The Nucleus of an Application Service Provider in Telemanufacturing

Electronic Commerce Application Track

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Abstract

The past 5 years has witnessed a rapid growth in the use of the Internet for shopping, learning, and networking. However, the adoption of the Internet in major production functions has not evolved as rapidly. In this paper we present a nucleus of an application service provider, ASP, in Telemanufacturing/e-Manufacturing that can be visited @www-ec.njit.edu/telemfg/. The ASP is accessible via the Internet and currently provides service in design of manufacturing cells, rapid prototyping, make or buy decisions, as well as evaluation of technological alternatives. More modules shall be added in the near future, such as computer aided design and computer aided manufacturing feature.

Keywords: Telemanufacturing, e-shift, flexible manufacturing.

Introduction

Today's revolution and evolution in computer and information technologies offer industrial, service, and government sectors with the means to expeditiously join in benefiting from the application of these advances. An evolving practice that these advances render is the e-shift in many business activities, see Starr, 2000. In manufacturing, on the other hand, a similar infrastructure that utilizes these advances and should strengthen the industrial base is Telemanufacturing/e-manufacturing. Telemanufacturing is defined as an infrastructure whereby a firm uses services afforded via communication networks and across the information superhighway in order to perform, in real time, operations and processes necessary to efficiently and flexibly design and produce items and goods [Abdel-Malek et al, 1998].

In order to establish a Telemanufacturing/e-manufacturing infrastructure, in addition to media of communication, there should be two essential components which we define as Specialized Expert Centers (SECs) and In-House Controller (IHC). The SECs provide services via communications medium such as the Internet. The services could range from activities such as product development, design, and production control, to NC programming. The manufacturer can subscribe or enlist services from the appropriate SECs as fit. On the other hand, the IHC acts as the coordinator that orchestrates these cross functional activities and oversees their execution. The IHC is actually the brain of the enterprise on the factory floor.

The purpose of this work is two fold: 1) to introduce the concept of Telemanufacturing / e-manufacturing, its components, and give an illustrative example for the design of such an application service provider (ASP); 2) to show its viability and potential of applicability.

The paper is organized as follows: after this introduction we begin by a background section describing current concepts in both industrial and service sectors, and how they relate to Telemanufacturing. Then Telemanufacturing/e-manufacturing service provider taxonomy, its major components, and how to design it are presented. This is succeeded by a summary section .

Background

The premise of Telemanufacturing/e-manufacturing is affordability, flexibility and adaptability. This section reviews pertinent works and philosophies to Telemanufacturing. The review includes the principles of the newly defined marketspace, the role of flexibility in its environment.

In general, today's companies not only must strive in the marketplace but also in the marketspace. We quote from Harvard Business Review article, by Rayport & Sviokla, 1995, "Every business today competes in two worlds: a physical world of resources that managers can see and touch, and a virtual world made of information". They call this new information world "marketspace".

As the market continues to evolve from a marketplace to a marketspace, companies' strategic goals shift as well. Suarez et al, report that during this century three inclusive "strategic imperatives" have emerged: efficiency, quality, and flexibility, in this chronological order. In today's environment, both practitioners and academicians agree on the importance of flexibility for success in manufacturing. The following paragraphs are further illustration on flexibility, its importance and how the Telemanufacturing concept serves its enhancement.

Simply defined, flexibility is the ability to respond effectively to market needs. It should be stated that flexibility has successfully been used to measure the impact of adopting new technologies and concepts on manufacturing firms (the interested reader is referred to three reviews by Benjaafar & Ramakrishnan, 1996, Saker et al 1994, and Sethi and Sethi 1990, for the details of flexibility, its attributes, and measurement). The essence of most of the research findings in the area of flexibility as it relates to this article can be summarized as follows: i) flexibility should be self-reinforcing (meaning that what is flexible today, should also be flexible tomorrow, and should not suffer from technological obsolescence, see Figures 1 and *2*; the large investment associated with the acquisition of current flexible manufacturing systems binds companies to work with it for a considerable period of time, which can result in an undesirable flexibility level); ii) turning only to machine hardware and software will not suffice to achieve competitiveness (people count more than machines; this led several companies to perform more of their operations overseas, especially in developing countries); iii) flexible manufacturing solutions should be tailored according to the needs of each firm; iv) flexibility has been successfully used to assess and measure an enterprise's strategic success.

