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Parameters of Manufacturing Informatics and Smart Manufacturing and their Roles in Improving Productivity and Accelerating Innovation

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***Abstract*— The manufacturing sector throughout the world in general and in India & other less developed countries in particular has undergone major changes in last few decades. Manufacturing industries in the developed world are now going in for customized production than mass production and involving extensive use of new technologies (viz. Information and Communication Technology, Manufacturing Informatics & Smart Manufacturing etc.) for improving productivity and accelerating innovation. Many of these changes are also visible in Indian industry as well. This paper has been planned to identify the parameters of manufacturing informatics and smart manufacturing.**

Keywords*— *Manufacturing Informatics, Smart Manufacturing, Manufacturing Intelligence, ICT.

I. INTRODUCTION

The manufacturing industry is treated as the source of many problems; still it is recognized as the leading mechanism for revolution through economic growth [3]. Many large companies are reacting to competitive pressures by "digitizing" their supply chain, manufacturing processes, parts, and in-service data. Data is captured during the product development and analyzed for chances to decrease tooling costs and lead times, while improving productivity and innovation. The axiom, "Digital Thread," is generally used to describe this process [20].

Manufacturing informatics helps to optimize individual unit processes. Manufacturing Informatics applies ICT to accelerate innovation, improve productivity, achieve extraordinary performance goals, and motivate the economic advantage of funds.

Smart Manufacturing assimilates Manufacturing Intelligence in real-time across an entire manufacture operation in medium and large companies. Real time administration of energy is a perfect example of the inconsistency between the potential benefits and hurdles to the employment of Smart Manufacturing technology. Smart Manufacturing provides the interoperability, operative infrastructure, initiative technology and approaches for tracking raw materials in plants and the complete supply chain that are required to deal with this condition.

As a new manufacturing technology and concept, smart manufacturing is going to be typical growth roadmap of advanced manufacturing.

The key types and tasks of smart manufacturing are:

1. No uncertainty and reusability of digital depiction of products.
2. Predication of product growthprocedure and product's performance
3. Manufacturing activities are independent of distance, time and location. It is expected that smart manufacturing will develop rapidly in this decade.

II. REVIEW OF LITERATURE

A. Parameters of Manufacturing Informatics

Information and Communications Technology (ICT) is the assimilation of computers as well as necessary enterprise software, telecommunications, service providers, middleware, storage, and audio-visual systems, which help the users to access, store, transmit and manipulate information. The implementation of ICT solutions as a tactical knowledge, previous and current work in the subject has been focused on investigating present exhibitions of informatics in manufacturing supply chains, understanding the obstacles to the adoption of informatics solutions and providing high level strategies for the initial acceptance of ICT's. In latest years, ICT has become progressivelysignificant in the manufacturing enterprise. Operational information sharing and exchange among computer systems during a product's life cycle has been a serious issue [9]. Information modelling is a technique for postulating the data requirements that are needed within the application purview [13]. The greater use of ICT in manufacturing acquaintances the design stage of a specific component to the larger assembly manufacturing system to the use of manufactured products [10]. The use of ICT not only increases overall productivity in the factory by increasing communication speed and efficiency, it also preserves quality by better regulating processes [10].

Enterprise Resource Planning (*ERP*) is a group of business-management software particularly a collection of integrated applications that an organization can use to assemble, store, administer and interpret data from different industrial

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activities, including product planning, procurement, manufacturing or service providing. It improves manufacturing processes all the way through the supply chain to increase efficiency and decrease costs. The data assembled by linked manufacturing processes are interpreted in real time. Intelligent feedback loops permit adapting designs, materials, or activities to manufacturing and maintenance shortfalls [20]. ERP helps to integrate and handles all major business actions including product planning, parts procurement, inventory management, order tracking, HR management, projects management, and funding. ERP links business processes electronically across different business tasks and thus help to improve efficiency in operating those practices. ERP systems can play an important role for supporting the connectivity between firms. ERP systems are an important "hub" for much of their e-commercefunctions with other manufacturing firms.

Informatics (IFT) refers to the usage of novel and emerging ICT tools and information methodologies for advanced manufacturing technologies, activities and tools. In addition, it is involved in internal and joint projects in areas including quality and equipment health, developing informatics solutions for various applications, such as additive manufacturing and robotics. Sectors of work include space, locomotive, nutrition and beverages and logistics. Even though the Manufacturing Informatics is new, it is emerging speedily and so is the competency developed. An information prototype is anillustration of theories, associations, constrains, guidelines, and procedures to specify data semantics for a chosen area of discourse [15]. The advantage of using an information prototype is that it can offer a sharable, established, and systematized structure of information requirements for the areaof interest. There are variousmethods in developing an information prototype. Informatics will be vital to coupling developments in modeling through its mining of information and developments[14]. Due to the several modeling and simulation measures already in use and there are many groups that develop them, innovations in informatics may also play a vital role in establishment to connect across them [14].

Cyber-physical production system (CPPS) is a system that synergizes orthodoxmanufacturing technology and ICT, permitting machines and products to communicate with each other in the Internet of Things (IoT). Hugeamount of data potentially fetched from multiple reliable sources can be subject to pattern recognition and analytical techniques that can couple correlations between parameters that investigational studies cannot simply couple [29]. These methods, which comprise data discovery, mining, and modeling, provide insight into how a material's composition and form, process variables, and geometric structure can be optimized.

Data mining tools use computer algorithms, graphics, algebra, mathematics, statistics and to extract meaningful information and identify patterns in collections of data [22].

