E Manufacturing a Technology Review

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Abstract: **With a rapid change in technology especially in the manufacturing sector, customers are demanding more value, less risk, and better integration of products, hence there is a need to change the manufacturing strategies, which can result in improved performance thereby meeting the customer demands. This paper critically reviews a new area to overcome the above problem called "E – Manufacturing" which can integrate customers, products and suppliers with the help of Internet Technology. The concept of E - Manufacturing, its development, tools and potential benefits are discussed along with application examples on Automobiles. Areas like E – Maintenance, E – Diagnostics, E – Business related to E – Manufacturing is also discussed. By adopting such a manufacturing technique zero downtime, reduced product error, customer satisfaction, quick manufacturing changes can be accomplished. In addition the concept of E-Manufacturing applied to the manufacture of gears is also discussed there by providing better understanding of this process.**

***Index Terms*— E – Manufacturing, E – Maintenance, E – Diagnostics, Automobile, Gears.**

I. Introduction

For today's manufacturing companies what matters more is that how efficiently their company can compete globally with others as an organization followed by meeting the day to day requirements of the customer and exchange of hassle free information while not focusing only on sales of the company [1]. Today's customers provide top priority for money, better quality and less risk. In order to cater to the needs of the customer, manufacturing companies have adopted a new technique called E Manufacturing. It is concerned with the use of the Internet and E-Business technologies in manufacturing industries wherein a network can be established between the customer, the manufacturer and the product. The internet offers a frictionless path for exchange of information. The concepts of E-Maintenance, E-Business, E Diagnostics and E-Care have led to the formation of an E-Factory which can produce quality products at remarkable speeds. In short, the customer is just a click away from a business deal. Within manufacturing concerns, the various enterprise-wide systems like ERP, MES, SCADA, and even newer acronyms like Enterprise Asset Management (EAM) and Product Lifecycle Management (PLM) are communicating with each other, and sharing data through internet connections.

Manuscript received October 11, 2007.
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II. Evolution of E Manufacturing

For decades, the dominant manufacturing model was based on principles of mass production [2]. Standardized parts and processes made economies of scale achievable, but limited design flexibility and customization. The outsourcing and lean manufacturing movements of the 1980s and 1990s drove the emergence of a new paradigm, termed the Quality Management era. Manufacturing companies, particularly large Original Equipment Manufacturers' (OEM) outsourcing shifts critical elements of the design and production process onto a manufacturer's supply chain. The lean manufacturing movement places a premium on time and inventory reduction. Combining the attributes of the Quality era suggests a very different business model for manufacturing – enterprise integration or E-Manufacturing. In the E-Manufacturing era, companies will be able to exchange information of all types with their suppliers at the speed of light.

III. E Manufacturing

E-Manufacturing can be most cogently and generally described as the application of the *Internet to Manufacturing* [3], further E-Manufacturing is becoming popular with the increased use of the internet. Due the widespread availability of the Internet; large-scale distributed projects in manufacturing are becoming popular. It is the methodology and framework for collaborative Virtual Manufacturing. The ability to exchange information and automate manufacturing processes forms the building blocks of the virtual manufacturing companies of the near future. It covers all aspects of manufacturing - sales, marketing, customer service, new product development, procurement, supplier relationships and logistics manufacturing strategy development and so on. As a result, it is now so much easier to allow certain people gain access to certain sections of the system, according to whatever criteria they like; maintenance people need certain parts of the data, but not others; operators would be able to access a limited number of devices; managers would be allowed to monitor, but not change anything, etc. New technologies such as the Extensible Markup Language (XML) are now making it easier to share data between different application programs, and to set up computers to take actions based on criteria ‹ for instance, to order supplies when inventories reach a critical low point. The E-Manufacturing

technique also affects products as well since it is possible to use Internet technologies to add new product functions and to provide new services. The Internet is being used even at the shop floor level. For instance, computer numerical control devices (CNC's) can be connected via intranets or the Internet to ERP (Enterprise Resource Planning), production planning, or maintenance systems. As such, the E-Manufacturing project aims to develop an appropriate framework for a common platform to enable distributed planning and control in manufacturing for quicker, easier, secure and cost-effective collaborations. The developed system will allow dispersed engineering team members to work together productively, as if they were under one roof. This transformation of the enterprise coincides with the increasing content of information contained in products and processes. This new production enterprise is information-rich.

