World Class Manufacturing: Blueprint for Success

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Manufacturers are facing new challenges as global competition accelerates and supply chain management intensifies. Consumers are demanding short delivery times for customized products with exceptional quality and high performance. To respond, firms are examining their strengths and weaknesses and considering how to change their practices and capabilities to be effective world-class competitors. This paper provides managers with an overview of World Class Manufacturing, describes a process to implement it, and discusses building commitment for it. To succeed, firms should set business goals and understand customer expectations, define the essential competencies needed to achieve those goals, create metrics for each competency, establish target levels for each metric, develop plans and programs to achieve the targets, organize and manage the implementation process, and evaluate and revise the efforts as needed.

Expanding global competition, rapidly changing markets, and the world-wide spread of advanced manufacturing technology are creating a complex and uncertain environment (Bayus, 1994; Manufacturing Studies Board, 1986). As customers become more demanding and global competition intensifies, manufacturers feel the pressure to meet tighter quality, cost, and delivery requirements (Doll & Vonderembse, 1991; Skinner, 1985). To effectively respond to these challenges, many manufacturers are striving to become world-class competitors.

Simply stated, world-class manufacturers design, produce, and deliver products that delight customers and enable firms to compete with the best in the world (Schonberger, 1996). World Class Manufacturing (WCM) is a process, based on employee development and involvement, that unites key cross-functional actions such as product development (Wheelwright & Clark, 1995), material acquisition (Senter & Flynn, 2000; Tracey & Vonderembse, 2000), lean manufacturing (Womack & Jones, 1996), and quality management (Deming, 1986; Juran, 1981a, 1981b) in ways that meet precisely specified customer requirements. Success is achieved by (1) setting business goals and understanding customer expectations, (2) defining essential manufacturing competencies that determine a firm's ability to meet or exceed customer expectations, (3) creating metrics for these competencies, (4) benchmarking performance, (5) determining target levels for each metric, (6) developing plans and programs that enable the firm to meet these targets, (7) organizing and managing the implementation process, and (8) evaluating performance and revising the system. When properly executed, these actions lead to customer satisfaction and positive business results (Gunn,1992; Schonberger, 1996).

For many years, manufacturing was an internally focused activity aimed primarily at efficiency and cost reduction. Employees often completed tasks without understanding the effects of their actions on customers. The internal focus was perpetuated by separating critical functions such as marketing, engineering, manufacturing, purchasing, and quality control. This separation was often described as the "over-the-wall" approach to manufacturing. These walls inhibited direct and continuous interaction between functions and shielded decision-makers from internal and external customers. The results of separating tasks by functions are the loss of time, information, and money, and the creation of finished products that do not meet customer needs (Doll & Vonderembse, 1991). World-class manufacturers build cross-functional processes that focus outward on customers and build strategic relationships with internal and external suppliers (Swinehart, Miller, & Hiranyavasit, 2000). These efforts at supply chain management and customer relationship management unify actions and focus attention on the customers of the final rather than intermediary products (Panizzolo, 1998; Schonberger, 1996).

This paper provides practicing managers with an overview of WCM as an integrated, cross-functional effort that focuses on customers and strives for business success. Its primary contributions are to describe a process for implementing WCM and to discuss ways to build commitment for its success. The paper provides managers with a set of actions to guide implementation and a set of metrics to measure performance.

World Class Manufacturing

WCM is a cross-functional process for designing, producing, and delivering goods that delight customers and lead to exceptional organizational performance. It combines skills and resources from various functions to focus on opportunities and threats in the environment. By seeking leadership in the global marketplace, organizations are choosing to be "world-class." The popularity of Richard

Schonberger's *World Class Manufacturing: The Next Decade* (1996) helps to raise awareness and give definition to a new and better approach to manufacturing.

