Agile Manufacturing

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Introduction

As we transition into the twenty-first century there are radical changes taking place that are reshaping the industrial landscape of western economies. The marketplace has become truly global. There is increasing fragmentation of almost all markets. Customers are requiring smaller quantities of more customized products. Customers want to be treated individually. Most companies have much wider product ranges, are introducing more new products more quickly, and are focusing their marketing. We are on the cusp of the information age and these changes are ushering in new and exciting challenges for western manufacturers.

In the 1970's and 80's we struggled to bring our manufacturing operations under control through the use of formal production and materials planning, shop floor scheduling and control, and systems like MRPII (Manufacturing Resource Planning) and ERP (Enterprise Resource Planning). With varying degrees of success. In the 1990's we struggled to bring our companies to world class status. We implemented TQM (total quality management) methods to bring our processes under control and create continuous improvement. We introduced just-in-time manufacturing techniques like cellular manufacturing, quick change-over, one piece part flow, kanban, and zero inventories. Spurred by success stories and social change we moved to team-based continuous improvement and experimented with self-directed work teams. We studied best practice and benchmarked ourselves. And our customers pressed us into greater flexibility, shorter lead times, and more varied products and services.
How Does Agile Manufacturing Differ from World Class Manufacturing?

As we are approaching the end of the 1990’s we must build upon these improvements to develop truly agile manufacturing approaches. How does agile manufacturing differ from world class or lean manufacturing? Lean or world class manufacturing is being very good at doing the things you can control. Agile manufacturing deals with the things we can NOT control. Agility is the ability to thrive and prosper in an environment of constant and unpredictable change. Agility is not only to accommodate change but to relish the opportunities inherent within a turbulent environment. Here are some of the axioms of agile manufacturing:

- Everything is changing very fast and unpredictably. The market requires low volume, high quality, custom and specific products. These products have very short life-cycles and very short development and production lead times are required.
- Mass production is moribund. Customers want to be treated as individuals. This leads to a people intensive, relationship driven operation. Perfect quality and very high levels of service are expected and required. Products and services become information-rich.
- The swift trend towards a multiplicity of finished products with short development and production lead times has lead many companies into problems with inventories, overheads, and efficiencies. They are trying to apply the traditional mass-production approach without realizing that the whole environment has changed. Mass production does not apply to products where the customers require small quantities of highly custom, design-to-order products, and where additional services and value-added benefits like product upgrades and future reconfigurations are as important as the product itself. While it is difficult for many people to accept that mass production must be replaced with new approaches, there are many telling signs. The proliferation of finished products; the rapidly increasing introduction of new products; short product life cycles; the customer demand for products that specifically address their needs. All these trends negate the fundamental ideas of mass production that have served western industry so well for decades.

Even world class manufacturing and best practice approaches are based upon the time-honored concepts of mass production of standard products. The famed Toyota Production System (TPS) has two kinds of products; type A and type B. Type A is a standard product and type B is custom product. Practitioners of TPS strive hard to eliminate type B parts and products because they do not fit the concepts of one piece part flow and rate-based schedules (heijunka). An agile approach to manufacturing faces the reality that we must serve customers with small quantities of custom designed parts with perfect quality, 100% on-time delivery, and at very low cost. To approach agile manufacturing requires that the company already be world class and using lean manufacturing methods. This is a starting point. You can only build agility on a firm foundation. These changes are more apparent in some industries than others. In the consumer electronics and automotive industries the need for agility is most apparent. New products are coming very fast. The range of products is increasing at an astonishing level. The customers and the markets are becoming continuously more fragmented and specialized. Only the innovative and
agile companies will survive these changes.

Similarly in the food and consumer products industries the same trends can be easily seen. In Australia, the supermarkets have been adding 500 sku's every year with very few eliminations. Every product comes in a bewildering variety of sizes, packs, and variations (diet, low sodium, decaffeinated, kids size, and so forth). All of these trends lead away from the old ideas of large factories making huge quantities of relatively few standard products. Other industries will need a few more years before these changes begin to bite, but already the pharmaceutical industry, the metals industries, garments, industries supplies, and many others are seeing the start of these trends through product proliferation and increased customer requirements for custom products. Here are some of the important aspects of agile manufacturing; customer prosperity, people and information, cooperation within and between firms, and fitting a company for change.

