PREPARING FOR A GLOBAL ECONOMY AND MULTI-CULTURAL WORKFORCE

Dr. Susan Wood

Westinghouse Electric Corporation, Baltimore, Maryland

Abstract

The 90's have ushered in revolutionary changes for technology-based corporations. The quest for agility and flexibility will lead to the formation of "virtual corporations" - companies seamlessly bound through an integrated information network and extending beyond traditional company/country borders. The new workforce of this agile enterprise will be multi-national and multi-cultural well beyond our current vision in order to succeed. This presentation explores the role of engineering in this evolving global corporate environment.

Background

The 90's is truly the value decade! As a consumer, you can hardly deny that you increasingly expect more quality and flexibility from products. You also expect to pay less for performance. And you do not expect to repair or service products very often, if at all. Think about your telephone, household appliances, personal computer - airplanes, store check-out/inventory systems, etc. We do not expect these things to fail! U.S. companies have indeed become more customer oriented over the past decade. Much of this change was driven by offshore competition: global competition. The Japanese, in particular, have also pushed the focus on time to market: the time it takes a company to develop and introduce a product to the consumer. Less than five years ago, Westinghouse's typical product evolution cycle time for radar was 24 to 30 months. The new Westinghouse wind shear detection radar system for commercial aviation and the A-12 system, developed for the Navy, had 11 and 15 month cycle times, respectively. Interestingly, cycle times for very dissimilar products such as cameras and printers are very similar in period.[1] The current benchmark is 18 months. This means, that companies aim to introduce a new sophisticated product every 18 months or less in order to remain competitive.

While the U.S. is improving at cycle time, overall our grades are poor. In Fortune's business score card from March, 1992, Aerospace received a B+ ; computers scored a C+; and electronics only scored a D.[2] The U.S. scored A's in pharmaceuticals and forest products. We must implement new strategies, globalize, network, streamline our design process and develop flexibility. We must also ensure that our workforce is trained and empowered, and that we use them to maximum advantage. On the average, the U.S. workforce is somewhat younger than previous decades. They also work harder compared to Western Germans (almost as many hours as the Japanese) -- but the U.S. lags behind in productivity. This is a competitiveness issue particularly since U.S. compensation costs are higher -- we pay more. The shift in male/female ratios and the growth in the minority workforce will have a major cultural impact on the U.S. workplace -- there were almost 10 million Latinos working in the U.S. in the 1991

period. There were 57.1 million females in the workforce in 1991, compared to 31 million in 1970 and 20.5 million in 1955.[3] This major cultural shift does not begin to hint at the need to focus on the changes brought about by globalization.

Major changes will dramatically reshape the U.S. workplace over the next decade. Companies will be smaller. We have already seen that trend -- big companies are shrinking and the U.S. manufacturing growth is predicted to be in small and medium-sized companies. Organizational structures are becoming leaner and flatter. The role of manufacturing operators will be expanded. We talked earlier about customer expectations regarding reliability and maintenance -- customers expect that a product will last forever, but if it breaks, the manufacturer must provide quality service. Finally, the old nine to five mentality must go. We must ignite the entire workforce to a constant learning/constant growth mode. These needed changes bring major challenges for U.S. industry: reward systems; communications; business nuances/practices; human behavior; and language. We, in industry essentially, have to rethink (and are already rethinking) how to motivate our workforce; how to communicate effectively -- knowledge is not be used as a power base; how to cross the boundaries of international business by respecting the language and culture of others. If there are cultural differences between the U.S. and Britain, these differences are an order of magnitude greater for the Pacific Rim.

Globalization

Selling products, developed for the U.S. market, in European and Pacific Rim markets is a non-trivial exercise. Adherence to the ISO-9000 standards, for example, is a requirement for all products sold in Western Europe after the summer of 1993. ISO-9000 began in Britain and is well established in Europe. It is growing fast in Asia. Some U.S. companies have implemented this standard, but not enough. If we are to continue to compete, we must understand the nuances of the European customer. To be cost effective, we must manufacture abroad. This requires electronic design and manufacturing data linkages -- we cannot reduce the cycle time by using *Federal Express* to send drawings and data packages, etc. These data transmission needs drive the technology implementation. In essence, we must "wire the globe." Another factor is "dual use." For many of us, defense industries, this means transitioning technologies developed for defense needs into the commercial market -- a difficult task. The markets tend to have different driving forces. The commercial market always needs things cheaper and faster.

