



# World Class Manufacturing Performance Measurements



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# ***Introduction to World Class Manufacturing***

Very few industries are unaffected by global competition. With higher levels of competitiveness it follows that the consumer will ultimately decide upon the products which meet their needs in the areas of product features, dependability, availability and overall value. No business can afford to stand still. If a company is successful today it can be certain there is someone who is preparing to take all or part of the marketplace in the future.

In today's business environment it is no longer good enough to be better than the competition down the street or in the local marketplace. Each company must strive to meet and beat the best from anywhere in the world. A business enterprise can no longer think that failure to make it in world markets will not affect business in local markets. The very opportunity to compete in world markets carries with it the explicit threat that the same opposition experienced overseas can indeed knock the company out of its local markets.

The response to this challenge of global competition is through the ideal of World Class Manufacturing. World Class Manufacturing is the term used to describe the very best manufacturers in the world. These World Class companies recognize the importance of manufacturing as a strategic weapon. Manufacturing plays a fundamental role in developing and sustaining customer satisfaction through the elements of quality, cost flexibility, reliability and innovation.

World Class Manufacturing is being worked on by many companies today under many names. Some of the names include: Just-In-Time (JIT) or Lean Manufacturing, Total Employee Involvement (TEI), Value-Added Manufacturing (VAM), Continuous Improvement (CI), Activity Based Management (ABM), Total Quality (TQ) and Enterprise Resource Planning (ERP). Each is an improvement vehicle which, when utilized properly, can yield significant improvements to the business.

In the past several years World Class Manufacturing has been the subject of several books and executive seminars which have begun to spring up in an attempt to pull together the best practices and experiences into a cohesive package.

BECOMING A  
WORLD CLASS  
COMPANY MEANS  
BEING THE  
PREFERRED SUPPLIER  
IN WORLD MARKETS;  
THE CAPITAL MAGNET IN FINANCIAL  
MARKETS;  
THE SOUGHT-AFTER  
PLACE OF EMPLOYMENT;  
AND THE BUSINESS OF  
CHOICE BY THE COMMUNITY.

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In 2001 and beyond World Class Manufacturing is the descriptor of the emerging globally competitive manufacturer.

The term World Class Manufacturing is used to describe the highest level of manufacturing performance. Some of the concepts of World Class Manufacturing go all the way back to Henry Ford's River Rouge plant in 1914. Achieving World Class Manufacturing comes only when the improvement effort is integrated across all functions in the company. The real strength for a manufacturer lies in its ability to add value in its manufacturing processes.

It is important to note that all types of businesses – banks, hospitals, insurance companies and distribution companies – are utilizing World Class principles. What business is not working to improve flexibility, responsiveness, timeliness, exactness, precision and repeatability to delight the customer? Manufacturing companies today are where the premier examples of improved quality, lead time reduction and shorter product introduction cycles can be seen.

World Class Manufacturing benefits the major stakeholders in the business – management, employees, shareholders and the community. Management is in control of a continuously improving business; employees develop their skills. Knowledge and productive abilities; shareholders receive a higher than normal rate of return on their investment; and the community benefits by having a business entity that creates jobs and produces product with an absolute minimum of waste.

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# Characteristics of World Class Manufacturing

For the World Class manufacturer, manufacturing plays a fundamental role in developing and sustaining customer satisfaction through the elements of quality, cost flexibility, reliability and innovation.

The characteristics of these World Class manufacturers are:

1. *An ongoing company-wide education and training initiative for human resource development to allow everyone to actively participate in the improvement process.*

The importance of education and training for all employees cannot be over-emphasized. Studies show that World Class Manufacturers provide a minimum of forty (40) hours of education and training per employee on an annualized basis. In today's business environment the only long-term sustainable competitive advantage is organizational learning.

2. *Relentless pursuit of continuous improvement in all business activities.*

The management focus is on establishing operating performance measurements that drive the behaviors consistent with the goal of continuous improvement in both process and product. Measurements in place focus on rates of improvement.

3. *A dedication to developing a competitive advantage based upon superior product quality and service.*

The World Class company creates a level of customer satisfaction through being not only "easy to do business with," but by exceeding customer expectations. The term "customer delight" is an often used expression when procuring product or service from a World Class manufacturer.

4. *Utilization of an integrated business system that links people and process.*

All business functions actively pursue a process of factory and business simplification resulting in a systems integrative approach.

# World Class Manufacturing Results

World Class Manufacturing gives a company the lowest costs, the fastest time to market, the best customer service and satisfaction, the highest quality, the shortest product lead time, the highest return on investment and the most productive work force. The results companies are achieving from a World Class Manufacturing initiative are:

## Lead time 50-75 Percent Reduction -

A lead time reduction of 50-75 percent applies not only to the manufacturing cycle time but also from order entry to product shipment. To accomplish significant reductions in cycle or lead time, the focus is on elimination of cost-added activities. Cost-added activities would include inspection of material and/or information, rework of material, storage of material and subsequent issuing of production material, and moving material from one container to another. Our studies show the typical manufacturer has a 70 percent ratio of cost-added compared to 30 percent value added activities. The World Class Manufacturer has a ratio of 70 percent work to 30 percent cost-added.

## Quality Costs 45-55 Percent Reduction -

The reduction in the cost of quality by 45-55 percent is accomplished through a reduction in appraisal, internal and external failure costs. Elimination of inspection of incoming material, in-process material, sorting finished product and fool-proofing processes that eliminate rework contribute to a reduction in defects.

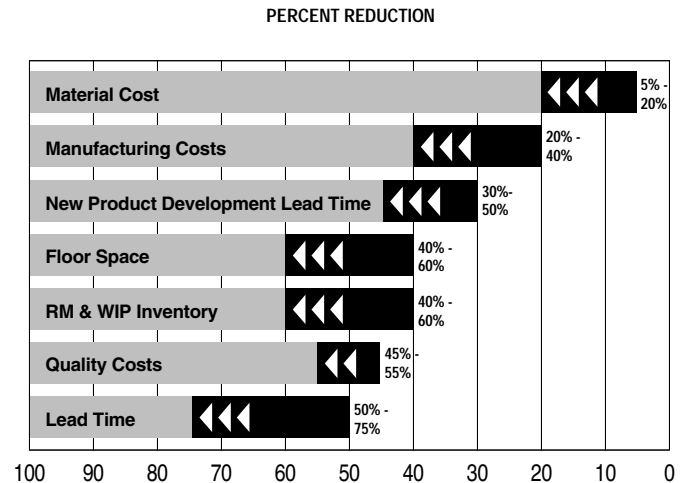
## Inventory 40-60 Percent Reduction –

The reduction in inventory may include not only in-process material but raw material and finished goods. Reductions are attributable to collapsing the throughput time in the total business process, significantly improved quality and improved flexibility to respond to customer requirements.