The major functions and objectives of e-manufacturing are: (a) provide a transparent, seamless and automated information exchange process to enable an only handle information once (OHIO) environment; (b) improve the utilization of plant floor assets using a holistic approach combining the tools of predictive maintenance techniques; (c) links entire SCM operation and asset optimization; and (d) deliver customer services utilizing the latest predictive intelligence methods and Tether-free technologies [4]

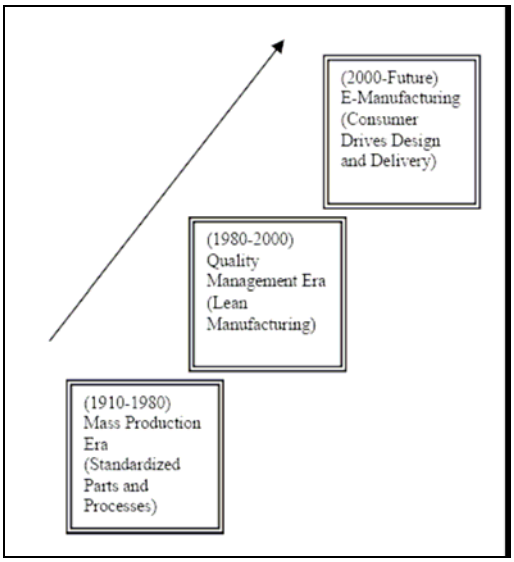

Fig 1 Evolution of E Manufacturing (Source NACFAM)

The contrast between the traditional system and the system with E-Manufacturing is indicated below [3]

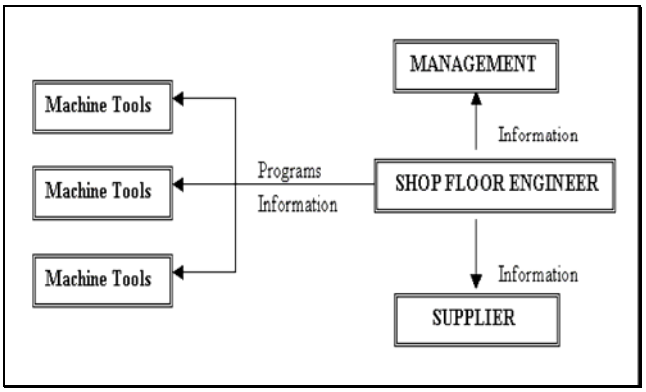

Fig 2: Before Implementing E Manufacturing

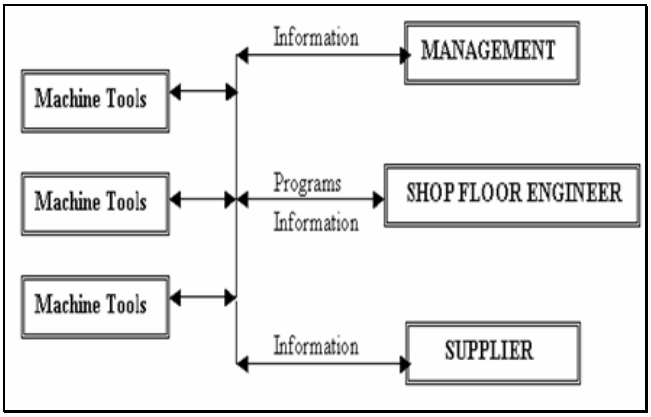

Fig 3: After Implementing E Manufacturing

IV. E Manufacturing Tools

Implementation of the E-Manufacturing tools results in cost saving, regardless of the company size. E-Manufacturing tools enable connectivity among the various modules of the manufacturing process. Areas where the E-Manufacturing tools need to be developed are listed below [5 - 9].

Data and information transformation tool:

The large amounts of raw data collected during a manufacturing process are rendered useless, unless the data is gathered and transformed into some useful information which may be used to monitor a system. To understand this better a simple example is taken below. Consider a CNC machine hooked to the Internet as shown in Figure 4. It shows the way data and information are transformed from the machine to the internet. Here the idea is to monitor the health of the tool [life of the tool] fixed in the CNC machine. This technique can also be used to calibrate a machine from the Internet.