At the strategic level, Gilgeous and Gilgeous (1999) describe a framework for success that shows how programs and their enablers combine to link company strategy to activities at the operating level in order to achieve manufacturing excellence. Munda and Hendry (2002a, 2002b) describe the development and implementation of WCM for firms involved in make-to-order operation. This approach relates the organization's areas of strength to key make-to-order principles and ultimately to potential improvements. Swinehart, Miller, and Hiranyavasit (2000) describe strategies that can be used to achieve WCM status in a globally competitive environment. These strategies require manufacturing operations to be externally supportive and play a key role in helping firms build a competitive advantage. Flynn, Schroeder, and Flynn (1999) provide strong support for the use of WCM, alone and in combination with other manufacturing practices, as a way to achieve competitive advantage. In a survey of 229 Canadian firms, Lagace and Bourgault (2003) provide insights into the association between WCM and competitive positioning.

Billo, Needy, and Bidanda (1996) discuss the supporting role played by information technology (IT) in companies seeking WCM outcomes while Saxena and Sahay (2000), in their survey of Indian manufacturing, stress the need to align IT initiative with WCM objectives. As part of a longitudinal case study of a Swedish firm, Lind (2001) discovered that WCM involves change in methods of control, empowerment, and the process for implementing new ideas.

Gunn (1992) describes the WCM environment as having sophisticated customers, global manufacturing systems, a faster pace and wider scope of activities, and an emphasis on product quality.

1. **Sophisticated Customers:** Increasing consumer sophistication and wealth as well as more sophisticated marketing are leading to a proliferation of products that target more diverse tastes and accommodate special market niches (Clark & Fujimoto, 1991; Cooper & Kleinschmidt, 1994). The growth in stock keeping units (SKUs) compounds manufacturing complexity exponentially. This increases the need for flexible systems to design, produce, and deliver these products (Blackburn, 1991; Doll & Vonderembse, 1991).

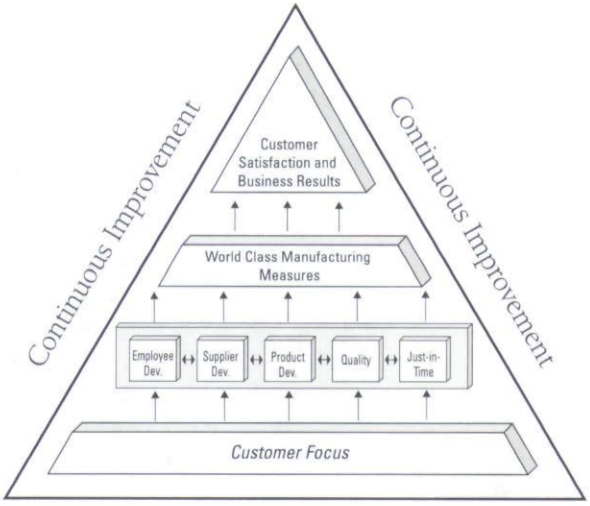
2. **Global Manufacturing Systems:** Design expertise and production capabilities are sourced globally. Subassemblies may be produced on three different continents while final assembly takes place on a fourth. Coordination and control are managed through integrated, worldwide information and distribution systems that work to meet customer needs (Flaherty, 1996; Hill, 2000).

3. **Pace and Scope of Business Activities:** Time and distance are being compressed by the electronic movement of information in all forms including television's influence on consumer desires, electronically connected markets, and the influence of e-mail, fax machines, and mobile telephones on management styles. Business activities that took weeks now take days, or are performed in "real time" (Blackburn, 1991).

4. **Demand for Higher Quality**: Customers cannot afford to buy unreliable products. Their lifestyles and schedules leave little time for getting products serviced or returning defective ones to their supplier. The conventional wisdom that zero defects is unachievable has been debunked by a flood of products that work and work well (Deming, 1986, 2000; Juran 1981a, 1981b).

As illustrated in Figure 1, WCM focuses on customers, relies on critical manufacturing competencies, and develops measures that lead to customer satisfaction and positive business results (Gunasekaran, 2000; Schonberger, 1996). The key differences between WCM and traditional manufacturing begin with a shift in focus from internal operations to customers. Employees and suppliers must understand customer needs and how their efforts impact those needs. Key competencies shift from engineering effectiveness, quality control, and efficiency to employee development (Badore, 1992), supplier development (Handfield and Nichols, 1999), product development (Clark & Fujimoto, 1991), quality improvement efforts (Deming, 1986, 2000; Juran, 1981a, 1981b), and just-in-time (JIT) (Mondon, 1983). As organizations adopt WCM principles, outcome measures tend to become multi-dimensional with throughput time, supplier capability, employee skills, and other measures being added to more traditional financial measures such as labor costs or material variances.