## Floor Space 40-60 Percent Reduction –

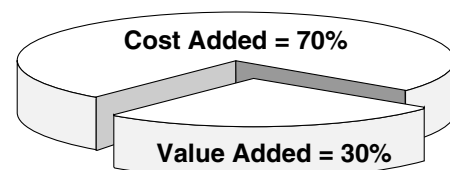
A 40-60 percent reduction in floor space pertains to the distance product travels during the manufacturing process. The preferred method of manufacturing becomes one of a focus on flow and throughput, using concepts such as cellular manufacturing, group technology and continuous

## World Class Business



## Fundamental Principle:

### Cost Added VS. Value Added



**Cost Added = Waste**

---

flow manufacturing. This method replaces the more traditional approach to manufacture by department where the focus is on maximizing individual department efficiency.

**New Product Development Lead Time 30-50 Percent Reduction –**

With a business environment characterized by shorter product life cycles a competitive advantage is achieved through time to market. Reducing new product development lead time enables more frequent product introduction and roll out of product performing to a slot in time.

**Manufacturing Costs 20-40 Percent Reduction -**

The reduction in manufacturing costs results from a management focus on process improvement throughout the business. Process improvements are achieved through elimination of non-value-added activities (see lead time reduction) driving factory and business simplification. Reduction in manufacturing costs are a confirmation of quality, improvements in cycle time reduction, reduced inventory levels and space utilized to manufacture.

**Material Costs 5-20 Percent Reduction -**

Material costs are reduced not by focusing on price, but on total costs. Approximately 40 percent of total cost of purchasing material from the supplier base is in non-price areas. Examples of non-price areas are inspection of incoming material, storage of material, rework of material, and excessive material handling before performing value-added activities.

Achieving World Class Manufacturing results in the business becoming:

- (1) *The Preferred Supplier in World Markets*
- (2) *The Capital Magnet in World Financial Markets*
- (3) *The Sought After Place of Employment*
- (4) *The Business of Choice by the Community*

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# ***Detail Performance Measurements***

In World Class Manufacturing the focus is on continuous improvement. Measurements in place should therefore activate improvements. Management evaluates the measurement process based upon the rate of improvement. The measurements are designed to drive the improvement process in the critical elements of quality, cost, flexibility, reliability and innovation. The measurements we at Buker, Inc. have seen and recommend for companies striving for World Class levels are as follows:

## ***Quality***

- 1) Percent reduction in total cost of quality.
- 2) Percent reduction in defects.
- 3) Percent of certified suppliers.
- 4) Percent reduction in supplier base.
- 5) Percent reduction in time between defect occurrence, detection and correction.

## ***Cost***

- 1) Percent increase in inventory turnover.
- 2) Percent reduction in data transactions.
- 3) Percent increase in materials shipped to point of use by supplier.
- 4) Percent increase in dollars of output per employee.
- 5) Percent reduction in floor space utilized.

## ***Flexibility***

- 1) Percent reduction in cycle time.
- 2) Percent reduction in setup time.
- 3) Percent reduction in lot/batch size.
- 4) Percent increase in number of jobs mastered per employee.
- 5) Percent increase in common materials used per product.

## ***Reliability***

- 1) Percent increase in process capable equipment.
- 2) Percent increase in overall equipment effectiveness.
- 3) Percent reduction in product or service warranty costs.
- 4) Percent reduction in engineering changes.
- 5) Percent increase in on-time delivery.

## ***Innovation***

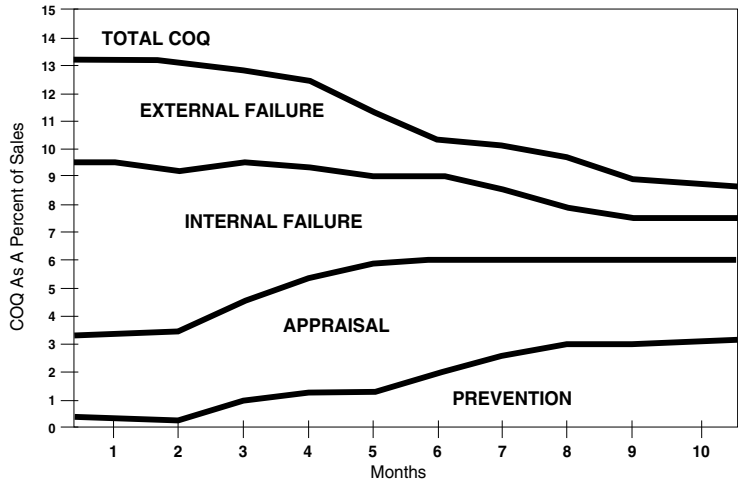
- 1) Percent reduction in new product introduction lead time.
- 2) Percent increase in new product sales revenue as a percent of total sales revenue.
- 3) Percent increase in number of new patents granted.
- 4) Customer perception of the company as a leader in innovation.
- 5) Percent of management time spent on leading or fostering innovation.

# QUALITY

## 1) *Percent reduction in total cost of quality*

The reduction in total cost of quality would be measured on a monthly basis and typically is displayed in graph format. The elements of cost of quality measured are prevention, appraisal, internal failure and external failure. These four elements are measured monthly.

