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The virtual manufacturing paradigm: The impact of IT/IS outsourcing on manufacturing strategy

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Abstract

Globalization has opened up more markets to manufacturers and generated exceeding pressure on them to provide high-quality products fast, economically, and with high level of adaptability. This pressure is more of an encumbrance to small manufacturing enterprises (SMEs). The paper explores a virtual manufacturing strategy that SMEs could adopt to maintain and gain competitiveness. Also, the paper traces technological advances in manufacturing from the cottage industry to the present day information superhighway and how it might impact the future of manufacturing. How these advances impact SMEs is explored. A possible infrastructure for integrating IT/IS and manufacturing strategies is presented.

Keywords: Manufacturing strategy; Virtual manufacturing; Telemanufacturing; Outsourcing; IT/IS; Integration

1. Introduction

Virtual manufacturing is the use of information technology and computer simulation to model real world manufacturing processes for the purpose of analyzing and understanding them. Unlike in the classical discrete event simulation, an easily understood but complex three-dimensional animation models are used to engineer the real manufacturing environment. Machines, machine cells, parts, and facilities can be designed and evaluated on-screen before actual facilities or products are constructed. In some instances the actual simulation could be carried on concurrently as the manufacturing facility is being built. The advantages of such an approach are many. It enables the manufacturer to speed up the time to market by integrating product development and production so that the system and parts are tested out in real time on a computer while at the same time allowing for "what if" type scenarios and conservation of valuable capital to take place. As Daly [1] puts it, the "simulation tools are so powerful that designers can produce a perfect product on the first try without any scrap and without building a prototype". This level of agility in manufacturing has been made possible by advancements in information technology and its ubiquity fueled by the Internet and electronic commerce (e-commerce).

To the average small manufacturing enterprise (SME), virtual manufacturing (VM) could be nothing short of a buzzword not unlike some of its predecessors CAD, CAM, FMS, CIM and so

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on, which were once characterized as the "alphabet soup" of technology. The basis of such views about technological innovations lies in the fact that these SMEs often do not have the wherewithal to acquire them, especially given the dynamic and volatile nature of these types of technologies. On the other hand, large manufacturing enterprises (LMEs) that enjoy breadth of cash flow and depth of their technical competence have the advantage to choose to delay acquisition of these technologies till opportune time. Unfortunately, SMEs do not have this luxury and must devise a means to acquire the technologies contiguously as their survivability in the global marketplace might rest on their ability to do so.

In the past, where technology and its adaptation has traditionally been a prerogative of the large international conglomerates, the growth in the use of Internet, e-commerce and information technologies (ITs) have made these technologies more accessible to the SMEs. The fact that these technologies are accessible does not necessarily mean that they are being acquired in droves by SMEs. Indeed, the technologies are still quite expensive to own. For example, a recent NUA, Inc. report estimates that SMEs in the UK will spend about $5.6 billion on Internet-related technologies in the next 12 months [2]. Thus, unless ways and means of dissemination of these technologies to the SMEs are sought, they will continue to be a mirage and make their competitive posture ever more so in doubt.

As a means for ameliorating the dilemma of the SME an area of VM, Telemanufacturing, has emerged. As Abdel-Malek et al. [3] define it, "Telemanufacturing is an infrastructure whereby a firm utilizes services afforded via communications networks and across information superhighways to perform, in real time, operations and processes necessary for the design and production of items". Three components are central to Telemanufacturing: a communication medium, Specialized Expert Center (SEC), and In-House Controller (IHC). The key element of the communications medium is today's Internet, which is now readily available and affordable to most SMEs, and provides the service channel for the SECs. A SEC is a center that specializes in a particular function that could include, but not limited to, product development and design, production control and NC part programming. The IHC for its part coordinates and oversees all cross-functional activities of the Telemanufacturing system, much like the data link layer of the ISO/OSI architecture in a local area network.

Our taxonomy in presenting the virtual manufacturing paradigm is as follows. In Section 2, we outline the growth and application of IT in manufacturing from the early times to the present. Section 3 takes a critical look at the SMEs and their place in the economic wellbeing of any nation in particular and the world in general, hence establishing the need for them to acquire VM technologies. In Section 4, we provide a test bed infrastructure for a Telemanufacturing system and discuss its inherent advantages. Section 5 discusses the subject of manufacturing flexibility and how Telemanufacturing is a natural evolution of existing technologies. Finally in Section 6, we provide our conclusions and directions for future research.

2. The pedigree of IT in manufacturing

Computer and information systems technologies have gone from the turn of the 20th century novelties–toys for researchers and their cohorts–to the turn of the 21st century state-of-the-art flat panel displays, cellular phones, Internet, e-commerce, and yes virtual reality/manufacturing to name just a few. Indeed, computers and information systems have become so much a part of every business's core that other areas of the business are now designed around it.

Cohen and Apte [4] identified three stages of manufacturing technology evolution as *craftsman*, *mass production*, and *automation technology*. In this paper, we add a fourth stage–*IT-based manufacturing networks*–to that evolution and modify the authors' stages as shown in Table 1. As can be seen in the table, the IT-based manufacturing network stage shows a matured manufacturing environment that is offering more capabilities to its users.