Having our workforce interact and compete with Europe and the Pacific Rim can also be a challenge. Without a quality product we cannot hope to compete. But how do we stack up culturally?[4]

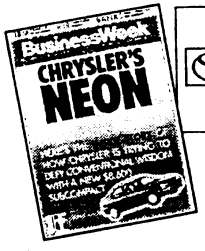
- U.S. culture demands major step-function changes -- not interested in incremental improvements
- workforce does not accept change easily
- we react against process improvements (change)
- our workers see zero defects as threatening their jobs

Our culture has a very short-term focus. In the U.S., we tend not to reward for a major success which has been built from a series of small steps. This the wrong modus operandi for the 90's! But some U.S. companies are doing the right things. The Japanese, and subsequently the Korean's targeted and penetrated the U.S. small car market in the 70's and 80's.[5] The U.S. automobile companies launched a small car counter attack and have had significant success (Figure 1). Saturn (introduced by the

Chrysler Corporation) is a superior product, cost competitive and gaining market share.[6] Note the heavy investment cost and significant time to market, however. Saturn was developed using an integrated product team approach. But, cost and cycle time were directly related to the amount of new technology inserted on this platform. Both Saturn and Neon are progressive products and the companies are learning from these experiences how to compete "Japanese style." They are also working hard at reducing time to market.

Figure 1

U.S. Success in the Small Car Market



TOYOTA $11,200	Ford	GM	CHRYSLER CORPORATION
Car	Escort	Saturn	Neon
Time to Market	5 Yrs.	7 Yrs.	42 Months
Development Costs	$2B	$5B	$1.3B
Base Cost	$8,335 - $11,923	$9,395 - $13,570	$8,600 - $12,500

Source: *Business Week* - May 3, 1993 pg. 116 and *Automobile Magazine* - May 1993 pg. 88

So, how are we changing in U.S. industry? We are not yet able to adopt the group equity/ownership strategies of Japanese companies, but we are beginning to implement more of their operational approaches. We are learning to pool resources for generic, pre-competitive research so that individual companies have the affordability to leverage the product application in the marketplace. U.S. companies are vertically integrating suppliers: from design through production. We no longer use 'lowest bid" as the order driver. Actually, the U.S. automobile industry has effectively implemented a vertical integration strategy. And, we are integrating our service strategies. Just-in-time and incremental improvement are becoming the management battle cries. A significant chunk of U.S. technology has been focussed toward maintaining our military superiority. Neither Japan nor Western Europe have had such a serious distraction -- from a commercial perspective. The need for U.S. companies to remain competitive and healthy are now driving us to convert our technology base to other markets. We call it dual use technology and conversion of the defense industrial base. At Westinghouse, we have success stories. The electric vehicle power train grew out of aircraft electrical generators and a power controller for elevators. Our mobile satellite communications systems are derived from design and manufacturing capabilities in radar. But, there are thousands of other opportunities. In particular, we must tap into national technology resources more

effectively. U.S. industry must partner more with one another and the national laboratories, as well as offshore resources.