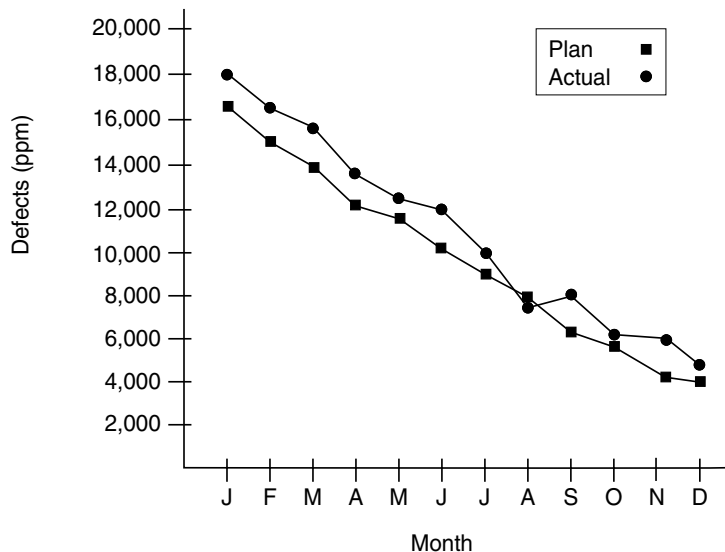
Example: Cost of Quality History



## 2) *Percent reduction in defects*

The reduction in defects is measured in parts per million. The measurement is defects per unit relative to the number of opportunities possible for defects to occur. Reduction in defects is measured weekly and monthly. Normally this is displayed on a trend chart and is one million divided by total opportunities times the number of defects.

(Parts Per Million)



Example: 100 Board Assemblies Produced  
 X 100 Components Per Board  
 -----  
 10,000 Opportunites for Defects

10 Defects Occur

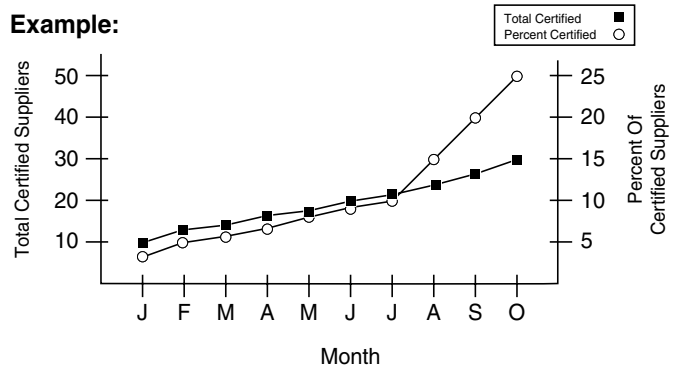
Parts Per Million =  $\left( \frac{1,000,000}{10,000 \text{ Opportunites}} \right)$

= X 10 Defects = 1,000

### 3) Percent of certified suppliers

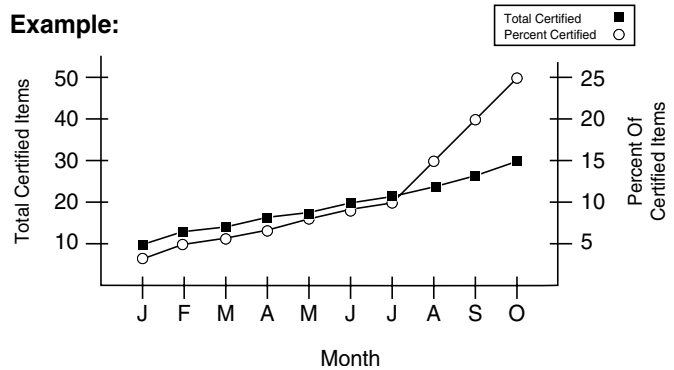
Certified suppliers require, at the minimum, supplier's process has been certified to the point that there is no incoming material inspection required. Many companies that are working on certification certify by individual part rather than source of the part. Whichever method is used, the data should be displayed on a trend line and reviewed monthly and appropriate actions taken.

Example:



### Percent Of Certified Items

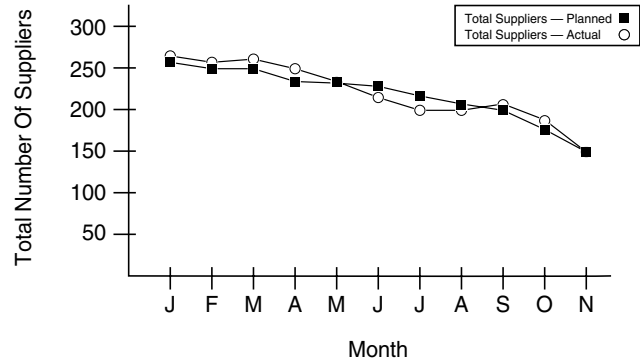
Example:



### 4) Percent reduction in supplier base

This measurement is utilized to review improvements in quality of source of supplier. The supplier base typically is reduced by rewarding those sources that continuously improve quality, reduce lead time, improve on-time performance and supply materials that can be delivered to the point of use. The measurement is monthly and displayed as a trend line.

Example:



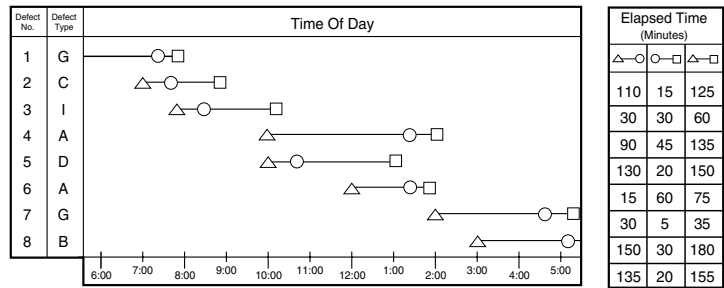
## 5) *Percent reduction in time between defect occurrence, detection and correction*

There are actually three measurements: defect occurrence, defect detection and defect correction. This could be measured by way of a chart located in each work area with time horizontally displayed and defects vertically displayed. Operators would record time of occurrence, detection and correction. Results are summarized weekly and monthly.

