SOME STUDIES ON RAPID PROTOTYPING IN CONTEXT TO E-MANUFACTURING

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ABSTRACT

E-manufacturing as a new generation of product development solution allows original equipment manufacturers across the worldwide to speed up and lean operations activities starting from design to manufacturing. Rapid prototyping (RP) is one which helps in automated manufacturing process to builds physical models from CAD files of 3D prototype or scanning them from the real model. With the high advanced network technologies, many different software and hardware systems can be integrated as a distributed platform to provide more services that solve more complicated problems in order to achieve better performance. It has been employed in a wide range of manufacturing activities like casting etc. Networked Virtual Environments have already started to foster an insightful, intuitive and interactive environment that allows effective communication among the multiple users. Productivity gains resulting from larger wafers, smaller device features, and 90% and greater yields are now assumed, equipment utilization and manufacturing effectiveness have become target areas for further improvement. This study will be helpful to the academician, manufacturer, researcher, and any person concerned in the field of manufacturing.

Keywords E-manufacturing, RP (Rapid Prototyping), Manufacturing sector

I INTRODUCTION

With the fast development of the world economy, e-manufacturing becomes important since it can quickly respond to market changes and make the resource sharing in more efficient among manufacturing partners [1]. The e-manufacturing can be seen as a type of digital connected with network leading to commerce driven manufacturing technologies in context to current manufacturing environment with legacy and sophisticated systems. Under this scenario, the partners and resources (man, material, machine, etc.) may locate at different geographical locations, and scheduling distributed resources to fulfill production tasks with constraints is a vital task.

In order to cope up with different information, expertise and decision-making in the e-manufacturing paradigm, effective and efficient coordination among autonomous entities is becoming ever important for its success in the competitive and distributed environment. As one kind of efficient approach of co-ordination, negotiation policy is one of the opportunities and challenges in the distributed manufacturing scheduling system[2].

Organizations are trying to become more competitive and efficient by transforming themselves into digital firms where nearly all core business processes and relationships with customers, suppliers and employees are digitally enabled. The Internet is bringing about a convergence of technologies that is further widening the use of information systems in business and transforming industries and business models [3]. Zhang and Fowler [5] e-manufacturing is a modern interdisciplinary investigation area that combines information systems and decision technologies. Moreover, in the semiconductor manufacturing industry,Tag and Zhang [6] defined e-manufacturing as the complete electronic integration of all factory components using industry standards Koc [7] and Lee [8] proposed an e-manufacturing model. This model depicts that e-manufacturing fills the gaps existing in the traditional manufacturing systems. The gaps are among product development, plant floor, and Supply chain. These gaps consist of lack of equipment, productivity, life-cycle information, and lack of information about supplier capabilities.

In this paper, the authors studied the concept of RP in context to E-Manufacturing leading to efficient and effective utilization of resources to get the desired output. This study will be helpful to the academician, manufacturer, researcher, and any person concerned in the field of manufacturing. The subsequent section of this paper deals with the issues pertaining to the importance of advanced maintenance in context to e-manufacturing.

II E-MANUFACTURING

E-Manufacturing is an advanced manufacturing that takes advantage of the information and Internet technologies to integrate all functional components of a factory. Since market competition in the consumer electronics industry has intensified, short product life cycle becomes essential. A company that generates innovative research and development can garner market share. Its benefits as compared to traditional manufacturing are given below:

The benefits of E-manufacturing are;

(i) Quick installation of software updates with no need for expensive integration projects.

(ii) One enterprise wide view of the customer, product or process.

(iii) Global deployment from one instance of the software, making all applications accessible globally via a standard Web browser.

(iv) Simplified systems and maintenance for IT staff due to the one-vendor approach.

(v) Streamlined business processes.

(vi) Better decision-making and business intelligence because of the single-database architecture and pre integrated applications and rapid deployment at lower cost.

Thus, from the above discussion, it is clear that e-manufacturing have many advantages over the current manufacturing techniques. However, the different phases of e-manufacturing are described below.

For decades, the dominant manufacturing model was based on principles of mass production [4]. 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. Thus, the advanced manufacturing technologies are also well equipped with the advanced maintenance techniques. The next part of the paper deals with the concept of e-manufacturing in the current scenario.

III 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.

IV E-DIAGNOSTICS

It is required to upkeep the system in operational state, that may achieved through diagnostics leading to maintenance actions and thereby the diagnostics is one of the important aspect of advanced and modern technologies. Among the diagnostic, E-diagnostics is one of them which may be either reactive and/or proactive diagnosis. 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:

(i) Remote capture, transmission, analysis and dissemination of equipment performance data.

(ii) Remote takeover of equipment to manipulate equipment settings during and after repair.

(iii) A trigger for replenishing spare parts.