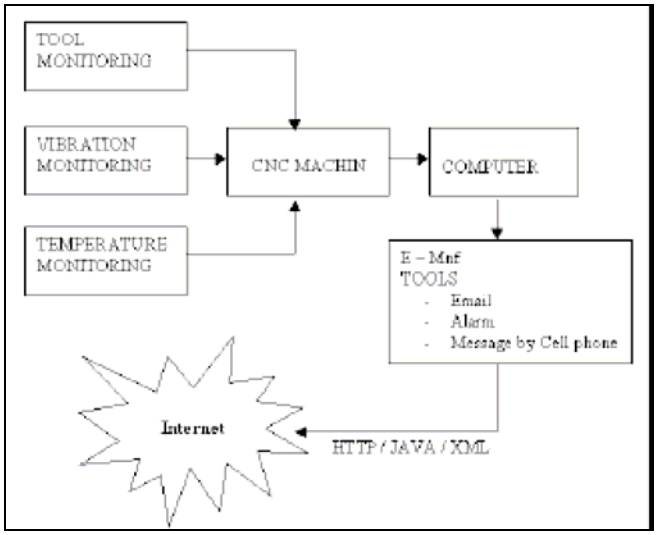

Fig 4: Tool Monitoring in a CNC Machine Using Internet.

Prediction Tools:
Apart from data being gathered, certain tools need to be developed, which can predict or detect the degradation of various parts of the machine, performance loss and trend of failure. Developing a tool which monitors these aspects could set the trend for an advanced diagnostic system.

Optimization Tools:
As far as E-Manufacturing is concerned data can be accessed from any part of the globe at any time. Hence certain tools need to be developed which can optimize the data and provide easy to read results. For example, these tools should be able to provide the performance of a drill bit for various drilling operation verses time, temperature, tool tip failure with various materials etc.

Synchronization Tools:
This is an important tool in the E-Manufacturing environment, which can associate various groups such as customer's suppliers and manufacturers, where first hand information needs to be sent to these groups during emergencies, for example – if tool needs a replacement or tool has worn out then the information is sent from first the manufacturer to the supplier and tool maker where the tool can be assessed for performance. The new connectivity and communications tools will boost productivity, profits, speed to market, and flexibility for those manufactures who are willing to upgrade. Some of the common E-manufacturing tools are SMS, E Mail, Bluetooth, Wi-Fi, Fax and Infrared Connectivity.

V. E Maintenance

Progressive plant executives, maintenance managers, and work planners have always wanted to have information about the condition of equipment assets at their fingertips when they need it. Unfortunately, it typically is scattered among separate information systems. It is difficult to view, compile and synchronize the different information types on the same computer terminal. If one wants to maximize business continuity by increasing device up-time and minimize the time, costs and headaches associated with device administration he must adopt the E-Maintenance strategy. It is a network that integrates and synchronizes the various maintenance and reliability applications to gather and deliver asset information where it is needed, when it is needed. Interconnectivity of the islands of maintenance and reliability information is embodied in E-Maintenance. The E-Maintenance network can be developed from a collection of information islands by using a single proprietary system, a custom bridge, or by using an open systems bridge. E-Maintenance also removes the need for manual meter readings that is your device administration is virtually reduced to nil. It is estimated that 15- 40% of indirect costs of manufacturing is maintenance related. About 50% are unnecessary corrective maintenance, which costs 10-15 times more than predictive maintenance. Furthermore, 25% of maintenance is preventive, which is 3-5 times more expensive then predictive. An effective E-Manufacturing strategy uses predictive maintenance techniques to forecast equipment wear and predict failure. Apart from this, it also alerts MRO managers to unexpected problems. This allows managers to proactively correct problems, thus maximizing the use of machinery and personnel while minimizing preventive maintenance expenses. Predicting the reliability of plant-floor equipment can be the difference between a few minutes of preventive maintenance and hours or days of downtime for corrective maintenance. Ultimately, predictive maintenance, computerized maintenance management systems or CMMS, and effective utilization of maintenance specialists make E Manufacturing work.

