AN OVERVIEW OF e- MANUFACTURING

Neeraj Kumar Dagur\textsuperscript{1}, Tilak Raj\textsuperscript{2}

\textsuperscript{1,2} Department of Mechanical Engineering, YMCAIE, Faridabad
\textsuperscript{1,2} E-mail : ne2raj83_ymca@yahoo.com, tilakraj64@rediffmail.com

Abstract

With the Globalization and tremendous improvement in the Manufacturing Technology, the scope for improvement in the area of manufacturing (through process / technological upgradation) has been almost reduced to nothing. So, the manufacturing industries have been looking for other areas where they can improve to survive in this market full of cut throat competition. The IT Revolution, which has greatly affected the manufacturing industry since the late 90’s has again answered the questions posed by the current situation in the manufacturing domain. But, this time IT will not be implemented just as another part of manufacturing, but IT will integrate all the domains of manufacturing into a single unit, thus forming an IT based integrated system. This technology is being called e-manufacturing. This paper presents some researches done in this area and also a new (holistic) approach to the subject of e-manufacturing is ventured in this paper, in which all the major IT based tools in manufacturing are included as a part of the vast area of e-manufacturing.

KeyWords: Web technologies, Tether-free, PDM

1.0 Introduction

The invention of steam engine added power to the manufacturing capabilities, thus accelerating the progress of manufacturing, F. W. Taylor’s management science improved human efficiency, and the relatively latest being the invention of world wide web by Tim Berners-Lee which started the IT revolution, which has changed the way of working in the industries. The IT revolution has added pace to each and every domain of the various activities performed by the human being. Advances in IT ranging from the introduction of Electronic mail (e-mail) to the implementation of Central Control of the CNC machines in the manufacturing industries (DNC), have all led to the minimization of the time lag between the dispatch and receipt of information. The implementation of many modules of IT in the manufacturing has led to the speeding up of product realization, manufacturing, delivery and costumer servicing. All these developments have brought us closer to the “Webbed” future i.e. the web based manufacturing. With globalization the costumer base has increased on one side whereas the market competition has increased on the other side, the social and political environment has also changed. All this has led the manufacturing industries to shift their focus from factory integration to the supply chain based e-factory philosophy.

2.0 Basic Concept and Definition of e-Manufacturing

Imagine that when a person wants to buy a car he visits a manufacturer’s website rather than a showroom. Sitting at ones own desk a person decides on the model he want, selects the color, chooses the options, and agrees on the price, all without human intervention in the process. Then the person gives his mouse a final click that sends the instruction to start assembling your custom automobile directly to the manufacturing plant [12]. This is just what one can expect the future of manufacturing to be, and the technology that will make this possible has just arrived in the form of e-manufacturing. This concept mentioned above is shown in Fig. 1

e-manufacturing is the recent concept developed as an to answer the aforementioned needs of e-business strategies and to meet the requirements for the complete integration of all the business elements including all the suppliers, costumer services networks and the manufacturing units through the effective use of the web-enabled computational tools and tether-free technologies [1]. In simple terms e-manufacturing can be termed as virtual handling of real enterprise, which is based on utilization of advanced Information Technology in the manufacturing unit. It is concerned with achieving concurrency, integration of human & Technical resources and transforming of useful information into useful knowledge [9].

Koc et al. [2] have defined e-manufacturing in the following way: “E-manufacturing is a system methodology that enables the manufacturing operations to successfully integrate with the functional objectives of an enterprise through the use of Internet, tether-free(i.e. wireless, web, etc.) and predictive technologies”
3.0 E-Manufacturing Includes

Lee [1], and Crandell and Tomoyuki [11] have mention about some constitutes of e-manufacturing, which are mentioned below:

- Ability to monitor the plant floor: its machines (machine tracking), man power, their relative interactions through web, and the ability to control the equipments i.e. – Control and monitoring, Advanced process control, Run to Run control, Engineering Analysis systems, Quality management & Test Systems [1].
- Automated WIP tracking and material handling spare parts management [1].
- Ability to automatically gather all the related information and transfer it to central data base (data ware housing)
- Ability to predict variation from standards and judge the performance loss due to errors/variations (e-diagnostics)
- Fault detection and classification [1].
- Ability to prepare the production scheduling and ensuring the follow up without making a physical contact at the shop floor or even the plant area; automated dispatching [11].