(iv) Faster and more effective response to field service engineering requests, bringing the experts remotely to the problem.

(v) Reduced equipment and process variation, through better visibility and response to differences in equipment performance among machines.

The e-manufacturing required sophisticated equipments that may need e-maintenance pertaining to the e-diagnostics and thereby the better performance. The rapid prototyping is one of the advancement in the field of e-manufacturing, the detailed description of which is given in the subsequent section.

V RAPID PROTOTYPING

Prototyping or model making is one of the important steps to finalize a product design. It helps in conceptualization of a design. Before the start of full production a prototype is usually fabricated and tested. Manual prototyping by a skilled craftsman has been an age old practice for many centuries. Second phase of prototyping started around mid-1970s, when a soft prototype modeled by 3D curves and surfaces could be stressed in virtual environment, simulated and tested with exact material and other properties. Third and the latest trend of prototyping, i.e., Rapid Prototyping (RP) by layer-by-layer material deposition, started during early 1980s with the enormous growth in Computer Aided Design and Manufacturing (CAD/CAM) technologies when almost unambiguous solid models with knitted information of edges and surfaces could define a product and also manufacture it by CNC machining. The reasons of prototyping are many.

One is to reduce the risk of introducing new technology. Working with suppliers to prototype concepts and standards can:

- Confirm the integrity of the targeted standards and guidelines
- Complete an early analysis of implementation and deployment feasibility
- Establish a sufficient level of experience to create early use case scenarios
- Prove the standards are interoperable
- Demonstrate implementability of e-manufacturing

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. E-manufacturing as a new generation of product development solution allows manufacturers all over the world to speed up and slim down everything from design to manufacturing is related to Rapid prototyping (RP) which help in automated manufacturing process that quickly builds physical models from CAD files of 3D prototype. 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.

VI CONCLUSION

E-manufacturing scheduling mechanism plays an important role in enabling and executing e-manufacturing systems. The scheduling problem is solved by means of combinatorial auction, which is described and implemented by the distributed rules as the negotiation policy of the agents. With the negotiation policy, distributed agents solve local problem with local constraints, at the same time, realize distributed resource scheduling in the global view in the time window. Therefore the performance of the system is improved. Also, the interactive rule implementing negotiation policy is encapsulated in the agent, which reduces the complexity of construction, modification and update by reconfiguration, reused and regroup of the distributed rule according to the change of the manufacturing system.

In order to further advance the development and deployment of the e-Manufacturing system, research needs can be summarized as follows:

1. Predictive intelligence (algorithms, software, and agents) with a focus on degradation detection on various machinery and products.
2. Mapping of relationship between product quality variation and machine and process degradation.
3. Data mining, reduction, and data-to-information-to-knowledge conversion tools.
4. Reliable, scalable, and common informatics platform between devices and business, including implementation of wireless, Internet, and Ethernet networks in the manufacturing environment to achieve flexible and low-cost installations and commissioning.
5. Data/information security and vulnerability issues at the machine/product level.
6. Distributed and web-based computing and optimization and synchronization systems for dynamic decision making.

REFERENCES

1. Zhang Y. F., Jiang P. Y. and Zhou G. H., GA- driven part e-manufacturing scheduling via an online eservice platform. Integrated Manufacturing Systems, 2003, 14, pp. 575-585
2. Weiming S.: Distributed Manufacturing Scheduling Using Intelligent Agents. IEEE Intelligent Systems, 2002, 17, pp.88-94.
3. Laudon et all: *Management Information Systems*: Canadian 3rd edition, Pearson Education, 2008
4. Exploiting E Manufacturing: Interoperability of Software Systems used by US Manufacturing " National Coalition for Advanced Manufacturing, 2001, pp 1-13
5. M.-T. Zhang, J. Fowler, T.-W.-Y. Chen, J.G.Shanthikumar, and C.-F. Chien, ''Editorial e-Manufacturing in the semiconductor industry,''IEEE Trans. Automat. Sci. Eng., vol. 4, no. 4, pp. 485–487, 2007.

6. P.-H. Tag and M.-T. Zhang, ‘‘e-Manufacturing in the semiconductor industry,’’ IEEE Robot. Automat. Mag., vol. 13, no. 4, pp. 25–32, 2006.
7. M. Koc, J. Ni, J. Lee, and P. Bandyopadhyay, ‘‘Introduction to e-Manufacturing,’’ in Proc. 31st. North American Manufacturing Research Conf.(NAMRC), Hamilton, Canada, May 2003, pp. 97-1–97-8.
8. J. Lee, ‘‘e-Manufacturing-fundamental, tools, and transformation,’’ Robot. Comput. Integr. Manufact., vol. 19, no. 6, pp. 501–507, 2003.