**Example:**

Name \_\_\_\_\_ Date \_\_\_\_\_  
Shift \_\_\_\_\_

Occurrence  $\triangle$   
Detection  $\circ$   
Correction  $\square$



Total Elapsed Time 

690	225	915
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Average Elapsed Time 

86	28	114
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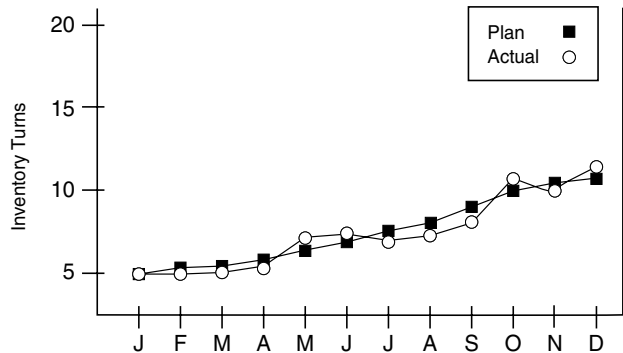
## COST

### 1) *Percent increase in inventory turnover*

Inventory turnover is looked at as a measure of material throughput. The measurement is completed by compiling the annualized cost of sales and dividing it by current total inventory. Turnover is measured monthly and displayed on a trend line. Raw material and work in process can be measured separately from finished goods inventory.

$$\text{Inventory Turns} = \frac{\text{Annualized COS}}{\text{Average RAW \& WIP Inventory \$}}$$

**Example: RAW & WIP**

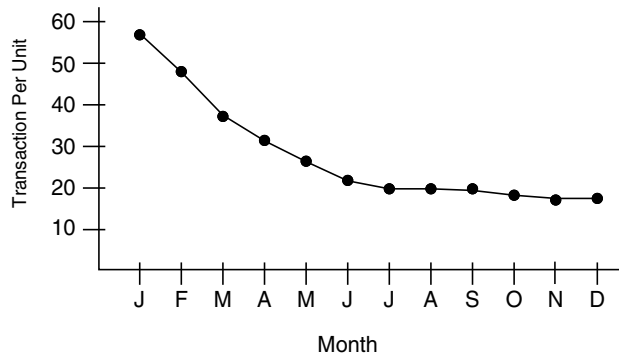


## 2) Percent reduction in data transaction

Data transactions are considered one of the key wastes in the business process and should be minimized. The measurement should be by product line and measure transactions such as labor and inventory movement. The measurement should be against a baseline of business activity such as total units produced. This measurement is monthly for the product line and is displayed on a trend line.

$$\text{Transactions per unit} = \frac{\text{Total Transactions}}{\text{Total Units Produced}}$$

Example: Transactions per unit produced for the Neptune line

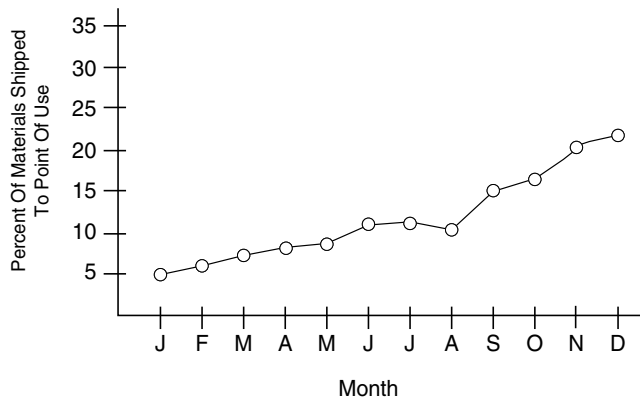


## 3) Percent increase in materials shipped to point of use by supplier

Companies need to shorten the time to process incoming materials. Activities such as incoming inspection, material movement and taking material out of the shipping container to be put in another container suitable to the manufacturing process are cost-added. The measurement tracks by supplier the percent of materials that are able to be shipped directly to work-in-process. A trend line is used on a monthly basis to display the information.

$$\text{Percent Of Materials Shipped To Point Of Use} = \frac{\text{Total/Monthly Receipts Delivered Directly To Point—Of—Use}}{\text{Total Monthly Reciepts}}$$

Example:

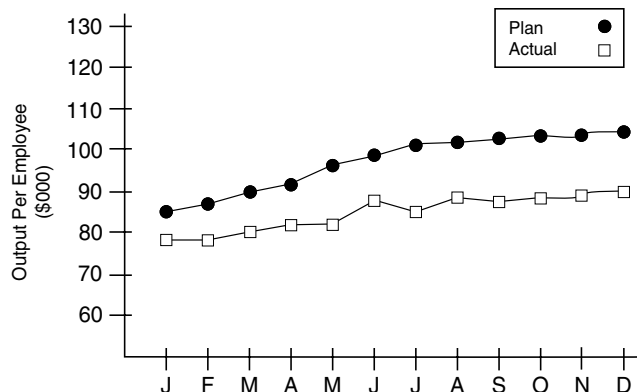


## 4) Percent increase in dollars of product output per employee

The measurement is a measure of productivity. It determines how effectively people and resources are being used in the production of the product. The calculation would be annualized sales divided by total number of employees. This should be measured monthly and displayed using trend lines.

$$\text{\$ Output Per Employee} = \frac{\text{Annualized Sales}}{\text{Total Employees}}$$

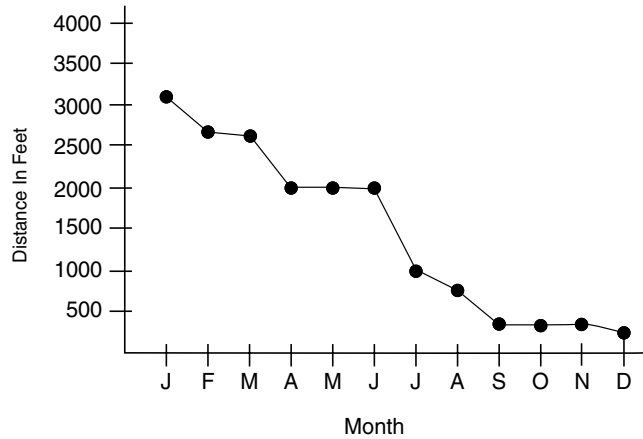
Example:



## 5) Percent reduction in floor space utilized

The reduction in floor space utilized is measured by product line. This is typically accomplished by mapping the process and measuring the physical distance the product travels from first step to last step in the production process. Measure monthly and display trend by product line.