Figure 1: *World Class Manufacturing Model*



Continuous Improvement

The top of the WCM model lists the overall goals, which are customer satisfaction and business results. Good customer service has long been a primary objective of manufacturers. Over time, the objective with respect to customers has changed as the word "service" became "satisfaction" or even "delight." From meeting specifications and delivery dates reasonably well, the criteria now include anything relevant to ensuring complete customer satisfaction. The Malcolm Baldrige National Quality Award describes business results as key measures and/or indicators of company

operational and financial performance. Surrounding the WCM model is continuous improvement. Striving to achieve WCM status is an on-going, iterative process that seeks continuous improvements to meet rising expectations. Recognizing, evaluating, and acting on opportunities for improvement set world-class manufacturers apart from their competitors.

Process for Implementing World Class Manufacturing

Even though WCM depends heavily on continuous improvement, initiating these concepts and ideas may require radical change (Hammer, 1996). Radical change requires top management commitment, support, and involvement. Each of those words implies different things. Top management commitment implies the consent of organizational leadership to pursue WCM. Top management support is the allocation of sufficient resources in people and capital to design and implement WCM. It requires the time and talent of the best and brightest people from across the organization. Top management involvement includes the time of top executives in defining the concept of WCM, communicating its importance, and breaking down barriers to change (Gunasekaran, 2000; Hammer, 1996; Schonberger, 1996).

Success requires a process that integrates WCM initiatives into the business planning process. A process for achieving this integration, illustrated in Figure 2, has eight steps.

1. Set *business goals* and understand *customer expectations*,
2. Define essential *manufacturing competencies*,
3. Create *metrics* for these competencies,
4. *Benchmark* performance,
5. Determine *target* levels for each metric,
6. Develop *plans* and *programs* to achieve the targets,
7. *Organize and manage the implementation process*, and
8. *Evaluate performance and revise the systems.*

While steps 1, 7, and 8 may apply generally to the achievement of any radical change, it is important to discuss each briefly. The primary focus is on understanding manufacturing competencies, metrics, benchmarks, targets, plans and programs, and implementation.

Business Goals and Customer Expectations

Business goals and customer expectations are two sides of the same coin. A firm's performance and profits are directly related to its ability to add value and delight customers (Cooper & Kleinschmidt, 1994). Business goals define the organization's direction. They should be as specific as possible, such as "We want to have the highest level of customer satisfaction in the industry" or "We want to have a 25 percent market share." They should relate to both business performance and customer satisfaction. These goals guide and motivate an organization to initiate change. The process of goal setting should involve all levels of the organization in order to achieve buy-in and commitment (Dettmer, 1998; Gunn, 1992).

Figure 2: *Management Overview of the Process for Achieving World Class Manufacturing Success*

Approach	Issues to Address
1 Set Business Goals and Understand Customer Expectation	• What goals does the firm want to achieve? • How can WCM improve customer satisfaction?
2 Define Essential Manufacturing Competencies	• What manufacturing competencies are essential to achieve positive business results? • What competencies should the firm possess to achieve the speed, productivity, quality and flexibility demanded by customers?
3 Create Metrics for these Competencies	• What metrics are important to my customers? • What metrics are important to achieving positive business results?
4 Benchmark Performance	• Where does the organization stand in relation to "best-in-class" and World Class Manufacturers? • What areas need improvement? • What technical knowledge will be required?
5 Determine Target Levels for Each Metric	• What is the process for setting performance targets? • Who should be involved in setting performance targets? • How should these targets be communicated?
6 Develop Plans and Programs to achieve the Targets	• Develop plans that enable the firm to meet performance targets. • Design programs that focus on improving the metrics.
7 Organize and Manage the Implementation Process	• Define a phased approach. • Who needs to perform the actions and by what time? • What is needed to continue progress? • What is needed to support personnel?
8 Evaluate Performance and Revise the Systems	• Are the plans and programs sufficient for supporting WCM? • Do the metrics need revision because of changes in customer demands or in the business environment?