Customer Prosperity

The key to this is to look at the products and services that your company provides in terms of how much value they add to the customers. World class manufacturers have placed great emphasis on being close to the customer; customer prosperity goes much further and examines how much value is added to the customer by the use of your company's products and services. This requires an intimate understanding of the customer's needs. It requires a short term, medium term, and long term view. It requires you to understand your customers use of your products more thoroughly than they know themselves. To address the customers' real needs you must sell solutions and not products. Selling solutions requires a detailed and thorough understanding of the customers needs, and requires bringing together a package of products and services to fulfill those needs. Your product alone many not be enough. You may need to add extra services or technical support or special terms. You may need to add complementary products supplied by other companies - perhaps by your competitors - to truly satisfy the customers needs.

You will almost certainly need to design or develop products that are focused specifically on an individual customers requirements. Product design, in most cases, will need to be closely integrated with the production process. The need for fast and effective design means that the traditional approach of having all new products routed through a design area must be eliminated. It always causes delay, misunderstanding, and a lack of cooperation between the design area and the production floor. The design process must be integrated with the manufacturing
process. Often the manufacturing people on the production cell can be trained to do the majority of the design functions. Often the products can be modularized to allow configuration rather than the separate design of each product; thus simplifying the design process.

Sometimes automated design systems need to be introduced so that the CAD (computer aided design) systems can remove much of the detailed skills from the design process. Sometimes these CAD systems are integrated with CAM (computer aided manufacturing) systems so that the designs can be automatically fed into the computer controlled production machines. The design process can be significantly enhanced by having the customers fully participate in the design of the product. The two companies working together cooperatively for mutual benefit. The customer bring their design skills to bear of the project and your company adding its production skills into the equation. In some cases the suppliers and outside process vendors can also be integrated into the design process so that the product is designed to meet the customers needs very effectively. This close cooperation allows for the development of service-rich products that can evolve over time, as the customer and the company work closely together. This leads to the development of long term relationships. The products may be designed to not only meet current needs but to be reconfigurable to meet the customers' future needs. Attention is paid to configurability, modularity, and design for the longer term satisfaction of customer requirements. Where the product contains software, it can be built to accept software updates over time. Where the product is mechanical, it can be designed for easy reconfiguration and upgrades as technologies change, as new features are added, and as the customers needs change over time.

Honda Motorcycle in Japan has developed a range of machines that have a credit-card sized electronic key. This key serves not only as a security device to unlock the steering mechanism, the electronic fuel pump, and other major components; it also contains information that changes the performance of the machine by changing the fuel injection, the timing, the ignition settings, and other parameters. The rider can choose between fast, high performance, economy, town, or mountainous driving, and so forth. The addition of electronic configurability allows the rider to easily reconfigure the machine to meet his or her needs. This flexibility and customer responsiveness was created because Honda has an understanding of the customers varying needs and saw an information-based method of providing a wide-ranging solution. Increasingly it becomes the company's information and the skill of the people that becomes a premium. The company ceases to sell products, as such. The company sells its ability to fulfill the customers needs. This knowledge and skill needs to be valued, it needs to be protected, and it needs to be shared. New information systems technology has made it possible for the company's personnel to be directly in contact with each other wherever they are in the world. This makes information, skills, and knowledge accessible to the people who are the primary providers of customer service. This can be a powerful tool linking people, customers, and other third parties closely together.
The skills and knowledge of the people within the company become a paramount consideration as a company develops solutions-based selling. This knowledge includes product knowledge and experience, but it also includes a rich depth of knowledge of the customers’ needs, anxieties, and service requirements. The relationships that develop between the customers and company’s people when the company sells solutions instead of products become very much a part of the product itself. The customers need to be treated as individuals, with individual needs, and a history of experience with your company. This is very much a part of the agile approach. In some ways it is good, old fashioned service, but in other ways it is very modern. This level of customer enrichment can only be achieved through the use of knowledge based systems. Increasingly, the best way to create close customer awareness is to provide the people within the company, and the customers themselves, a great deal of information. This may be product information, company information, education and training in the use of the companies products, analysis and data, product upgrades, manuals, drawings, instructions, and specification. These days all this information can reside within the computer systems and be readily available to all authorized users including customers, suppliers, and other third party partners. This way the sales representatives can be highly knowledgeable about the customers, their requirements, their ordering pattern, their payment history, their use of the technical support or customer service facilities, and so forth. Available, complete, pertinent, and easy-to-access information is fast becoming a key competitive weapon that enables all customer contacts to be thorough and satisfactory.