Example: Distance Traveled - Pinker Line

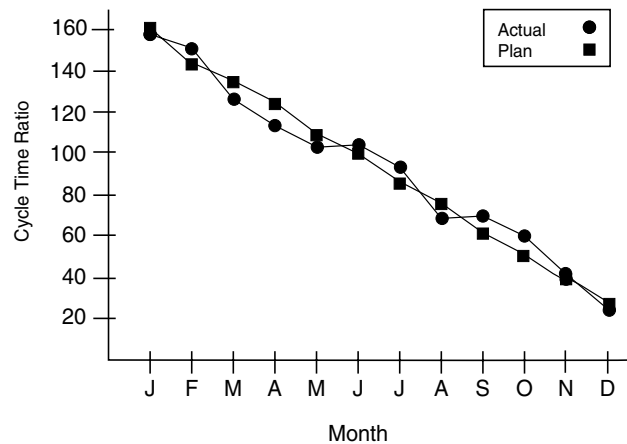


## FLEXIBILITY

### 1) Percent reduction in cycle time

The reduction in cycle time is measured by product line. The measurement is the ratio calculated by dividing actual cycle time by the theoretical cycle time. Actual cycle time is normally based on average work in process throughput time. Theoretical cycle time is based on value add time for a lot size of one. It contains no inspection, setup or queue time. Both work in process and administrative cycle times should be measured. Measure monthly and display trend.

Example: WIP Cycle Time



$$\text{Cycle Time Ratio} = \frac{\text{Actual Cycle Time}}{\text{Theoretical Cycle Time}} =$$

$$\frac{\text{Average WIP Throughput Time}}{\text{Theoretical Cycle Time}} =$$

$$\frac{8 \text{ Days} \times 2 \text{ Shifts} \times 8 \text{ Hours/Shift}}{.812 \text{ Hours}} =$$

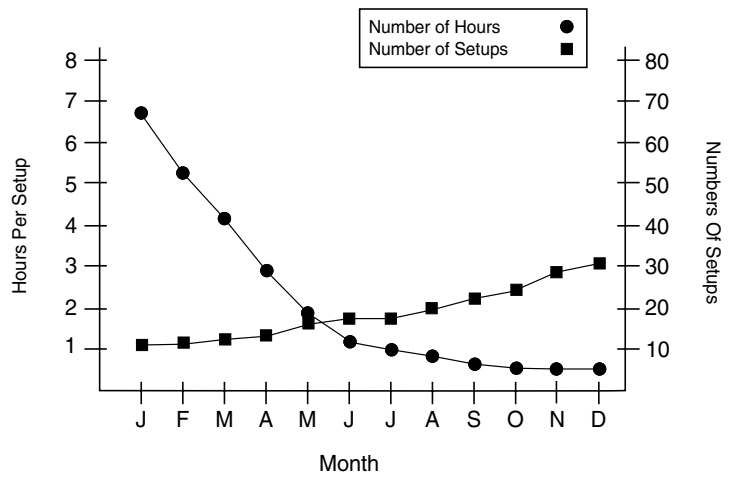
$$\frac{128 \text{ Hours}}{.812 \text{ Hours}} = 158$$

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## 2) Percent reduction in setup time

Reduction in setup or changeover of the equipment or production line is an important measure of continuous improvement and flexibility. The measure can be daily, weekly or monthly, depending on the current frequency of changeover. Measure by machine and display on a trend line.

Example: Injection Molding-Machine A

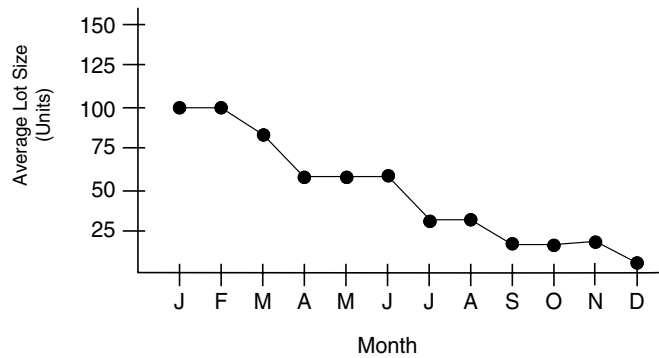


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## 3) Percent reduction in lot/batch size

The measurement of lot/batch size reduction measures the trend in reduction of lot sizes. It is measured monthly as average lot size by production process.

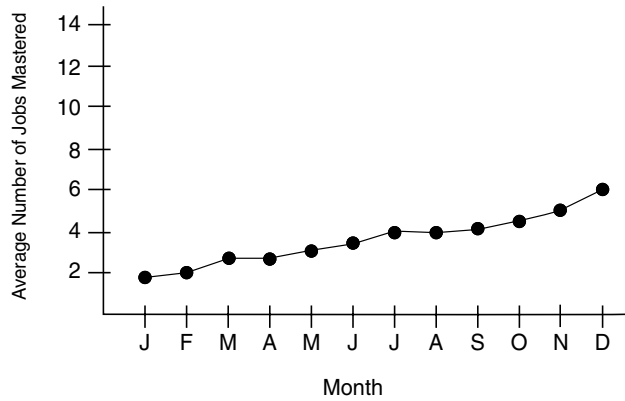
Example: Light Assembly



#### 4) *Percent increase in number of jobs mastered per employee*

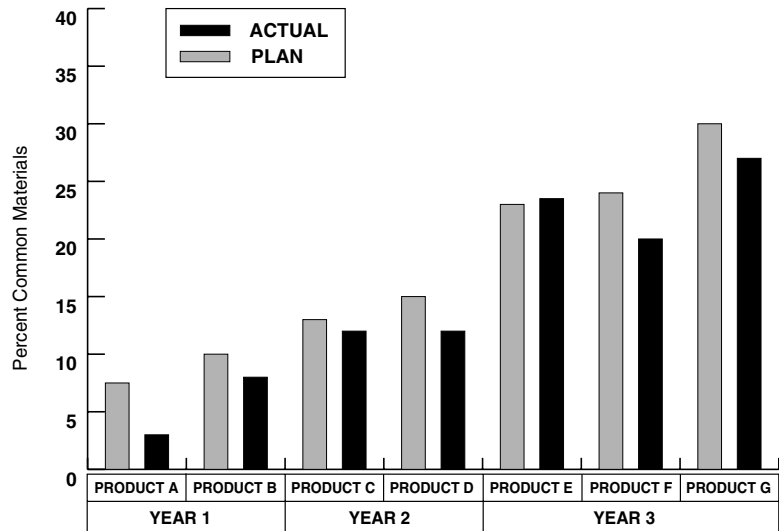
The purpose of increasing the number of jobs mastered per employee is not only for improvement in flexibility, but to help facilitate the habit of improvement. This is accomplished by continuously providing a "different set of eyes" engaged in the process. Most companies involve other hourly workers in the development of qualifications for certification and deciding whether someone is to be certified. Display in the work area, showing the number of jobs each individual has mastered.