Manufacturing Competencies

The foundation for success in WCM is the five manufacturing competencies: employee development, supplier development, product development, quality, and JIT shown in Figure 1. These elements, summarized in Table 1, are interrelated, and they provide a foundation that enables firms to create a win-win environment for customers and shareholders.

Employee Development

Organizations that strive to be world-class manufacturers create systems that integrate decisions across functions and develop new methods and procedures to streamline operations. The roles of managers and shop floor employees change substantially as decision-making is pushed down the organization. Teamwork,

Table 1: *World Class Manufacturing Competencies*

Competency	Reason
Employee Development	An organization's most important assets are its employees. WCM relies heavily on all employees. Management is responsible for providing all employees with the proper tools to do their jobs. In addition, employee growth through learning, motivation, and opportunities for advancement contribute to WCM success (Badore, 1992; Hammer, 1996; Nonaka & Takeuchi, 1995).
Supplier Development	Raw material and purchased part quality directly affect manufacturing processes and their output, including productivity. By choosing to work with a supplier as a manufacturing partner, the supplier's processes become an extension of their customer's processes. Many benefits await companies that develop their supply chain, including reduced waste, enhanced quality, and improved problem solving capability (Handfield & Nichols, 1999; Senter and Flynn, 2000; Tracey & Vonderembse, 2000).
Product Development	The ability to bring new and better products to the marketplace faster has become a determinant for sustaining competitive advantage and enhancing performance. A structured approach is necessary to ensure a fast and effective product development cycle (Clark & Fujimoto, 1991; Cooper & Kleinschmidt, 1994; Wheelwright & Clark, 1995).
Quality	Today's consumer demands a quality product. Manufacturing products have several quality dimensions. 1. *Performance* 2. *Features* 3. *Reliability* 4. *Conformance* 5. *Durability* 6. *Serviceability* 7. *Aesthetics* 8. *Perceived quality* Customers want products that meet their quality requirements. Quality is defined by customers and must be the driving force for any company regardless of the type of product (Deming, 1986, 2000; Juran, 1981a, 1981b; Schlickman, 1998).
Just-In-Time Manufacturing	Customers want the lowest cost and fastest delivery. The methods for manufacturing product will be one of the determinants for meeting customer demands of low cost and fast response. Effective and efficient methods of manufacturing are necessary to reduce and eliminate manufacturing waste and to preserve investments in manufacturing equipment (Dettmer, 1998; Koufteros, Vonderembse & Doll., 1998; Monden, 1983; Womack & Jones, 1996).

training, and shared knowledge become critical ingredients for success. Managers facilitate, coordinate, and integrate activities that move the organization towards its objectives rather than command and control the actions of a few subordinates. Shop floor employees participate in the planning and execution of key manufacturing practices such as set-up time reduction and quality improvement efforts (Badore, 1992; Nonaka & Takeuchi, 1995).

World-class manufacturers invest in people. They understand that employees grow more valuable with time and experience. They expend significant resources to develop the full potential of their employees through job training and continuing education (Badore, 1992). World-class manufacturers also create many opportunities for people to contribute to their success. They encourage and obtain high levels of employee participation in a wide variety of formal and informal improvement efforts (Lind,

2001). These improvement efforts should not go unrecognized. Company-wide celebrations of special achievements and financial participation in the profits and savings are ways to provide positive feedback and to keep employees involved (Dettmer, 1998; Gunn, 1992; Schonberger, 1996).

Supplier Development

Advocates of WCM recognize that competition is no longer between individual firms; rather, it is between their supply chains. For example, the development, design, production, marketing, and delivery of a car should be a coordinated team effort that begins with extracting raw materials from the earth, continues through fabrication and assembly, and ends with fit and finish in the dealer's showroom. When customers buy cars from Ford, they choose the output of the entire supply chain and pay all the participants. For Ford to be successful, the entire supply chain must work effectively. Ford should develop methods to manage the supply chain from its roots in basic materials such as iron ore, sand, and crude oil all the way to the dealer network. That does not mean ownership or even direct control, but it does imply mechanisms that coordinate actions, influence decision-making, and impact performance. Supplier relations and development are critical to success in product development, quality improvement efforts, and JIT (Handfield & McNichols, 1999; Senter & Flynn, 2000; Tracey & Vonderembse, 2000).