Leading from this, of course, is the ability to closely link the customers’ systems into your company’s systems. Orders can be placed automatically from the customer and scheduled within the plant, yielding the customer accurate delivery promises. The design requirements can be automatically picked up in the customers information systems without drawings or specification being printed and passed. This enables the company to address customer needs with great agility. Design, delivery information, history, accounts receivable, customer service contact can all be integrated and made available. Some of the technologies required to achieve this level of information sharing and availability have only become available recently. The wide access to the Internet and the World Wide Web opens up a standard and direct method of accessing information and providing the customers with a standard link into a company’s system. For the customers to be linked into a company’s information systems in the past required a direct link (usually through dialing into the company’s computer center). The Internet, and other networks, allow the customer to have a simple and standard link to place orders, make inquiries, send message, and specify their needs. IBM has recently established a world wide information system for their 350 partner companies. The system, using Lotus Notes communication methods, provides the partners with a window into IBM for technical information, product availability, personal communication, help-desk facilities, trouble-shooting data, the ability to enter orders, check delivery dates, and order statuses. This kind of information was previously either unavailable or required the partner company to contact a customer service person or sales representative. This open sharing of information is a key aspect of creating an agile operation.
Cooperation

The rapid change in technology (and other skills) added to the customers requiring highly specific, customized products, has lead to the need for far greater cooperation within and between firms. No company can have all the required skills and knowledge. In high-tech areas it is very often the small and virile organizations that develop and harness the latest advances. It is just not possible for one firm to have everything it takes to fully meet a customers needs. There may be additional services, information, or logistics required to meet the need. To achieve these diverse and ever changing needs requires great cooperation. This cooperation is needed within the firm. Often traditional companies have very little flexibility and cooperation from one department to another. This must be solved and the various departments or areas of the company must work together for the enrichment of the customers, irrespective of the department's short term benefit. The customers, supplier, and other third parties can be brought into the cooperation to design a product or develop a value-added service. In some cases the company will need to seek out specific partners with special skills or attributes and create a virtual corporation from several parties to focus on meeting the needs of a customer or a market. These virtual corporations are opportunistic alliances of core competencies across several firms to provide focused services and products to meet the customers highly focused needs. With the advent of the information revolution, these various companies can readily communicate and cooperate across long distances and provide products and services that are widely scattered geographically and politically. The beginnings of the information age has made possible the ability to create widely diverse virtual corporations that can quickly and effectively address the needs of the customers and the marketplace. The agile organization will choose inter-enterprise cooperation as the first choice.

These cooperative partnerships are not the traditional joint ventures or mergers. They are informally created by companies dedicated to cooperation. Usually there is no complex legal structure. The cooperative arrangements are quickly made, written down so everyone understands their role and expectations, and then put into practice. Virtual corporation require considerable trust, respect, and openness. Information technologies that allow groups of people to work together effectively even if they are geographically separated are tools that enable these kinds of informal, cooperative endeavors to flourish. Before the advent of the Internet, video conferencing, and multi-lingual systems it was not possible to provide the level of personal contact required to work together effectively and in a timely manner. These new technologies have opened up a world of communications that facilitate cooperative and virtual corporations to met the needs of specific customers and markets. A notable example of this kind of cooperation is the link that has been forged between IBM, Motorola, and Apple Corporation to develop the new PowerPC chip to compete with the Intel Pentium. The companies, in some aspects competitors with each other, have created a team to design, develop, and manufacture the PowerPC chip. None of them could have done this alone. An Australian company that was experiencing high costs and problems with the replenishment of materials from their principle suppliers entered a cooperative relationship with a transportation company. The truck drivers were given keys to the company's production plants and trained to identify component parts that were
in short supply or had kanban requirements. The driver enters a requirement message in the computer system and drives to the supplier for replenishment of the item. These transactions occur continuously throughout a 24 hour period, even when the plants are closed and empty. This significantly reduced costs, eliminated the purchasing/order entry role within the customer and the supplier, and solved many of the part shortages problems. Cooperation of this kind requires trust, training, and an openness to try unorthodox approaches. The difficult aspect of this change was not the organization of the approach, it was the acceptance by company managers that this would even work.