See Figures 1&2

According to these findings, it can be seen that the e-manufacturing concept allows a company to remain flexible throughout. Since it permits a company to outsource its functions to expert centers, consequently as shown in Figure 2, the flexibility level of the Telemanufacturing enterprise is not dependent on technological obsolescence of its system's components. Its flexibility is mostly dependent on the specialized expert centers subscribed to. Further, it is reasonable to assume that in order for those expert centers to survive, they must keep adopting and adapting to new technologies.

To enhance their flexibility, several conglomerates have successfully utilized the advances in computer and information technologies and implemented virtual manufacturing concepts (telepresence); we cite here three examples. The first example is that of Aero Tech Service Group [Upton & McAfee, 1996]. They built, with McDonell Douglas, a highly effective virtual factory where, in an open and flexible network, users with varying information technology sophistication were linked. This integration has allowed the inclusion of many five or six person shops into the production system of McDonell Douglas to download programs, procedures, data, and drawings, required to manufacture parts. The result is shorter lead times and lower costs. The second case is the teaming up of Netscape and General Electric Information Services to offer EDI services through the Web [Upton & McAfee, 1996]. This interface allows companies to put three-dimensional CAD drawings of their products on the Web, providing more exposure of their design to the customers, leading to more profits. The third application is a mock-up robotic job shop facility that Croning Glass Company is involved in [Cannon, 1996]. From three physically distinct locations a robotic cell is controlled by virtual presence. The task***s*** to be performed in the cell require***s*** different expertise. To avoid duplication, the experts in different locations are brought virtually together for the execution of the task; this reduced overhead costs.
The aforementioned discussions and examples show the capability of the current technology, demonstrate the feasibility of its implementation, and the ability of some companies to benefit from it. Telemanufacturing formalizes the design of such enterprises. It integrates these technologies and paves the way particularly for developing nations to gain from it. The following sections present the Telemanufacturing taxonomy and the available e-manufacturing service provider @www-ec.njit.edu/telemfg.

Telemanufacturing Taxonomy

In this section the taxonomy of a Telemanufacturing enterprise is presented. As mentioned before, the concept is based on the existence of SECs from who a manufacturer receives services, IHC to supervise the enterprise, and the medium for convenient real time communication. Figure 3 presents a schematic for the taxonomy of the Telemanufacturing enterprise. As pointed out previously, platforms and islands of this taxonomy are already implanted in large corporations and conglomerates.

See Figure 3

The Telemanufacturing Application Service Provider

One of the purposes of this ASP is to increase awareness of the potential use of information technology, virtual reality, and computers in manufacturing as well as providing some technical assistance. In other words this ASP is both educational and server at the same time. Therefore, the ASP is designed to present the user with an overview of Telemanufacturing and its possible infrastructure, links for other companies and research centers that provide similar services such as design and product development, and most importantly to start accessing the available three technical services of this test bed. These three services are a decision support system for the concerted selection of equipment of a manufacturing cell (RAMCOSS), rapid prototyping, and a make or buy decision module (additional services shall be added as we go along). A user can access these services via the Internet. In the following sections we present these services and their rationale.

Decision Support System for Cell Equipment Selection (RAMCOSS)

Equipment selection plays a major role in the performance of machining and assembly cells. For many manufacturing operations the problem of selecting the best machinery combination always arises. The conventional way of addressing the problem is to separately identify the equipment that seems to best satisfy specific application requirements. However, this is not an efficient way, since it does not select the equipment in a concerted fashion. This quite often leads to sub optimal choices. To address this problem, the Telemanufacturing ASP incorporates a DSS called the RAMCOSS that concurrently considers the selection for the cells' equipment. The DSS mainly consists of two components, a database and an optimization module. The database is made up of vendor information regarding machining centers and robots with the corresponding prices and specifications (in the near future, it is planned to go automatically to vendors web sites instead of the database). The DSS has a pre-selection module to exclude equipment that does not meet specific requirements. The results of the pre-selection phase can be modified by adding alternatives that do not exist in the database or for the matter leaving out those, which the user does not wish to consider. The optimization engine is then engaged to provide the most optimum combination of machining centers and robots that maximize the cell yield.