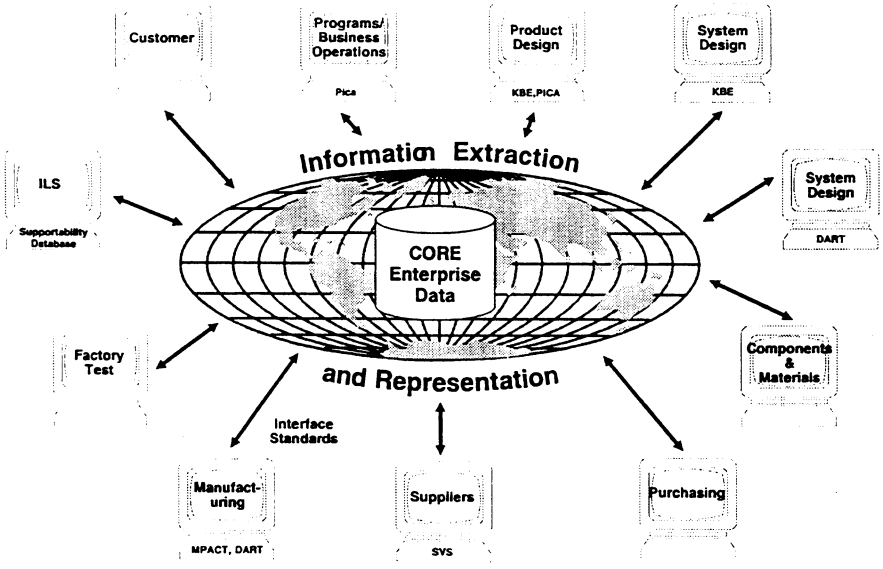
Lean Design

Lean design is key to reducing time to market and cost. Implementation of lean design requires technology implementation and a major cultural change. At Westinghouse, we have adopted Integrated Product and Process Development (IPPD) -- a team approach to dealing with the product from womb-to-tomb, in the defense vernacular. In the 60's, we addressed design, manufacturing, test and service sequentially. Quality was an oversight function. This meant that the product was not necessarily designed to be easily manufactured and tested or repaired! The first step toward fixing this problem was the integration of systems design and design engineering and then, in the late 80's, the further integration of manufacturing.

In the 90's, we have fully shifted to the Integrated Product Development Team (IPDT) concept. Everyone who touches the product, including the customer, has an equal voice. This was a cultural change which has still not gained universal acceptance. In the U.S. culture, we tend to foster the idea that we have a hierarchy in engineering superiority. This is destructive in an IPDT environment. We also need technology to do the job well. IPD does not just require teaching people to work in a team environment. Our engineers need integrated design tools with modeling and simulation capabilities and manufacturing processes and systems with flexibility. And they must have distributed information systems. Everyone needs the right information at the right time to facilitate the concurrent development of product and process. Schematically, Figure 2 shows what the typical design and manufacturing enterprise must ultimately achieve. Everyone who needs data has access to it in a timely fashion -- no matter where in the world they are located. Collectively, this does not exist today, but at Westinghouse and in the U.S., we are making great strides in implementation.

Figure 2

Systems Enable IPPD



If all team members are linked electronically, most design and manufacturing issues can be solved at the terminal. The manufacturing engineer can even query the new design against the manufacturing process database and use decision-making tools such as expert systems to enable the designer to pin-point the best manufacturable design. The power of the process relies on the accessibility and accuracy of the enterprise data. Additionally, data linkages speed up and enhance quality for our suppliers. The design engineer at our Baltimore facility can download data directly to a numerically-controlled machine on a factory floor which is five or 500 or 5,000 miles away!

Agile Manufacturing

The term agile essentially equates to lean and flexible. Implementation requires changing our organizational structure, enhancing worker skill and ensuring that we have process flexibility and control. "Agility requires integrating the skill base of a knowledgeable workforce with innovative non-rigid management structures and flexible technologies."[7] At Westinghouse, we use a supplier to fabricate chassis for electronic systems. In order for this process to work well, our designers must know the process specifications which set the design limits. This, in turn requires process or manufacturing engineers to understand their processes well, know what to measure and control. There are three major steps:

1. determine what to measure in order to control the process
2. have the ability to do the analysis
3. ensure feedback to maintain the process within spec

Optimally, this is done with a closed-loop feedback system. Understanding and controlling manufacturing processes is essential to maximizing flexibility, ensuring producibility of the design and minimizing defects. For the most part, this is a technical and cultural shift for the U.S. In many industries, we are used to counting defects, rather than understanding and controlling their origin. We also do not have the facility for a closed loop approach in many processes. Key exceptions include the chemical, bio-chemical and petro-chemical industries. Lean production and agility yield enormous benefits. The Machine That Changed The World[8] cites the following as benefits of introducing the Toyota (lean) production system: only one third the defects; cars built using one half the factory space; and cars built using only one half the man hours. This is compared to our old, mass production, way of doing business.

The Virtual Corporation

Virtual corporations must have plug compatibility allowing data flow.[7] A virtual corporation is a network of suppliers, producers and customers. Facilities utilization is optimized, particularly for production. This approach necessitates a new management model which can operate within a series of informal partnerships. The optimal inter-corporate team for one product is likely to differ from the optimal team for a different product. The organization must be structured to enable quick exploitation of market place opportunity.