Fitness for Change
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Everybody recognizes that the next few years will be a time of unprecedented change and uncertainty. But how should an organization be structured to take advantage of this turbulence? There is no clear-cut and simple answer to this question but there are a number of issues that can be addressed to help a company become change-ready. Change and customer focus requires the people closest to the customer to have authority to change the company’s methods to address the customers’ needs.

The local people need to have considerable authority. The company needs to have a clearly defined vision of the where the company is going, what its objectives are, and how those objectives will be met. This vision must be thoroughly disseminated throughout the organization. Principles of conduct and practice must be laid out so the local people making the changes and making the decisions, have clear policy guide-lines to direct their decisions. But the local people must then have complete authority, within the vision and principles of the company, to address the customers needs.

For local decision-making to be effective, a company must have a highly educated and trained work force. They must be people who know and understand the company’s vision and principles, people who know and understand the customers’ requirements, and people who know and understand the company’s products and services. They must also know how to create cooperative alliances, how to reconfigure products, when to “go the second mile”, and how to combine expertise towards a common goal. Added to this, an agile company will often have smaller production and service centers geographically spread out, so that the customers can be served locally. Sometimes this need for local-ness can be met by appropriate use of the information systems, but often the need for very short lead times and customer responsiveness requires physical proximity as well as excellent communications. Saturn Corporation, the new US car manufacturer, requires their employees to take no less than 96 hours of training every year. While training is voluntary, the company’s bonus system is set up so that there are strong incentives to achieve or exceed the training requirement. In the early days, the company used training achievement as the only performance measure for the plant people.
because it was clear that training was the principle key to quality, timeliness, low cost, team work, and the company's other strategies. If the local people are to have considerable authority then they must have the resources, the knowledge, and the authority to meet the customers needs. Agile companies put enormous emphasis on the training and development of their people. Some of this is through the traditional training classes, books, and seminars. Some of it is through team-based, cross-functional improvement initiatives. Some of it is through the intelligent use of information technologies making the latest information immediately available for education or for analysis. Some recent advances in information technology are important to change readiness.

The move to object oriented programming may seem to be a technical nicety. In reality, object orientation makes computer systems highly flexible. Instead of a program doing certain defined functions and those functions alone, the object oriented technology allows the users to string together the objects (or small, modular business transactions) so that processes are created within the system to address the needs of the organization. In fact, more than one set of object oriented processes can be present within the system. This enables the company to serve different customers in different ways - according to their needs - but using a single highly flexible system that can be readily adapted as the needs change. The company must also become adept at changing the organization. It is not only the ability to make changes; it is the ability to recover quickly and effectively from the disruption caused by the changes. Like a light-weight boxer or a graceful gymnast, an agile organization can elegantly recover from any blow or disturbance. Practice at change is essential. Reorganization must become routine. An agile company will often need more than one organizational structure at the same time. Different customers will need to be served differently. These differences will often require different internal structures. These are the challenges of agility. Agility requires significant management skills, wide distribution of expertise and authority, local decision-making to address local customers, and highly skilled and trained people. Leadership, motivation, and trust must replace the traditional management style of command and control.

Summary

Many industries and markets are increasingly requiring much greater flexibility and timeliness from their manufacturers. The need to manufacture small quantities of highly customized products with perfect quality and 100% on-time delivery, and at a low cost is forcing companies to abandon the old ideas of mass production; even lean or world class mass production. To compete in this changing and unpredictable marketplace, and to thrive upon it, these companies are adopting agile manufacturing methods. These methods require highly integrated and flexible technologies of production; not necessarily high-tech methods, but highly capable. To adequately address their customers fast changing and focused needs, the company's people must be very highly educated and trained, and significantly empowered within the
constraints of a clear vision and delineated company principles and goals.
The company itself must have the ability to effect change rapidly, have highly flexible management structures, and comprehensive methods of introducing change and prospering from it. There must also be a mechanism for readily creating informal alliances with other companies and organizations - even competitors - to design and produce products and service that address the needs of the customers and the emerging marketplace. These changes are taking place very fast in some industries, and more slowly in others. But the companies that will meet the challenges of the ever-changing global marketplace of the twenty-first century are those that are able to become agile in every aspect of their business. Agility is not a "magic wand" to solve all ills. It is built upon the firm foundation of world class or lean manufacturing methods, coupled with an organization that is physically, technologically, and managerial established for rapid and unpredictable change. [return to top]