Texas Business Review
ISSN 0040-4209

October 1997

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Commercialization of the Internet has been one of the hottest topics around the world in recent years. Once the exclusive domain of scientists and engineers, the Internet now connects over 60 million in a global communications medium. The population using this worldwide "network of networks" has doubled every year since 1988, and that growth rate is expected to continue. Matrix Internet Data Services, an Internet demographic firm in Austin, Texas, estimates that by the year 2005, a staggering 700 million people could be using Internet-networked computers.

The growth of this medium and the new capabilities deliverable on the World Wide Web have excited entrepreneurs, transforming some of them into multimillionaires overnight. There has been an explosion of new firms experimenting with "electronic commerce," or commercial transactions over the Internet. Most of these ventures are in industries, such as the service or publishing industries, that rely on information delivery.

But what about manufacturing? How will the Internet affect or reconfigure this industry? This topic has been neglected in the popular press, and, in fact, surveys show that many manufacturers are unsure whether the Internet will play an important part in their business in the next century.

The Manufacturers' View

In January 1997, the consulting firm Grant Thornton, LLP, released the results of a survey requesting U.S. manufacturers' opinions about the Internet's impact on their firms. The 253 surveyed companies showed annual sales between $10 million and $500 million.

Given the frenzy over the Internet in other economic sectors, the response of these manufacturers proved somewhat surprising. Only 13 percent said that the Internet affected their operations in any way. More than 50 percent said the Internet had had no impact at all. While nearly all the manufacturers believe that the Internet will be a permanent part of their business, they split evenly on whether the network will affect the chief activities of their companies in the future.

Grant Thornton's report assessed these results as a reflection of the novelty of electronic commerce in the manufacturing sector. Nevertheless, the presence of manufacturers on the World Wide Web is expanding rapidly. Between November of 1995 and a year later, when the survey was conducted, the number of manufacturers with a Web site almost doubled (from 14 percent to 25 percent), and nearly two-thirds expected to have a Web site by the end of 1997.

However, most manufacturers in this survey viewed the World Wide Web primarily as a means of advertising and marketing, and as a way to be perceived as a technological leader. Few, if any, regarded the Internet as a technology integral to their manufacturing efforts.

Although it has become commonplace to see robust Web sites for manufacturers, especially those in the information technology field, few manufacturers use the Internet in an innovative way as a support system for production. However, new innovations, and new technologies, are beginning to

appear, and their prospects for changing manufacturing are immense and exhilarating.

"Build to Suit"

In the last ten to fifteen years, U.S. manufacturers have adopted a series of production models that have proven revolutionary: "Just in Time" and, more recently, "Right on Time." By using information technologies to create "feedback loops" between a production line and a supply channel, manufacturers fine-tuned production schedules to reduce inventories, speed up time-to-market, and enhance product life cycles. This sea change in production and distribution has enhanced the competitiveness of American industry: nearly all the productivity gains in the U.S. economy over the past decade have come from the manufacturing sector.

"Build to Suit" represents a new variation on "Right on Time" production. And, at present, the principal beneficiaries of this production approach are two Texas computer companies, Dell and Power Computing, both in Williamson County north of Austin. Both companies sell their products over the World Wide Web and by telephone. Web sales are increasing for both companies, and Dell is reportedly making up to a million dollars a day from its Web site.

In the "Build to Suit" approach, orders taken over the telephone or the Internet cue the production line: when an order comes in, an electronic form containing the data goes to the line and the machine is assembled and prepared for shipping. While both Dell and Power Computing sell through mail-order houses and some retail stores, the overwhelming portion of their sales are direct, through the company's telephone banks or Web sites.

Dell further developed this model by establishing distinct, limited access Web sites for its largest customers. For example, one of Dell's largest customers, Boeing Corporation-purchasing 1,000 Dell computers every week-merits its own Dell-sponsored Web ordering system. Boeing procurement officials use this password-protected and secure Web site to order Dell computers in particular configurations, or in bundles with specific features, at volume-discounted prices.

Dell and Power Computing have been extraordinarily successful with the "Build to Suit" model and its World Wide Web component. Dell's stock price climbed 500 percent in one year, and the privately held Power Computing lists among the fastest growing companies in the United States. Their success prompted other companies to follow suit: Dallas-based Compaq, the world's largest supplier of personal computers, plans to move to direct sales on the Internet and a "Build to Suit" production line. Apple Computer, in California, is reportedly exploring the same approach.

Enterprise Integration

Computer networks have been part of manufacturing firms and other businesses for decades. Only recently, though, have separate firms started to tie their networks together to take advantage of data interchange as a form of cooperation and integration.

Electronic Data Interchange (EDI) is the standard used by businesses to translate data from one company's computer to another. EDI provides a way for firms to exchange electronic data in a particular format. Usually, the data are formatted to plug information into electronic business forms or databases. A bookseller, for example, might use EDI to pass information back and forth to a book distributor or to publishers. Each trading partner must agree in advance to use the same format for the data. For the most part, a network contractor, called a VAN (Value-Added Network) handles EDI transactions. These are middlemen businesses, and they charge for the set-up of the EDI system, the connection, and the transmission of the data.

The Internet threatens to change this pattern in a profound way. Many software applications now allow "browser" software, such as Netscape Navigator or Microsoft Internet Explorer, to connect to databases on Internet server computers. The new computer language called Java even allows programmers to write applications, or programs that run on client computers hooked to the Internet, so that people who once used proprietary systems now use the Internet for the same purposes.

The use of Internet-aware applications, layered over increasingly capable operating systems like Windows NT and Unix, will allow manufacturers to use the Internet for data interchange and bypass the systems set up by VANs and EDI vendors. Vastly cheaper than a proprietary VAN arrangement, Internet access also offers limitless potential for connecting to partners, unlike the VAN/EDI approach. While some VAN firms and EDI vendors are moving to the Internet as a matter of necessity, this is only a recent development. This process will speed up as manufacturers learn the potential of the Internet for enterprise integration using Internet-capable applications for data interchange.

Future Trends

Since years ago when an enterprising student at Carnegie Mellon University configured a soda vending machine to report its inventory to the Internet, thousands of applications have linked the Internet to noncomputing devices, such as video cameras or even robots. For example, the National Science Foundation sponsored an experiment in which people could control a robot in New Mexico from anywhere, through a Web page with robot control buttons.

The next challenge for this kind of technology is to find commercial applications in manufacturing. As the Internet speeds up, through greater bandwidth provided by telecommunications carriers, manufacturing integration will increase in sophistication. Designers will be able to pass around 2-D and 3-D blueprints, working simultaneously in many parts of the world. Engineers in widely dispersed locations will be able to control machine tools and see the results of their intervention in real time. Managers will have remote, real-time access to video overviews of production lines, along with simultaneous data, and they will be able to control robotic production machinery from anywhere in the world.

As standards for data collection and interchange evolve, the goal is a worldwide, distributed, Internet-accessible database of information about production needs, distribution channels, sales, and marketing. This database will accelerate "agile" manufacturing, job-sharing, tool-sharing, more efficient use of raw materials, and reduced inventories.

Indeed, if the concept of a fully robotic, so-called "lights-out" factory-one with no human workers at all-becomes a reality, the manufacturer of the future may need only the Internet to do his or her job.

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