**Example: Printed Circuit Assembly Line #1**



#### 5) *Percent increase in common materials used per product*

This measurement would be taken at the time of design release and is total common materials divided by total materials by product. Measure relative to goals set for standardization at the time design was initiated.

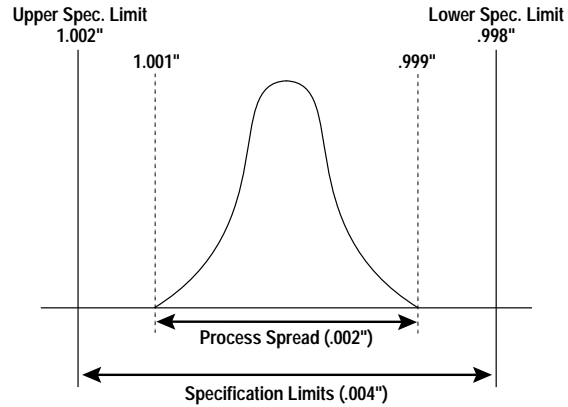


# RELIABILITY

## 1) Percent increase of process capable equipment

The first step must be to establish that the equipment is statistically in control, then measure process capability. The measure is percent of machines or processes at CP = 2.0. CP is the specifications width (tolerance) divided by the process spread (+/-3 sigma). Measure number of machines in the department divided by the number of machines capable of meeting this standard.

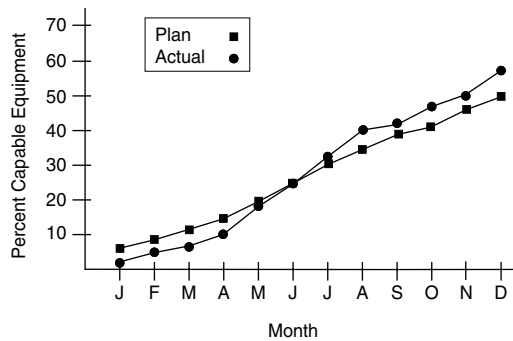
Example: 1.000" Diameter Steel Shaft  
(Spec. = 1.000" - .002")



$$CP = \frac{\text{Specification Limit}}{\text{Process Spread}} = \frac{.004"}{.002"} = 2.0$$

$$CP = \frac{\text{Specification Limit}}{\text{Process Spread}} \quad \text{Percent Capable Equipment} = \frac{\text{Total Process Capable Equipment}}{\text{Total Pieces}}$$

$$\text{Percent Capable Equipment} = \frac{\text{Total Process Capable Equipment}}{\text{Total Pieces Of Equipment}}$$



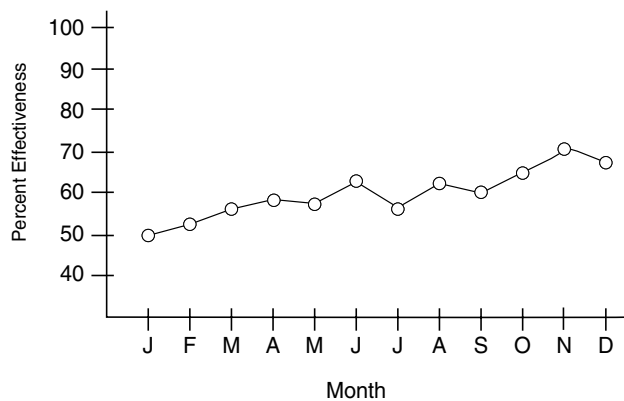
## 2) Percent increase in overall equipment effectiveness

Machine effectiveness is availability (hours running divided by scheduled run hours) times performance (actual machine cycle or rate divided by theoretical machine cycle or rate) times rate of quality product (good material divided by total material run).

Measurement is for three purposes: One, does the machine run all of the time scheduled? Two, is the equipment fit for use to be run at the speed it was designed to run? Three, does the equipment produce quality material?

Measure progress on run charts and summarize by department and machine monthly.

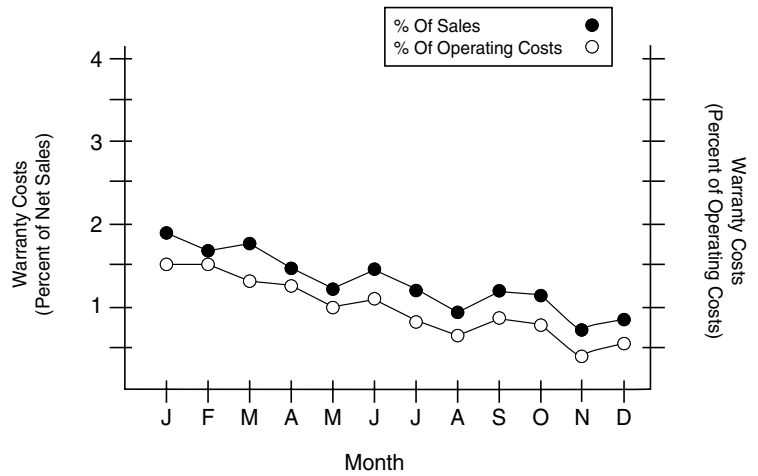
Example:



$$\text{Equipment Effectiveness} = \frac{\text{Actual Hours Run}}{\text{Actual Hours Scheduled}} \times \frac{\left(\frac{\text{Theoretical Machine Cycle}}{\text{Qty. Produced}}\right)}{\text{Actual Hours Run}} \times \frac{\text{Total Good Material}}{\text{Total Material Run}}$$