In today's environment, suppliers are often selected on the basis of quality, delivery reliability, and flexibility. The benefits of consistent quality and JIT deliveries are often more valuable than a few cents off the piece-part price. In many cases, supplier-customer relationships governed by strategic partnerships lead to lower prices than competitive bidding (Vonderembse & Tracey, 1999; Vonderembse, Tracey, Tan, & Bardi, 1995). Joseph Juran developed a framework for distinguishing between adversarial and teamwork relationships among customers and suppliers (see Table 2). These partnerships allow suppliers to become an extension of the world-class manufacturer's operations. The benefits can include integrated information and quality systems and cross-company problem solving efforts (Juran, 1981a, 1981b).

Product Development

Companies and their associated supply chains vie with competitors to be first with innovative new products. As the rate of technological advance increases and as competition between domestic and foreign companies heats up, it becomes increasingly important to bring new and improved products to market quickly. Many world-class manufacturers have set clear targets for improving speed and quantity of new product introduction. Quality Function Deployment (QFD) and Concurrent Engineering are tools that help world-class manufacturers quickly deliver the right product to the customer.

QFD is a broad-based product development tool that combines aspects of value analysis with market research. The primary objective of QFD is to specify the product and the process correctly from the outset. QFD translates the voice of the customer into product specifications by associating customer wants with appropriate technical requirement at each stage of product development and production. It bridges the gap

Table 2: *Adapted from Juran's Supplier Relationship Framework (Juran, 1981a, 1981b)*

Competency	Adversary Concept	Teamwork Concept
Pattern of collaboration	Arm's length; secrecy; mutual supervision	Mutual visits; disclosures; assistance
Supplier selection	Single criterion usually via competitive bidding; in most cases a 2 or 3 percent reject rate may be acceptable	Multiple criteria including price, delivery and source with high quality; a low (zero) percent reject rate is essential
Product specifications	"Tight" specifications which inhibit suppliers from suggesting improvements	"Loose" specifications which allow suppliers wide latitude in designing products and processes
Quality planning	Separate	Joint
Criteria for quality	Conformance to specifications	Fitness for use
Number of suppliers	Multiple; often many	Few; often single source
Duration of supplier contracts	Annual	Three years or more

between customer-driven specifications and concurrent engineering constraints. QFD enables managers and engineers to make trade-offs between conflicting objectives in a way that maximizes the benefits to the customer (American Supplier Institute, 1989; Vonderembse, Van Fossen, & Raghunathan, 1997).

Concurrent Engineering is a nonlinear approach to product design where all phases of engineering and manufacturing operate at the same time. It is a process where engineering and manufacturing professionals, both in-house and supplier, provide input during the entire design cycle. It reduces downstream problems and builds quality, cost reduction, and reliability into the process. When combined with QFD, concurrent engineering brings problems to the surface early and creates an environment where better decisions can be made in less time (Sanderson, 1992; Susman & Dean, 1992). Concurrent engineering is based on the following principles:

- Concurrence: Product and process design run in parallel
- Constraints: Process constraints are considered part of the product design. This ensures parts that are easy to fabricate, handle, and assemble and facilitates the use of simple, cost-effective process, tooling, and material handling solutions (also known as Design for Manufacture and Assembly).

- Coordination: Product and process are closely coordinated to achieve optimal matching of requirements for effective cost, quality, and delivery.
- Consensus: High-impact product and process decision-making involves the full team's participation and consensus.

Quality

Formal quality systems play an important role in organizing a company to support quality as a key business objective (Deming, 1986, 2000; Juran, 1981a, 1981b). In the 1990's, the United States saw a large increase in the number of companies pursuing quality systems registration to the ISO 9000 and QS-9000 standards. In particular, QS-9000 has been a major focus of the automobile industry (Schlickman, 1998). In addition, many companies are using Six Sigma to achieve better quality and thus better 'bottom line' results. Six Sigma applies important quality tools such as experimental design and total productive maintenance to the quality control process (Evans & Williams, 2002; Pyzdek, 2003). In addition to helping secure future business, formal quality systems benefit companies by:

- defining authority and responsibility within the quality system,
- clearly communicating the objective of the quality system,
- promoting continuous improvement throughout the organization,
- monitoring quality system continuously, and
- ensuring consistent performance within the quality system.