4.0 E-Manufacturing Capabilities

e-manufacturing is mostly based on IT. In order to perform all the fundamental functions of an e-based enterprise, as described by Lee [1], e-manufacturing should have the following capabilities:

1. Development of intelligent agents for continuous, real time, remote and distributed monitoring and analysis of devices, machinery and items.
2. Ability to develop remote distributed and web based quality control systems and their integration with intelligent predictive agents in order to identify the variations in the product quality and understand their causes in real time.
3. Ability to develop a dependable and scalable information platform for complete transformation, optimization and synchronization of plant floor problems, issues and their solutions.
4. Ability to develop a virtual design platform for collaborative parts, process, tool design among suppliers, design and process engineering and as well as customer for fast validation and decision making.

5.0 Various Methodologies of e-Manufacturing

5.1 Web based decision making

With the advent of globalization the relative distances among the various departments and their personnel has increased a lot, and this geographical limitation has hampered the decision making process. To overcome this limitation a web based group decision support system (GDSS) has been proposed by Wang and Chien [2], to support various activities involved in decision making process of the members of a decision making group. These GDSSs can provide various levels of support, including idea generation, information sharing, decision analysis and alternative evaluation. The infrastructure of these GDSS is based on object-oriented and agent technology [2].GDSS is an interactive computer based system that facilitates a group of decision makers to solve unstructured or semi-structured problems. The web-based group decision support system as proposed by Wang and Chien [2], consists of two basic modules – an information classification and retrieval module, and a decision
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inference module that includes deterministic and probabilistic decision inference functions. These modules guide the user to follow the systematic decision making processes to structure problems, collect information, develop a model, and analyze a decision step by step [2]. In addition to these modules the input/output interface modules provide an interactive mechanism for the communication among the clients (user) and the other components of the system.

Fig. 2 System architecture of the GDSS [2]

5.2 Web based product designing, development / process development
With engineering design being one of the central processes in manufacturing, an efficient Engineering Design process is likely to enhance the performance of the production and ultimately the manufacturing processes [6]. The product / process development phase requires cooperation, coordination, and unrestricted information flow from people of different disciplines (Designers, Production Engineers, Marketing Executives, Materials Managers, and Service Engineers, Industrial Engineers …), located at different geographical locations; so as to enable them to specify and design the product. These requirements can be best achieved through the integration of ERP/SAP and CAD/CAM as suggested by Soliman and Clegg [6]. The model of CAD/CAM integration with ERP is shown in Fig. 3. The main objective of this model is to prevent wastage of work due to unnecessary duplication, thus eliminating waste of efforts and eliminating non-value added activity.

An additional feature that aids in e-design / e-development is the New Generation PDM (A Web enabled Product Data Management system) system as suggested by Xu and Lui [4].

PDM integrates many different areas of product development, which ensures that the right information is available at the right time, at the right place and to the right person through out the business enterprise [4]. The new generation PDM can support the entire life cycle of the product from the beginning i.e. from the idea generation phase to the final manufacturing of the product. One of the main features of the PDM system is its potential to include multiple users (with different design soft wares) in the product development process in a much open environment. And the existence of the many similarities between Web and PDM Technologies leads to better collaboration between the participants in the design/development process.

Xu and Lui [4], have proposed three tier architecture for the Web enabled PDM system using web and its technologies. In which a distributed Web serves maintains product data and information, and these can be accessed and used by the domestic users or the remote clients. The Fig. 4 shows the detailed PDM system architecture.
Fig. 3 Integration of CAD/CAM with ERP [6]

Fig. 4 Model of Web enabled PDM system in collaborative design environment [4]
With the use of these technologies many problems related may be solved and also development process of a product will result more results with the input from each area of manufacturing and that too at a global platform.