Internet Based Rapid Prototyping

Rapid prototyping has been found to reduce time to market of new or improved products. A shortened time to market has been known to enhance a company's competitiveness. Nevertheless, many SMEs cannot afford such equipment. This is the main reason behind choosing to provide this service in our test bed. Another reason for providing this service is that the user can request either physical shipping of the prototype or the required analysis can be easily transferred electronically. This gives an extra dimension to the test bed and can help in saving time, effort, and expenditure for the manufacturer. The equipment used for rapid prototyping in the test bed is Stereolithography apparatus (SLA). The machine uses a resin polymer for the pilot production of prototypes. The time taken to build a model depends on the size and porosity of the model. Companies subscribing to the Telemanufacturing web site/ service provider will be able to make use of this facility to submit their jobs for prototyping through the Internet. The prototyping device has full support for modeling software like SDRC-Ideas, Pro/Engineer and CADDS. Model files created using these packages can be submitted for prototyping to the server. The product model will be built and the design fed back to the

company for modifications. This will reduce the development time for the company, as mentioned before, and can also eliminate expenditure in equipment acquisition and reduce other operating expenses.
Our previous experience with using the equipment has brought forward some of the problems that may arise. These problems can range from defects in support structure to a file transfer problem. Or a simple problem where a volume of resin in the part cannot easily flow into or out of the surrounding liquid leading to improper building of the part can also arise. So, by using this test bed it will be possible to identify and practically solve these problems.

Make or Buy Decision

Many companies are today reliant on their manufacturing technology for product development. Likewise, the capabilities of a manufacturing technology are dependent on the sourcing policy that the host-company practices. The outsourcing industry is growing at a very fast pace and more and more companies are considering a make or buy decision with an aim to retain business focus, accelerate reengineering benefits and get access to world class technology. In relation to this, the Telemanufacturing test bed will provide a decision model, shown in Figure 4, which assists companies to form sourcing policies and determine whether to conduct a service or produce a part in-house as opposed to making use of outside sources. The decision tree provides a step-by-step approach for companies to judge what type of sourcing policy will be good for their business. It will also help them to differentiate their core competencies from the non-core functions. This decision tree is an analytical tool for ensuring that the decision the company takes regarding its sourcing policy meets all production criteria like economic, social, quality, etc. At each step the user is encountered with a question that pertains to the business and is critical to the final decision of make or buy. The decision tree is designed to function as a simple flowchart carefully covering all the relevant issues. By providing appropriate answers at each step a company/user can determine whether it will be feasible and profitable to outsource or to produce in-house. The "make or buy" module, in essence, provides a framework, particularly for SMEs, to plan their production strategies in a systematic way.

Navigating Through the ASP

The Telemanufacturing ASP can be contacted at http//www-ec.njit.edu/telemfg/. Once the user contacts the test bed, the screen will exhibit three buttons namely, Overview, Control Center, and Updates. By clicking on the Overview button, the user shall be introduced to the concept of Telemanufacturing, can connect via links to other research centers and service providers that offer similar activities, and tour the other various possibilities that the site renders. The Control Center offers, in addition to the explanation, the actual services. As mentioned before, the current services are, selection of equipment, product development, and "make or buy" (Telemanufacture or to do it in-house). The user can click the needed engine and will be guided through in a friendly fashion. The data required will be shown on the screen and once it is entered, the proper engine will be engaged and subsequently the response will be rendered in real time. It is also planned to have the site manned for trouble shooting, should the user encounter problems. An e-mail service for contact is currently available. Also, for site users, a statistical tally will be kept for future analysis of the user's various experiences. As of the update section, it is intended to share with the subscribers as well as the general users the new additions to the web site. Additionally, it will serve as a guide for new links to other service sites, and problems that other users might have encountered.

Summary

In this paper we proposed a taxonomy for the emerging Telemanufacturing/e-manufacturing concept and presented its ASP @www-ec.njit.edu/telemfg. Telemanufacturing structure provides an enterprise with the agility to choose among service providers in areas of manufacturing and business functions, such as product development and design, process planning, programming, etc. The economically available use of information superhighways and the World Wide Web are among the suitable media to end users for adopting the concept. In addition to the existence of these service providers and communication media, the application of Telemanufacturing concept requires an In-House Controller to harmonize and orchestrate the inputs from these out-sourced activities with the factory floor prior to execution. Implementing Telemanufacturing is expected to be affordable especially for small and medium size companies and manufacturers in developing countries, since it does not require large investments in hardware and software. Moreover, it does not need significant training programs for workers or the expenses of hiring and maintaining technical staff. Telemanufacturing draws on the expertise of the SECs to efficiently use the available capacity on the factory floor and minimizes large investment on equipment that can become obsolete as time progresses.