Just-In-Time

Many different manufacturing techniques have been developed to improve production. Each technique has it own benefits such as reducing lot size, increasing machine availability, or using computers to run part programs. The goal is to improve process control capability while reducing manufacturing time and cost. JIT is a systematic approach to eliminate waste and reduce throughput time. JIT can be accomplished by using a combination of manufacturing techniques, including setup redesign, cellular manufacturing, total productive maintenance, and synchronous manufacturing/pull production (Koufteros, Vonderembse, & Doll, 1998; Monden, 1983; Womack & Jones, 1996; Sakakibara, Flynn, & Schroeder, 1993).

Each of these techniques may require substantial changes in manufacturing practices. All employees affected by the changes need to be open to changes, willing to learn, and involved in the planning process. Overcoming the resistance to changes is often the most difficult part of successfully implementing an advanced manufacturing technique such as JIT.

Metrics

The old saying "you can't manage something if you can't measure it" holds true for the five manufacturing competencies. Davies and Kochhar (2000, 2002) claim that the disappointing results from the implementation of best practices are caused by a failure to link practices to specific measurable objectives. As shown in Figure 2, defining metrics for these elements is critical. Companies need to know how well they are

achieving the goals they laid down for customer satisfaction and business results. It is important to choose a small number of pertinent performance measures that enable the company to assess progress continuously. Employees concentrate on what the organization measures and how they are evaluated. Normally, when a firm measures, reports, and rewards the results of an employee's work, that person will be motivated to improve those dimensions of their work.

There is no absolute set of WCM Metrics because different customers in different industries expect and emphasize different outcomes. Table 3 contains a list of metrics that may be helpful in getting started. As metrics are selected from this list and new ones are created, it is critical to understand how these metrics contribute to the organization's overall business and profitability goals. Metrics were selected from readings and cases found in the following references (Blackburn, 1991; Deming, 1986, 2000; Dettmer, 1998; Handfield & Nichols, 1999; Hoop & Spearman, 2000; Schonberger, 1996; Womack & Jones, 1996).

Benchmarks

Benchmarking, the next step in Figure 2, is an external focus on internal activities, functions, or operations that enables a firm to improve performance. The objective is to understand existing processes and to identify points of reference or standards by which activities can be measured or judged. Selecting practices to benchmark is an important one and it should be based on the relationship between practices and performance objective (Davies & Kochhar, 2000, 2002). Benchmarking continuously measures product characteristics, service capabilities, and management practices against industry leaders. It is externally focused, and it is action generating. Benchmarking signals management's willingness to pursue a philosophy that embraces change in a proactive rather than a reactive manner. It can establish meaningful goals and performance measures that reflect an external customer focus, foster quantum leaps in thinking, and concentrates on high-payoff opportunities. It promotes teamwork that is based on competitive need and driven by data, not intuition.

Benchmarking begins with an understanding of unmet customer needs and/or performances gaps. Armed with this information, management identifies core processes that determine the firm's ability to meet those needs and close those gaps. As these core processes are identified, process flow maps help to identify current operating practices and to establish baseline performance levels for critical outcomes such as percent of on-time delivery to customers and labor turnover rate. Data are gathered from outside the organization to provide comparison points for these key performance attributes. The internal and external data are analyzed and the results of the benchmarking studies are used as input to the process of setting targets and developing plans and programs to achieve the targets.

Targets

Setting targets is not as simple as benchmarking competitors, determining the best performer for each metric, and selecting that performance level as the target. Benchmarking studies are useful inputs when setting targets, but benchmarking can only tell management what other companies have achieved not what might be