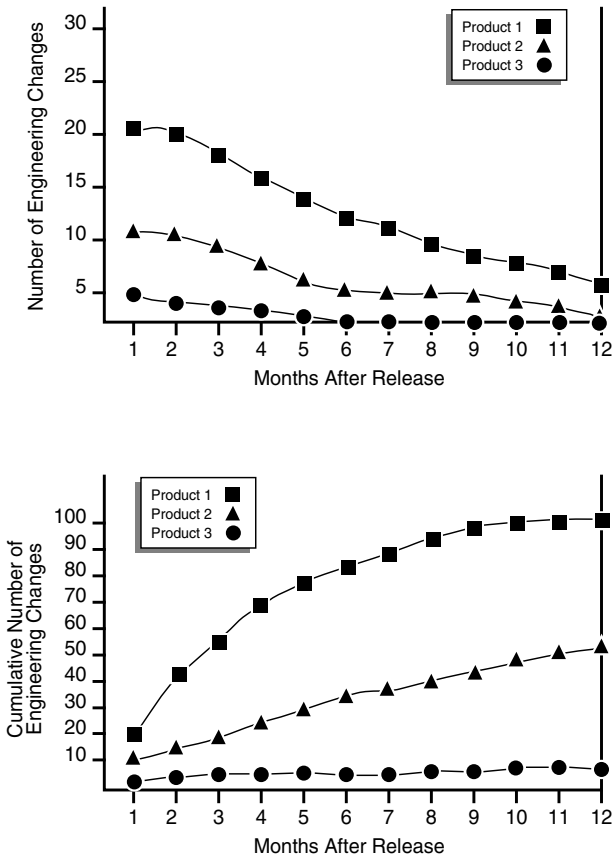
### 3) Percent reduction in warranty costs

Measure and track monthly by product line in dollars as percent of sales and as percent of operating cost. Utilize trend charts.



### 4) Percent reduction in engineering changes

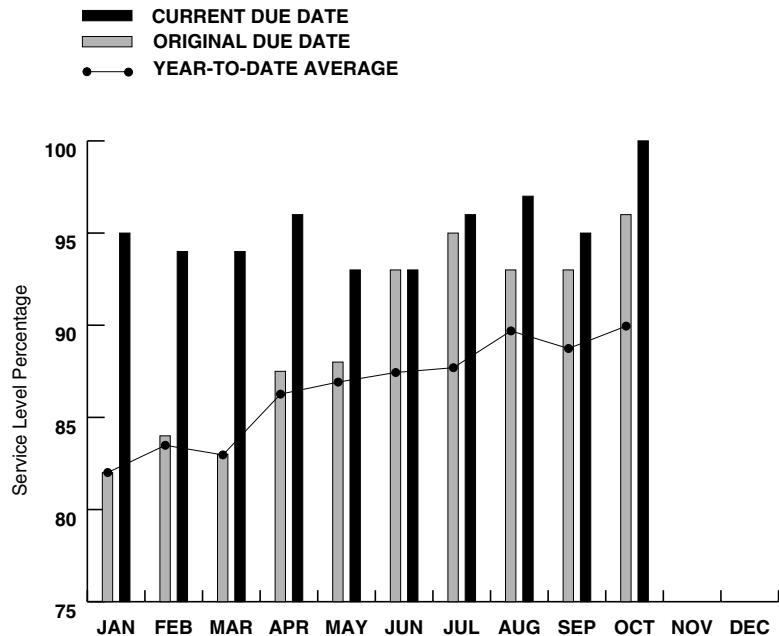
Measure by comparing a series of new products released to manufacturing. The measure is for right first time or quality of release. Depending upon the frequency of new product introduction, the measurement can be monthly by product line on a trend line.



## 5) Percent increase in on-time delivery

Measurement shows whether the product was shipped to the customer in the time frame promised. Actual measurement is orders shipped on time divided by total orders shipped.

### Example: Customer Service Level

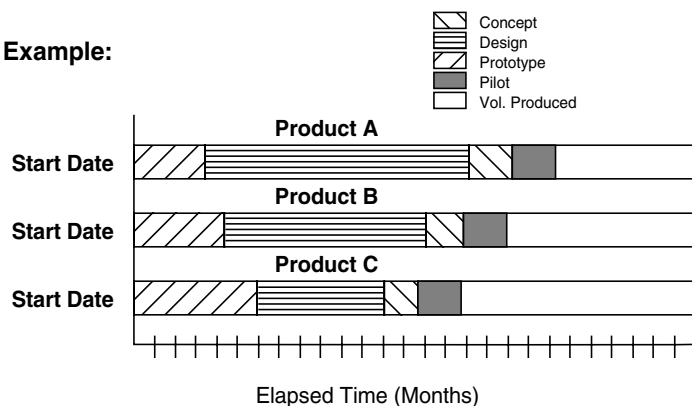


## INNOVATION

### 1) Reduction in new product introduction lead time

The measurement indicates your ability to achieve and maintain a competitive advantage by introducing more new product, faster, at lower cost and more reliably than your competitors. It is calculated as the total elapsed time in weeks from concept to release for volume production. It should be measured by product in total as well as by individual phases of the process (Concept, Design, Prototype, Pilot, Release to Volume Production).

#### Example:



#### Note:

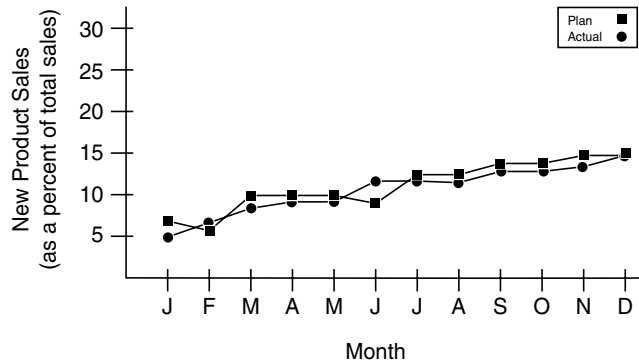
Better product definition in the concept phase, with more investment in time up front will improve the overall effectiveness of the process.