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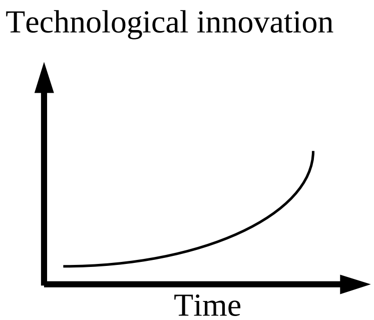

Figure 1 Technological Innovation

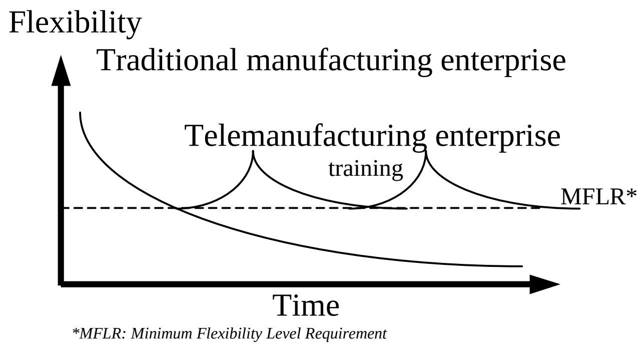

Figure 2 Flexibility trend

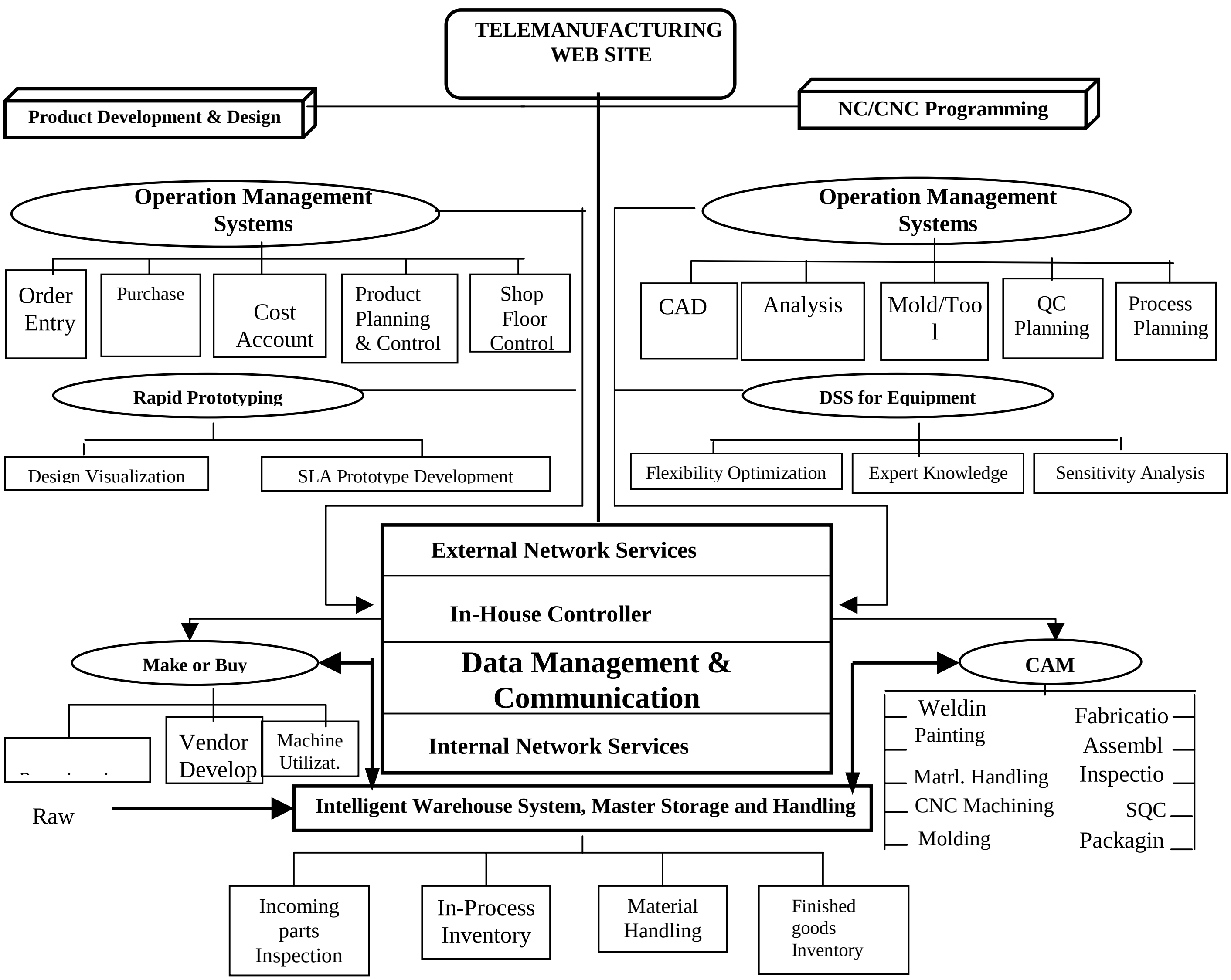

Figure 3: Telemanufacturing Taxonomy

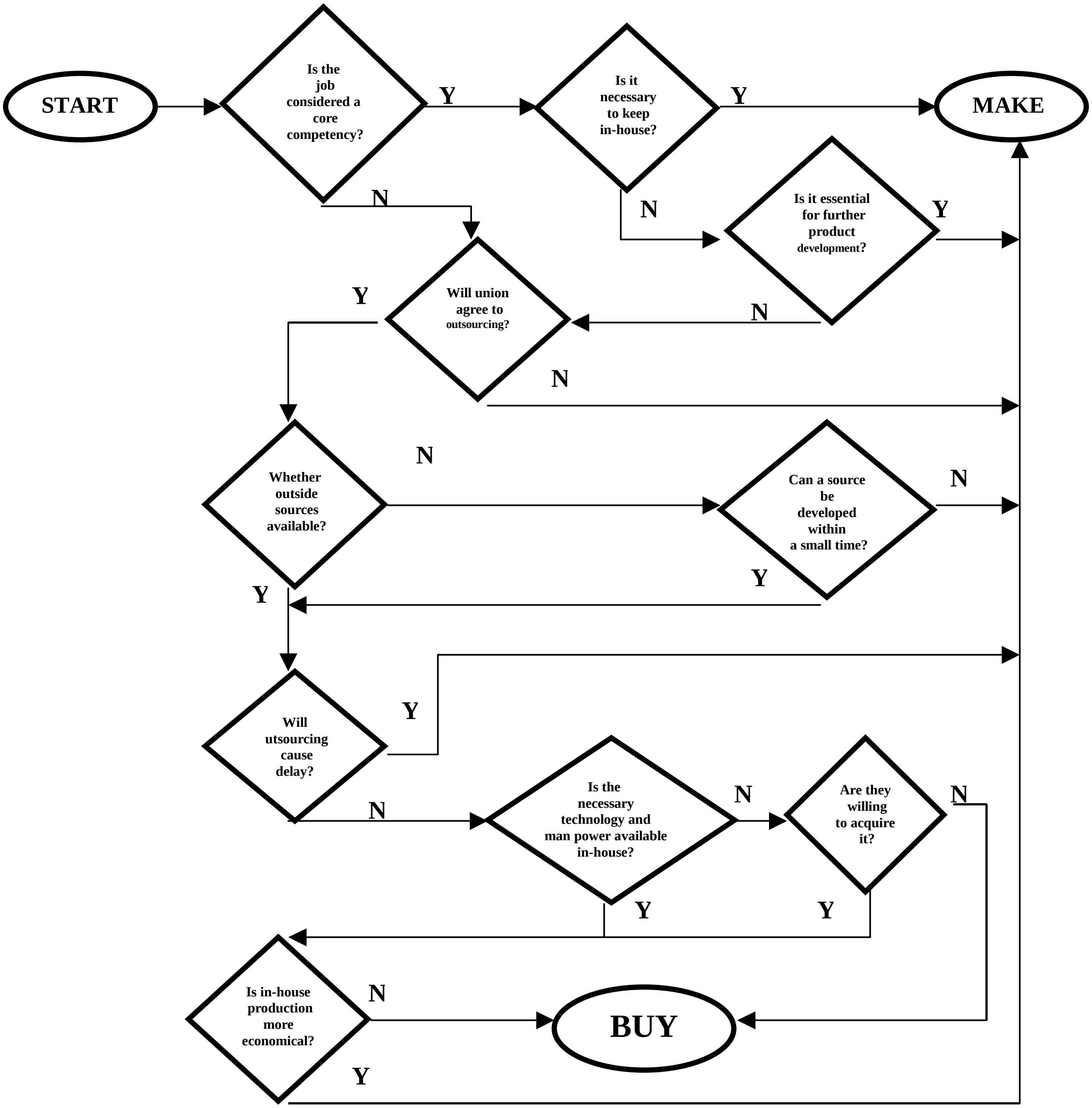

Figure 4: Make or Buy Decision Tree