LEAN SIX SIGMA: BLACK BELT" CERTIFICATION COURSE

WORK BOOK

Asian Institute of Quality Management (AIQM)

(A Division of Vijigeeshu QMS Pvt. Ltd.)

Head Office: 95 - 96 – 97, 5th Floor, K. K. Market, G – Wing, Bibewadi, Pune – 411043

Mumbai Office: B-1/204 Lok Gaurav, LBS Marg, Vikhroli West, Mumbai - 400083

*Phones: 91-20-40084939, 91-22-25790460 *Cell: 00 – 91 – 9320003503

*E-mail: director@aiqmindia.com | directoraiqm@gmail.com

CONTENTS - (SSBB Work Book)

SECTION – A

(SELF STUDY & QUESTION SETS)

1. SSBB QUIZ - 1

1. Normally distributed data, by definition, is distributed evenly around the:

a. Normal Value
b. Average Value
c. Median Value
d. Standard Deviation
e. Variance

2. When a process is set up optimally, the upper and lower specification limits typically are:

a. Set equal to the upper and lower control limits
b. Set outside the upper and lower control limits
c. Set inside the upper and lower control limits
d. Set an equal distance from the mean value
e. Both **b** and **d**

3. Which of the following is not a "special cause" of variability In process?

a. Temperature variation
b. Wear in the machine
c. Random variation that is inherent in the process
d. Different operators
e. Damaged measuring device

4. The upper and lower control limits are typically set:

a. Three standard deviation from the mean in each direction
b. Three s (sigma) from the mean in each direction
c. Inside the upper and lower specification limits
d. To detect when a process may be out of control
e. All of the above

5. A process goes out of control when there are:

a. Special causes of variation
b. Common causes of variation
c. Special and non-assignable causes of variation
d. Both **a** and **c**
e. All of the above

6. If there is a run of _____consecutive data points on either side of the mean on a control chart, the process likely to go out of control

a. Six
b. Seven
c. Eight
d. Ten
e. Eleven

7. Which of the following factors contributes to a greater need for quality management?

a. We are constantly pushing the state-of-the-art technology
b. Companies must survive on lower profit margins
c. There is a split responsibility for quality between the functional managers
d. Customers have come to expect a higher level of quality in all goods and services
e. All of the above

8. If the values generated from a process are normally distributed around the mean value, what percentage of data points generated by the process will not fall within +/-3 standard deviations of the mean?

a. 99.7%
b. 95.4%
c. 68.3%
d. 6%
e. 0.3%

9. Quality management:

a. Is another name for careful inspection
b. Is inversely related to productivity
c. Is primarily the responsibility of management
d. Is primarily the responsibility of workers
e. Is essentially a motivational technique

10. Cost of poor quality is:

a. A result of non-conformance to specifications and requirements
b. Primarily caused by poor workmanship of workers
c. Directly proportional to the sigma level for a process
d. Negligible for large organizations when expressed as a % of sales turnover
e. Both **a** and **c**

11. Cost of quality includes:

a. Appraisal costs
b. Internal Failure costs
c. Prevention costs
d. Advertising costs
e. All of the above
f. **a**, **b** and **c** only

12. To determine the root cause for a quality problem in a process, a very useful tool is the:

a. Cause-and-effect diagram
b. Flow chart
c. Control chart
d. Pareto diagram
e. Scatter diagram

13. A fundamental tenet of modern quality management holds that quality is most likely to be achieved by:

a. Planning it into the process
b. Developing careful mechanisms to inspect for quality
c. Striving to do the best job possible
d. Conducting quality circle activities
e. None of the above

14. Using metrics to manage quality:

a. Provide performance measures to monitor and improve process at various steps
b. Encourages decision-making that is based on opinion
c. Is not encouraged in six sigma projects
d. Makes it easier to assign blame when things go wrong
e. Improves team morale

15. The objective of a quality management system audit is to:

a. Help identify which factors might influence variables
b. Show how various elements of the system relate
c. Identify lessons learned to improve organizational performance
d. Use inspections to determine if results conform to requirements
e. Punish poor performance

16. For which of the following is a check sheet (primarily) primary used?

a. Idea generation
b. Idea screening
c. Fact gathering
d. Implementation of an approved solution
e. Checking schedule compliance

17. The tool is based on the concept that the majority of quality problems are caused by a few causes is called:

a. Pareto analysis
b. PERT analysis
c. Root Cause analysis
d. Fishbone diagram
e. Capability study

18. Benchmarking

a. Is primarily concerned with proper marking of benches in a production facility
b. Involves comparing actual or planned project practices to those of other projects
c. Is a Japanese technique that was not possible to implement in the US.
d. Refers to establishing a reference price in the oil industry
e. Is a team used by coaches to refer to certain members in some sports team