5.3 Online manufacturing (CIM, DNC, Adaptive Control, FMS)

Today’s machining shop floor characterized by large variety of products in small batches require dynamic control and real-time monitoring capabilities that are responsive and adaptive to rapid changes of the production capability and functionality [8]. So, there is the need to integrate all the automated equipments together. Till now modern manufacturing technologies such as CIM, FMS, DNC etc. have provided partial solutions to the manufacturing needs but now there is a need to integrate all these under a single platform, for which Wang et al. [8], have suggested frame work named wise shop floor (Web – based integrated sensor driven e-shop floor), which is shown in Fig.5.

The wise shop floor has been designed to provide a real time monitoring and remote control to the users through web based and sensor driven intuitive shop floor environment. This concept makes use of latest Java technologies, like Java 3D and Java Servlets, as the enabling tools for its implementation. The wise shop floor combines the real devices with the virtual reality through synchronized real time data communications, it aids the shop floor engineer/manager to be assured of normal shop floor operations, and enables web based trouble shooting.

In addition to this concept, a new concept of Tele operation of CNC Turning centre through internet has been suggested by A’ Ivares and Ferreira [7]. This concept implies continuous and direct control of CNC machine placed in a remote location, and allows exercising force and accomplishing movements through visual, resonant or tactile data.

In Teleportation, control and supervision of the system is done by the operator through a graphic station called system console, from which the operator controls and supervises the remote system by the aid of man machine interface. Internet enables the creation of graphic environments relatively easily, which facilitates the interface with the user, besides having a low cost with regard to the tele operated equipment [7]. Through the communication network of the system the information can be sent and received, which enables the execution of the commands through some device like robots connected to the network.

As depicted in the Fig.6, on the next page the operator can directly visualize the progress on the computer screen provided through web and control the operation without being present near the machining operation.
5.4 e-business/ e-marketing /e-procurement (Supply Chain Management, e-commerce)

E-business includes use of internet as a tool for marketing and information distribution & collection, extra net / email for inter/intra net communication, and provision for services and products; it enables electronic interaction among the modern day manufacturers and the consumers [5].

E-manufacturing provides web based strategies and systems that facilitate co-ordination between manufacturers and the suppliers & costumers for more efficient procurement, production and distribution.

Zhang et al., (2006) have proposed an approach towards the supply chain integration based on the concept of DIMS (Dynamically integrated manufacturing), which has three main domains: strategic, operational and technological domain. While in the strategic domain DIMS is concerned with development and integration of business capabilities, Operation domain of DIMS deals with the dynamic configuration and integration of physical resources (People, machinery and equipment and materials) .The Technological domain of DIMS is concerned with the modularized manufacturing hardware and software technologies that support the dynamic integration of manufacturing system (Zhang et al., 2006).

Fig. 6. WebTurning—teleoperation and remote monitoring of the CNC turning center [7]

Fig. 18 DIMS integral approach (Zhang et al., 2006)
6.0 Conclusion

e-manufacturing is a system that has a potential to answer most of the questions which the Globalization brings with it. So, there is requirement for the major manufacturing corporations and the technical institutions, to work towards research in this area and also promote the research in this area. As time progresses there will be the need to transfer from the relatively conventional methods of manufacturing to the holistic approach towards web based manufacturing that will include most of the areas of the current working of the manufacturing industries. In the years to come e-manufacturing will not only provide an edge to a company against its competitor but it will also become a necessity in the time to come. So, it can be definitely said that the day is not far away when the customer will take up the job of: a designer who selects the design of his own, a production engineering who gives the command to start the manufacturing operation when required, and then in the end ensures the dispatching and transportation of the product after its packaging while performing the work of a logistics engineer.

References