Table 3: *World Class Manufacturing Metrics*

Competency	World Class Metrics
Employee Development	• formal training hours per employee • labor turnover rate • % certified trainers • improvement suggestions • safety indicators
Product Development	• customer satisfaction • ability to meet customer-specified requirements • product development cycle time • competitive pricing • ability to set premium prices • number of new products introduced • sales from products developed in the past three years
Supplier Development	• level of cooperation with suppliers • level of trust with suppliers • involvement in product and process design • involvement in quality planning and continuous improvement • on-time delivery • parts-per-million (PPM) defective • process capability (Cpk) • assessment to quality system requirements • duration of contracts with suppliers
Quality	• assessment to quality systems requirements (ISO-9000, QS-9000) • customer parts-per-million (PPM) defective • on-time delivery • scrap/rework • costs of quality • process capability (Cpk)
Just-in-Time	• manufacturing cycle time • setup time • machine availability • process capability (Cpk) • material availability • distance of material movement • WIP turns • inventory turns

achieved. In fact, setting targets that are equal to other firm's current achievements may lead an organization to set low targets. Even if the company achieves the target at some point in the future, it may still be behind the competition because the competition has gotten better. Setting targets is a matter of investigation, judgment, and risk taking. The investigation is part benchmarking and part understanding the capabilities of the firm. Judgment is using experience and knowledge to have a feel for what is possible. Risk taking means setting stretch goals that test the limits of the firm's creativity.

These targets cannot be imposed from the top of the organization. To build commitment, the process for setting these targets must involve a cross-section of employees working together. Marketing has knowledge of customer expectations; engineering understands the technology and the important elements of product and process design, and manufacturing makes it work on the factory floor. Without the involvement of manufacturing managers, supervisors, and shop-floor employees, firms may be unable to build the support needed to reach its targets.

Plans and Programs

As illustrated in Figure 2, organizations should develop plans, programs, and practices that influence manufacturing competencies and enable the firm to achieve the targets. World-class manufacturers support employee development through (1) formal learning and training programs, (2) employee empowerment which enables them to apply that knowledge, (3) continuous improvement programs that seek better ways to meet objectives, and (4) reward and incentive programs that focus on systems wide objectives rather than personal goals. Employees learn problem solving skills, conflict management and resolution skills, and how to conduct meetings effectively.

Supplier development involves working closely with vendors to develop supportive relationships that create win-win opportunities. In many cases, larger companies are able to offer training to groups of suppliers who do not have the resources to develop these training programs on their own. Supplier certification programs, supplier involvement in continuous improvement and product development activities, and strategic partnerships provide opportunities to manage the supply chain in ways that benefit the final customer as well as the suppliers.

In this environment, product development shifts from an internal, functional, and sequential process to a process that focuses on customers. It attempts to achieve system level objectives through cross-functional activities. QFD gathers customer requirements and drives them from design requirements, to part characteristics, to manufacturing process, and finally, to production requirements. QFD focuses the product development process on customer expectations and attempts to cut time and cost while enhancing product design (American Supplier Institute, 1989; Vonderembse, Van Fossen, & Raghunathan, 1997).

Quality improvement efforts involve a wide variety of programs from employee empowerment to statistical process control charts. There are many books and articles that can help to define a set of actions. Some that are certainly important are Design of Experiments (DOE), Failure Mode and Effects Analysis (FEMA), error proofing, cause and effect diagrams, quality improvement teams, and supplier certification efforts (Deming, 1986, 2000).

JIT attempts to strip time and cost from the production process by the elimination of waste and responsiveness to customer demands. JIT involves employees in setup redesign, manufacturing cells, preventive maintenance, and quality improvement efforts to achieve pull production (Koufteros, Vonderembse, & Doll, 1998; Monden, 1983; Sakakibara, Flynn, & Schroeder, 1993).

Organize and Manage the Implementation Process

Implementation is the key to success. The efforts and coordination for achieving WCM should be driven from the top of the organizations (Hammer, 1996). In most cases, the shift to WCM involves significant changes in policies, procedures, and method of operations. Product development efforts, supplier relations, quality improvement activities, and JIT create complex changes. To cope with this, coordinated actions must take place across multiple functions in order for these efforts to be successful. The only group that can drive these changes is top management. That does not mean that top management makes the decisions and imposes them on the organization. Top management provides overall direction, makes resources available including the time of key participant, and champions the efforts. Top management walks a delicate balance, insisting that these changes take place and communicating the important roles for middle managers, first-line supervisors, and shop-floor employees.