VI. E Diagnostics

E-Diagnostics is the reactive and proactive remote diagnosis, maintenance and repair of equipment by service personnel. E-Diagnostics offers many businesses the promise of better equipment reliability and performance at a much lower cost. It is the hardened, reliable acquisition of time-stamped, high-speed information from the tool registers and ancillary data points, database retention and management, parsing and analysis. A complete E-Diagnostics solution would include the following:

(a) Remote capture, transmission, analysis and dissemination of equipment performance data.
(b) Remote takeover of equipment to manipulate equipment settings during and after repair.
(c) A trigger for replenishing spare parts.
(d) Faster and more effective response to field service engineering requests, bringing the experts remotely to the problem.
(e) Reduced equipment and process variation, through better visibility and response to differences in equipment performance among machines.

(f) Preventive response to pending equipment failures through the use of advanced process control (real-time multivariate statistical analysis).
(g) Enhanced next-generation tool development through improved awareness of deficiencies in current equipment designs.

Traditional E-Diagnostics systems monitor tool performance and provide "maintenance needed" alerts to service and engineering personnel. Much more can be derived from the rich sensor data generated as wafers pass through process chambers. This step in E-Diagnostics is to employ proven enterprise data mining (EDM) techniques to correlate device yield and performance with the vast amount of tool-level and wafer-level chamber sensor data. With this new approach, yield and process-level issues can be uncovered down to a particular sensor reading on a specific tool process chamber. Once a specific tool issue can be identified to have an impact on process results, specific E-Diagnostics monitors can be targeted to prevent future yield and process excursions, completing a closed loop process learning effort. The steps to be followed to implement the E Diagnostics strategy in an industry are as shown below.

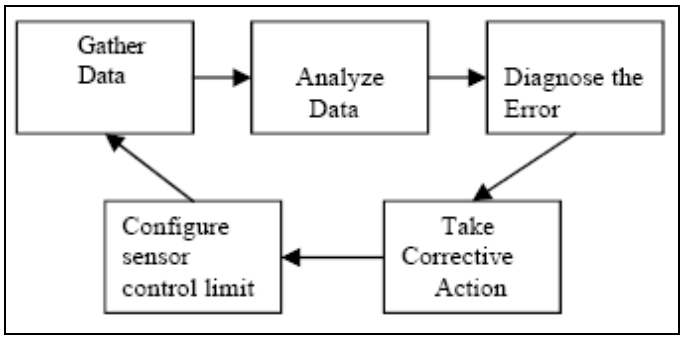

Fig 5: E Diagnostics

VII. E Business

In today's world it's the "Time Factor" that can make or break an industry. Gone are the days of buying different applications from a host of technology vendors and spending countless months and dollars integrating them. Increasingly, the customers are demanding more customized products, faster delivery schedules, and instant access to order status. Results have to be assessed in financial terms, with return on net assets or return on capital employed, the key measure. E-Business promises a solution to this customer demanding market. Automated scheduling provides a better method of managing production orders and increases the visibility of current and future scheduling activities. Tracking involves the collection, analysis, viewing and reporting of production data. To get the best productivity from the assets deployed, three main areas need to be addressed: Condition based maintenance; computerized maintenance management; E-Procurement. Condition-based maintenance predicts the deterioration of assets that allows the planning of maintenance actions more effectively and monitors the effectiveness of the maintenance programme. Computerized maintenance management systems optimize the deployment of all maintenance, repair, and operating (MRO) resources, such as people, spare parts, tools and facilities, and allow the creation of a planned maintenance programme for all assets. E-Procurement allows the replacement of stock with information and offers direct access to spares at lowest cost. For the successful application of E-Manufacturing there must exist a partnership between the supplier and the customer. The goal is to deploy best practices in e-business processes as quickly and effectively as possible while ensuring a quantifiable return on investment (ROI).

The benefits of adopting E business strategy are;

(a) Quick installation of software updates with no need for expensive integration projects.
(b) One enterprise wide view of the customer, product or process.
(c) Global deployment from one instance of the software, making all applications accessible globally via a standard Web browser.
(d) Simplified systems and maintenance for IT staff due to the one-vendor approach.
(e) Streamlined business processes.
(f) Better decision-making and business intelligence because of the single-database architecture and pre-integrated applications and rapid deployment at lower cost.

