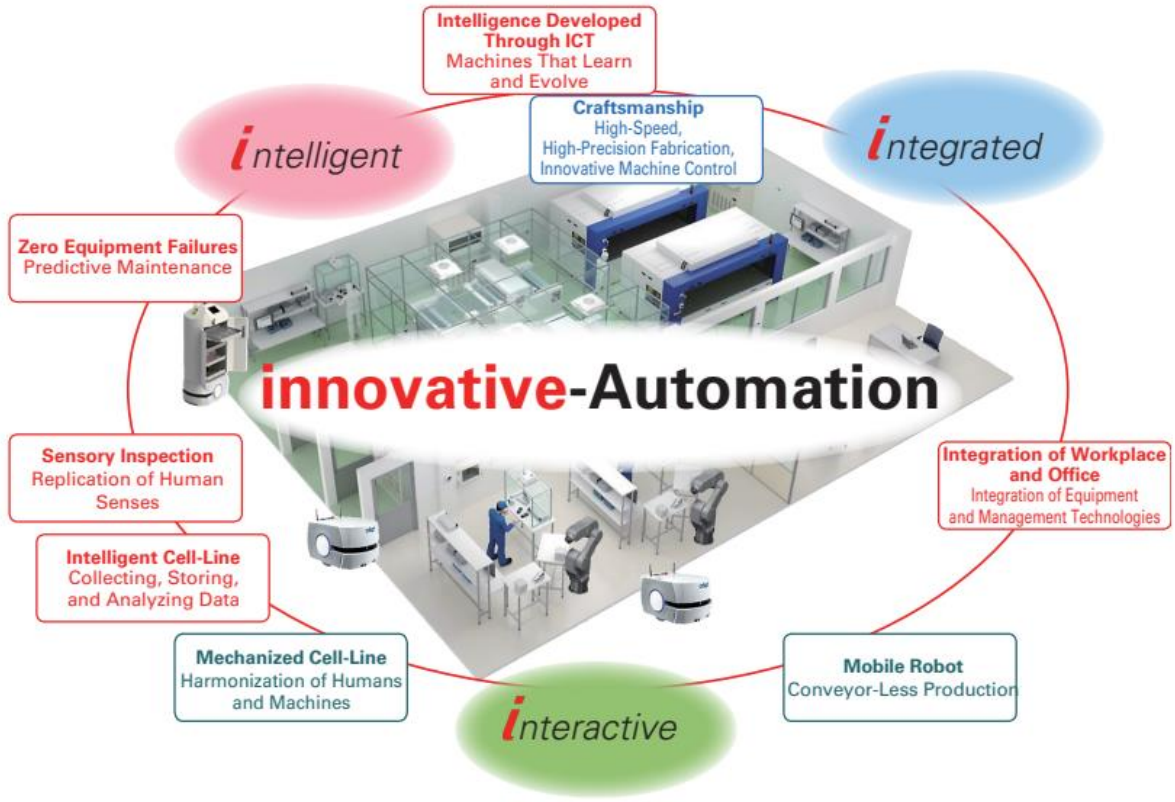

Figure 2.5. Innovative-Automation Platform

III. Conclusion and Recommendation

3.1. Conclusion

Product competitiveness may be advanced by using making use of automation era. Industrial sectors that require automation technology include the automotive, food and beverage industries, Original Equipment Manufacturer (OEM), and infrastructure.

Production potential is described as the maximum price of output that a manufacturing facility (or manufacturing line, paintings center, or institution of work centers) is able to produce below a given set of assumed operating conditions.

With the implementation of automation era that emphasizes maximum gadget overall performance and harmonious relationships between machines and workers, it is anticipated to have a positive effect on high manufacturing ability with the satisfactory product quality.

3.2. Recommendation

In the gap of inserting automation, the provider of automation system could improve recommendations over shared repositories and perhaps without delay improve activity reputation. Here, the major studies challenges involve incorporating the user's operating environment into the advice automation and system application to make the pointers correctly context aware.

For enhancing user decision making, recommenders can assist to arrange the choice space, providing sensible defaults for arrange of programming selections, along with appearing data flow modifications in an editor or selecting a nice generalization in a system. Challenges here encompass making suggestions about information-sparse decisions like simple edits. Again, context recognition could help to clear up the problems in manufacturing production process.

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