By 2025, advances in mobile and cloud computing joined with the growth of sensor networks will reveal the vision for a cyber-physical world with omnipresent computing capability [19]. The sensors may be implanted into objects or embedded into walls, leading to trillions of connected machines; the networked sensor systems enable real-time data processing on wireless computing devices, creating intelligent and adaptive cyber environments for developing applications such as autonomous transportation systems [21].

B. Parameters of Smart Manufacturing

Advanced Manufacturing (AM) is a knowledge-enabled, prototype-rich initiative in which all operating activities are automatically determined and performed proactively applying the best conceivable information and a varietyof performance metrics. Advanced manufacturing is knowledge-enabled and ICT has a vital role to play in enhancing manufacturing intelligence, supporting association, increasing productivity, accelerating innovation, and empowering new business prototypes and tools.

In advanced manufacturing, information is not only the prevailing factor but also the most dynamicstimulating factor. Improving the information handling ability of the manufacturing firm has become one of the significanttools of advanced manufacturing [30] [2] [26][32].

Advanced manufacturing consequences from practical advancements over the present state of art in the assembly of materials and products; these developments comprise developments in manufacturing activities and structures, which are frequentlyencouraged by innovations in basic science and engineering streams. These new systems, which are usually referred to as "intelligent" or "smart" manufacturing systems, assimilate computational probability and working productivity.

The main drift in advanced manufacturing is the administration of multifaceted global supply chains. From last few years, several drifts have led to more complex supply chains, among them growing demand for high-technology products, globalization, reducing logistics and communication costs, and the development of e-commerce [15]. The administration of these supply chains is supported by developments in ICT, such as ERP software and RFID technology.[1][31].

Flexible manufacturing system *(FMS)* refers to a system which produce parts those are readily compliant to the alterations in the product under production process, in which machines are able to produce parts and in the capacity to manage different stages of production. There is dire need for flexible manufacturing and supply networks, performance optimization, resource productivity and sustained equipment. All of these are linked by communications systems into incorporated flexible manufacturing systems and eventually into an overall programmedindustrial unit or CIMS.

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Most of the manufacturing industries are leading towards real-time management of energy use, whichare the larger resource expenditures for these industries. In spite of the propagation of real-time energy-management tools for commercial structures, commonly known as energy information systems [8], tools for manufacturing industries are rather less established, possibly because the amount of changeability between plants is greater than that between different structures.

Prompt changes in process technology claim manufacturing systems that are self upgradeable, and into which innovative tools and novel utilities can be easily incorporated [17]. This state has generated the requirement for novel manufacturing control systems that have capability to manage production change and disorders, both efficiently and effectively [29], and has evolved some new concepts such as "flexible manufacturing"[22],reconfigurable manufacturing" [17], "agile manufacturing" [7], and "holonic manufacturing" [4].

Manufacturing intelligence (MI) refer to technology which assimilates a company's manufacturing- associated data from a number of sources for generating the reports, analysis of data, visualization of summaries, and transmitting data between enterprise-level and plant-floor systems. On the other hand, technical work will be directed towards communications,advanced analytics &intelligence, and embedded intelligence. Tacticalcollaborations are also being designed for joint development of service platforms for the expansion and establishment of informatics services.MI improves efficiencyandthe effectiveness of operations. MI offersstraightlinking to machine panels to constantly monitor, track, compare, and analyze production parameters. This also empowers manufacturers to safeguard that machines are functioning within the defined limits.

*Smart Manufacturing Execution System (SMES)*refers to an online integrated industrial setup which leads to the gathering of the systems and tools used to accomplish production. It is a real-time production management technologyor information system which lies between the ERP and factory floor. Smart MES evaluation requires a variety of indicators [11] [12] [24]. The quality assessment index setting is directly associated to the successorquality of the Smart MES performance assessment. Selecting the accurate and rational performance assessment indicators can assist businesses and Smart MES to enhance the allocation of resources, to increase system performance, to propose methods for development. The use of computer-enabled toolsincreases communications that empower both "smart manufacturing" in the factory and "smart supply-chain design"— directing the right products to the right suppliers [25]. Most of the manufacturing systems are physically disseminated over a plant site, so that their embedded system components will also be physically apart. To interact and coordinate while meeting inflexible timing necessities, real-time industrial communication rules must be engaged, so that a well-timed communication occurs [16] [18].See Table I.

III. OUTCOMES

Productivity refers to average degree of the competence of production. It can be measured as the proportion of output to inputs used in the manufacturing process, i.e. output per unit of input. The use of ICT not only increases overall productivity in the plant by increasing communication speed and efficiency, it also preserves quality by better managing processes [10].

Innovation refers to changing processes or creating more effective processes, products and ideas. It can translate an idea or invention into a good or service that creates value or for which customers will pay. If the manufacturing leads towards decentralized production, more distributed, supply-chain management and innovation will provide even more [26].

IV. FUTURE RESEARCH

The study on manufacturing Informatics and smart manufacturing will accelerate the establishment and expansion of new streams like 'computational manufacturing' and 'intelligent manufacturing' and will thrust the advancement of the entire manufacturing discipline.

V. CONCLUSION

This review study determines the parameters of manufacturing informatics and smart manufacturing which are helpful in improving the productivity and accelerating the innovation. The manufacturing automation achieved through these parameters together with the Intelligent Automation themes and using our other technology themes as application drivers, enables the factories of the future. Innovation and productivity will be the key elements to future manufacturing system.

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