VIII. AUTOMOBILE INDUSTRY AND GEARS

Every automobile industry has an umpteen number of divisions, each division manufacturing a particular system of the automobile- like the steering system, brake system, engine, suspension, chassis and body, interiors, safety division, quality control division, etc. With so many departments working towards the creation of the same end product, a lot of time and money is spent in redesigning and related cases which may arise due to inefficient data transfer or delayed transfer of important information between the departments. Such a problem can be sorted out by implementing the E-Manufacturing strategy into the industry. The internet can be used to share data and information between various departments and between manufacturers worldwide. Data sharing can be extensively used between the head office and the various branches and service centers of a company which may be located at different locations around the globe. For example, if a component is found defective in one of the branches the information is relayed immediately to the other branches warning them to arrest the production of that component immediately. As a result of this, huge amounts of time, material and money are saved. The internet is a means of communication between production engineers, the manufacturing engineers, and the design engineers. Adopting this new technique can reduce the complexity of the part, without jeopardizing performance. Using CAE tools in the design process may have a profound impact on savings. In many cases, the virtual prototype is a much more accurate representation of what we designed than the physical

prototype. Apart from adopting this strategy in the production line it can also be used in the maintenance program of an automobile. For example, if you only repair your car when it breaks down, you face costly corrective maintenance. A preventive maintenance schedule, based on the manufacturer's recommendations, may prevent breakdowns. Preventive maintenance is possible using E-Diagnostics. When a car is taken in for servicing, it is hooked onto the diagnostic computer which indicates existing problems. Moreover the service centers are constantly hooked up to the internet and are updated on availability of spares, latest trends in servicing and solutions to commonly occurring problems. All this information is made available from their counterparts from around the world. To add to this the entire service history of the vehicle is uploaded to the net so that it is made available to all of the company's service centers around the globe which will help identify the status of the vehicle wherever and whenever one wants to service it. Gears form an important component in most machines as well as in automobiles. Today's Customers demand a multitude of gears in a short span of time, without any compromise on quality. The solution to this challenge is E Manufacturing. One can hook up the gear manufacturing machine to the net. It offers fully integrated production control software for estimating, order and job control, job travelers, scheduling, data collection, inventory control, purchasing, work center loading and cost accounting. Various design parameters can be entered by the customer and modifications may also be made until the last minute. Once the system is in place economic and efficient manufacture of gears is imminent.

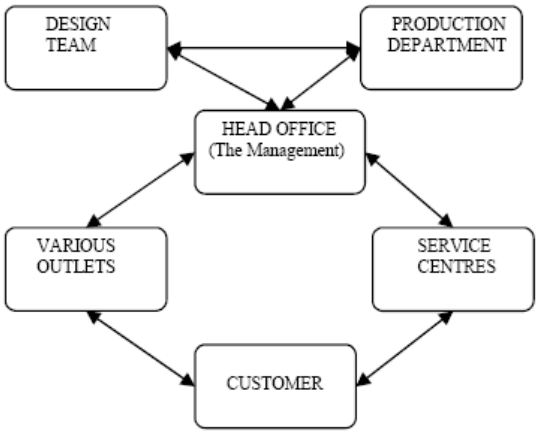

Figure 6 Application of E Manufacturing to Automobile Industry

IX. BENEFITS OF E-MANUFACTURING

E-Manufacturing is a fundamental change in the strategic value proposition for manufacturers. Its collection of systems, processes, and technologies that support and enable manufacturers to compete in collaboration with others has seven fundamental jobs:

1. Synchronize Production Processes with Business Processes.
2. Orchestrate Upstream Flows of Work, Information, and Material.
3. Automate Business Processes & Workflows within the Enterprise
4. Give Control to Managers with Plant Information & Analysis Tools.
5. Integrate the Design Process among All Collaborating Parties.
6. Leverage Bi-directional Down-stream Information.
7. Enable Collaborative Maintenance and Manufacturing Support.

X. CONCLUSION

This paper discussed certain key areas and subsets of the E-Manufacturing strategy which when implemented will yield priceless benefits to an industry that implements it. Further the concept of an E-Factory promises greater increase in productivity and performance, while at the same time decreases production costs. However, for E-Manufacturing to be a success, co-operation between various public and private sector organizations is mandatory. This new thinking paradigm to integrate web-enabled and predictive intelligence for manufacturing systems is becoming a new benchmark strategy for manufacturing companies to compete in the twenty-first century.

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