Retooling

The new workplace will have a leaner and flatter organizational structure. Teamwork will replace hierarchy.[9] For many job functions, flexibility and generalization will replace specialization. Continuous training is a necessity and more individuals will be required to develop and implement leadership skills. The old hierarchical organizational pyramid will disappear. This translates into a very different work environment:

- team oriented and work led by team leaders, not necessarily functional managers

- horizontal skill broadening will enable career growth - necessary before vertical growth
- changing workforce demographics and the global environment dictate a multi-cultural awareness and responsiveness

There are several routes to developing people to fill these rolls which augment traditional training courses. "On-the-job" development, including rotational assignments and stretch projects are a necessity. All personnel need team training, including leadership, team facilitation and the understanding of team interactions. Managers must have exposure to change management techniques. This quote from The Machine That Changed The World typifies the transition that we still have to make: *"University trained mechanical, electrical, and materials engineers start their careers in an interesting way at many of the Japanese lean producers: they assemble cars."* [8]

While many U.S. companies place incoming B.S. level graduates on rotational assignments, not many begin on the assembly line. The value is that they immediately learn the practicalities of the business. Motorola is one U.S. company which has an excellent reputation for people development. Formalized course work and OJT are combined in a continual approach. Each professional is required to participate in a minimum number of hours annually. Furthermore, all development is focused toward strategic company objectives, such as six sigma quality. The benefits to Motorola have been successful products resulting in growth from a $224M company in 1956 to a $13B electronics giant in 1993.[10] They have successfully penetrated the Japanese market and were the first winner of the Malcolm Baldridge Award in 1989.

Summary

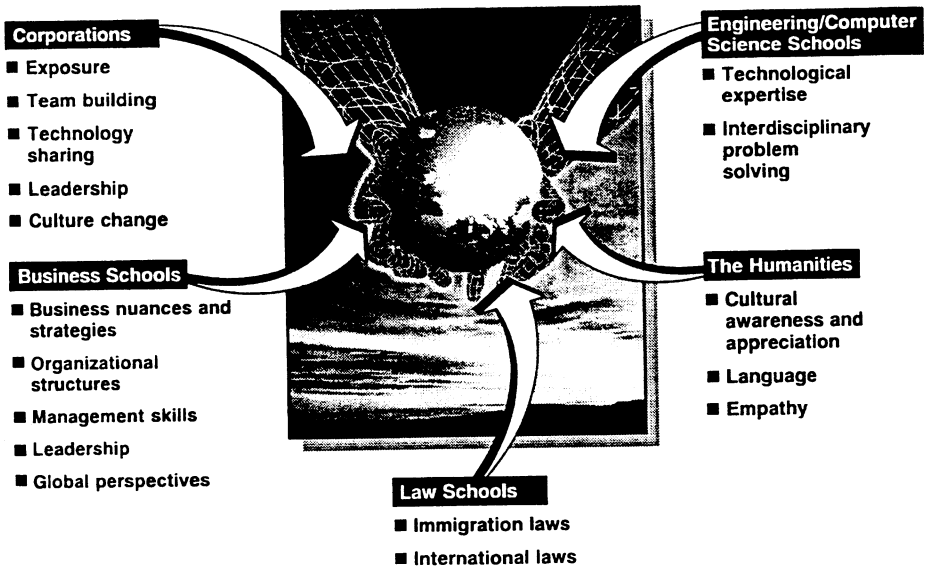
The key elements of a successful corporation in the 1990's and beyond are: globalization; lean design; agile manufacturing; the virtual corporation; and the multi-cultural workforce. Making virtual corporations successful requires that many organizations support workforce retooling (Figure 3). The professionals of today and tomorrow need a different foundation than those working in the 1970's and 80's. Undergraduate curricula should be responsive to these needs. Examples of change include:

- Tools for Teams: B.S. engineers need exposure to using design tools to solve inter-disciplinary engineering problems. Traditional senior theses could be transposed to team projects.
- Change Management: Leaders must understand how to shift to flexible organizational structures and the accompanying ramifications of empowering people in the workforce.
- Cultural Change: understanding different cultures and their associated business nuances.

If this discussion has not convinced you of the need for change, I will leave you with this quote from Raymond Smith, Chairman of the Board and Chief Executive Officer of Bell Atlantic -- *"the corporate landscape is littered with the remains of once formidable competitors who could not recognize structural changes in their industries or change fast enough to capitalize on windows of opportunity."*[11] The world is waiting, ladies and gentlemen, let's take advantage of it!

Figure 3

Tooling to Support Globalization



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