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## 2) *New product sales revenue as a percent of total sales revenue*

Determine optimum levels of new product sales revenue required for your products and markets. Incorporate this information into your strategic plans and annual business plans and record performance utilizing trend charts.

**Example:**

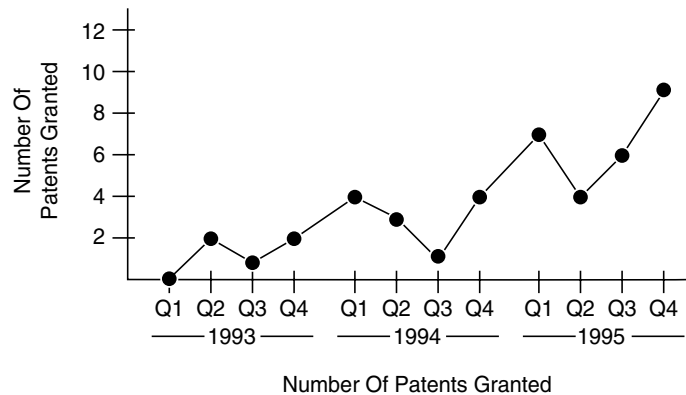


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## 3) *Number of new patents granted*

This measurement is a key indicator of the level of creativity and innovation in the entire company. It pertains to older products, existing product (extending their life cycles through such things as addition of new features and options), and processes used to develop, produce, administer, market and sell your products and services. It is measured quarterly and/or annually and depicted on trend charts.

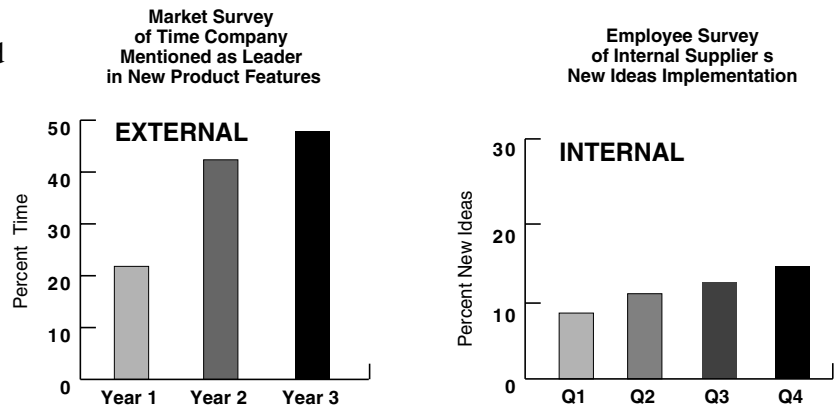
**Example:**



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## 4) *Customer perception of the company as a leader in innovation*

The focus must be both internal (your employees are your customers as well as customers and suppliers to each other) and external.

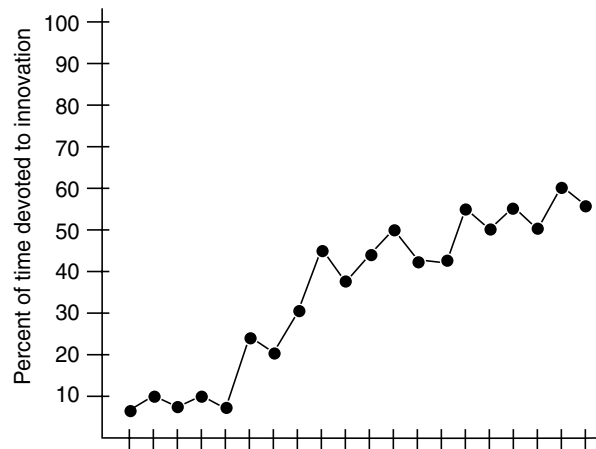


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## 5) *Percent of management time spent on leading or fostering innovation*

This is measured individually from personal calendars and estimates; summarized weekly and reported monthly. It is depicted on trend charts. Sometimes a more formal tool, called work sampling, can be used where individuals record their activity based on a random signal and on these samples estimating the percentage.

**Example:**



# WORLD CLASS PERFORMANCE HISTORY

FUNCTIONAL AREA		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
<b>QUALITY</b>	% reduction in total cost of quality												
	% reduction in defects												
	% of certified suppliers												
	% reduction in supplier base												
	% reduction in time between defect occurrence, detection and correction												
<b>COST</b>	% increase inventory turnover												
	% reduction in data transactions												
	% increase in material shipped to point of use by supplier												
	% increase in output \$ per employee												
	% reduction in floor space utilized												
<b>FLEXIBILITY</b>	% reduction in cycle time												
	% reduction in setup time												
	% reduction in lot/batch size												
	% increase number of jobs mastered per employee												
	% increase in common materials used per product												
<b>RELIABILITY</b>	% increase of process capable equipment												
	% increase in overall equipment effectiveness												
	% reduction in warranty costs												
	% reduction in engineering changes												
	% increase in on-time delivery												
<b>INNOVATION</b>	% reduction in new product introduction lead time												
	% increase in new product sales revenue as a percent of total sales revenue												
	% increase in number of new patents granted												
	customer perception of the company as a leader in innovation												
	% of management time spent on leading or fostering innovation												

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## *Conclusion*

Traditionally, financial performance has been the primary measure of success in most manufacturing companies. Manufacturing companies have developed financial planning systems for measuring their performance on a regular monthly, quarterly and annual basis.

Today companies need to establish operating performance measurements to enable them to effectively manage business operations and meet business and financial objectives.

Defining current performance in the elements of quality, cost, flexibility, reliability and innovation will enable you not only to evaluate current performance, but also identify performance problem areas and prioritize for initiating the improvement process.

It is important to remember how much and what kinds of improvements are being made by World Class companies. Conventional wisdom says 5-10 percent improvement in a process is certainly possible. But when we talk about a 5-10 percent improvement, how much change is required?

Our experience has been that a 5-10 percent change means fine tuning what a company is already doing.

The World Class companies are not settling for 5-10 percent improvement. The companies that we have seen are making 30-75 percent improvement in their processes.

How much change is required to get 30-75 percent improvement? Certainly not fine tuning what is already done. This level of improvement means fundamentally changing the way we do the work. Challenging the conventional wisdom and the way we do the work is management's job in those companies that want to be World Class.