These are two other important aspects. It may be necessary to develop a phased approach so that everything is not changing at once. This can occur across several dimensions. In larger companies with many products, product lines, and manufacturing facilities, it may be possible to consider the change to WCM in one group, division, product line, or plant. In this way, what is learned can be shared as WCM is rolled out to other parts of the organization. Within these pilot operations and in small firms, it is possible to break the process into even smaller parts. In examining the manufacturing competencies, employee development is a prerequisite for success in product development, quality improvement, and JIT. If employees are expected to participate in decision-making, they must have a positive attitude and the training to do the job well. Supplier development is important for quality improvement and JIT. Implementing JIT when key suppliers have poor quality and unreliable deliveries negates many of its benefits. Product development may not be important in firms that focus on manufacturing and have limited design responsibility. The second aspect is the application of project management tools to determine who is responsible for performing tasks and when those tasks should be complete. This approach should focus activities and increase the probability of an on-time delivery.

Evaluate Performance and Revise the Systems

Feedback is a fundamental element of any continuous improvement activity. Performance enhancement involves setting goals, evaluating actions, providing information about performance, and revising actions to improve outcomes. So, becoming a world-class manufacturer requires feedback loops that enable the organization to enhance learning and focuse on improvement efforts. Customer requirements are monitored because they drive the process. Competitor's actions and performance outcomes should be assessed to determine the firm's competitive position. Monitoring competitors' actions on a continuing basis allows the firm to assess progress, to understand and create new metrics, to set new target levels for these metrics, and to develop new plans and programs for the next cycle of continuous improvement.

Building Commitment

Becoming a WCM company requires *vision and commitment* from top management as well as continuous improvement. Top management's vision initiates the process and drives it to a successful conclusion. Edonsomwan (1996) outlines six steps that keep management committed to the *continuous improvement* efforts needed to become a WCM company.

Step 1: Train top management on continuous improvement tools and techniques, managing change, and creating a total quality culture. Involve top managers in continuous improvement training for middle managers, supervisors, and other professionals.

Step 2: Make continuous quality, productivity, and total customer satisfaction improvement the chief executive officer's personal mission. Encourage executive participation in the continuous improvement steering committee to oversee continuous improvement project plans, allocate resources, and monitor progress.

Step 3: Require annual continuous improvement plans from line executives and managers. Such plans should depict a blueprint for comprehensive implementation of specific improvement projects. The plan should include specifics on training requirements, customer satisfaction improvement, supplier management, information analysis, process control and data management, employee job satisfaction and human resources issues, benchmarking of competitors, and a cost-of-quality estimate for each business unit.

Step 4: Include discussion about continuous improvement projects in all staff meetings. Top managers should participate in continuous improvement projects, recognition events for quality excellence, and the enterprise suggestion program for continuous improvement.

Step 5: Put executives and top managers in touch with outside customers, suppliers, and professional organizations. An executive will have a greater appreciation of the requirements, needs, and problems of customers and suppliers if one-on-one contact is made. Such contact also provides a unique opportunity for the executive to share and exchange ideas on continuous improvement goals and on specific projects. The outside contact with professional organizations also provides positive exposure for the enterprise and professional validation of new ideas.

Step 6: Provide opportunity for top management to participate in benchmarking projects. This will enhance their knowledge of world-class improvement initiatives and programs.

Conclusion and Future Research

This paper describes a process for successfully implementing WCM. The process begins with top management commitment to pursue WCM and to provide the resources to support its activities. It also requires top management to communicate the importance of these efforts as well as break down the barriers to change. It must include a planning process that links business goals, customer expectations, and organizational capabilities. The process should define essential manufacturing competencies to achieve these goals, and it should select metrics to measure the competencies. Benchmarks may be used to help the organization set target levels for each metric. To institute change, firms should develop plans and programs to achieve these target levels, and they should organize and manage the implementation process. Periodically, the process change should be evaluated and the system should be revised.

This paper also provides a method for building commitment for this change. This method requires active participation in the process from all levels of management as well as supervisors and shop-floor employees. It clearly identifies top management as the driving force for these changes including involvement in training efforts, service on steering committees, and participation in continuous improvement projects.

Future efforts could involve empirical research to develop valid and reliable measures of WCM and to test the models described in Figure 1 and Figure 2. The development of in-depth case studies of the implementation process would be helpful for practicing managers.

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