19. Which of the following is likely to support an organization's quality improvement efforts?

a. Use of data for decision making
b. Use of statistical tools
c. Clearly defined objectives
d. Emphasis on reducing variations
e. All of the above

20. A flowchart is:

a. Same as a process map
b. A tool that can be used by hydraulics engineers in the design of water works projects
c. A tool that can help the project team anticipate where quality problems might occur
d. Both **a** and **c**

21. In a project, ten of 1000 parts need to be reworked before they get shipped to the customer. The rework cost is part of:

a. Normal variation
b. Appraisal cost
c. Inspection cost
d. prevention cost
e. Internal failure cost

22. In reviewing a standard control chart, a project manager notices only random variation within the upper and lower control limits, with no points outside these limits. The project manager should conclude that the process is:

a. In chaos
b. Unpredictable
c. In statistical control
d. Within specification limits
e. Unstable.

23. When quality data is expressed as a measurement on a continuous scale, such as dimensions or time, that is called:

a. Properties of data
b. Attribute data
c. Variable data
d. Discrete data
e. Count data
f. Continuous data
g. All of the above
h. Both **c** and **f**

24. The process of identifying relevant quality standards, and determining how to satisfy these standards is referred to as:

a. Quality planning
b. Quality implementation
c. Quality assurance
d. Quality control
e. Quality insurance.

25. The process of continually monitoring performance, comparing with standards, identifying and eliminating causes of unsatisfactory results, is referred to as:

a. Quality planning
b. Quality implementation
c. Quality assurance
d. Quality control
e. Quality evaluation.

2. SSBB QUIZ - 2

1. Which of the following is <u>not part</u> of generally accepted view of quality today?

a. Defects should be highlighted and brought to the surface
b. Higher level of inspection implies better quality
c. Improved quality saves money and increases business
d. People want to produce quality products
e. Quality is customer focused

2. Which of the following conditions are driving companies to achieve quality in all their processes?

a. Higher performance requirements
b. Higher technology requirements
c. Shorter product lifecycles
d. Materials and processes pushing towards the limits
e. All of the above

3. In today's view of quality, who defines quality?

a. Senior management
b. Functional management
c. Suppliers
d. Production / Operations
e. Customers

4. Which of the following is not a principle of modern quality assurance?

a. Increased expenditures on inspection
b. Zero-defect programmes
c. Total quality management
d. Reliability engineering
e. The cost of quality

5. Which of following is true of modern quality management?

a. Quality is defined by the customer
b. Quality has become a competitive weapon
c. Quality is now an integral part of strategic planning
d. Quality is linked with profitability on both the market and cost sides
e. All are true

6. A company dedicated to quality usually provides training for:

a. Senior management
b. Employees
c. Suppliers' Employees
d. Customers
e. All of the above

7. What are the components of Juran's Quality Trilogy?

a. Quality improvement, quality planning and quality control
b. Quality improvement, zero-defect, and quality control
c. Quality improvement, quality inspection and PERT charting
d. Quality improvement, quality inspection, and quality control
e. None of the above

8. Which of the following is considered a cost of conformance?

a. Creating process control charts
b. Rework costs
c. Collecting data for use in process improvement efforts
d. Mass inspection
e. Both **a** and **c**
f. **a, c** & **d**

9. High cost of quality in an organization indicates that:

a. The workers don't care about their work
b. Inspection / testing teams are too strict
c. Customers are too demanding
d. Top management participation needs to be increased
e. All of the above.

10. Inspection:

a. Is an appropriate way to ensure quality
b. Is less effective than preventive techniques
c. Reduces rework and scrap
d. Is always effective in stopping defective products from reaching the customer
e. All of the above

11. Which of the following is true?

a. ISO 9000 is a European standard
b. ISO 9000 is a paperwork nightmare
c. ISO 9000 certification ensures that your company produces quality products
d. ISO 9000 is a three-part, never-ending cycle including planning, continual improvement and controlling
e. None of the above

12. A well-written quality-policy must:

a. Be defined in good quality of English
b. Promote consistency throughout the organization
c. Provide an explanation of how customers view quality in their organization
d. Help in finding the CTPs
e. All of the above

13. Good quality objective should be:

a. Achievable
b. Specific & time-bound
c. Realistic
d. Measurable
e. All of the above

14. What is the order of the four steps in Deming's Cycle for Improvement?

a. Plan, do, check, avoid
b. Do, Plan, act and check
c. Check, do, act and plan
d. Act, check, do and plan
e. Plan, do, check and act

15. Quality management audits

a. Are not necessary if you do it right the first time
b. Must be performed daily for each process
c. Are expensive and therefore not worth doing
d. Are important only when producing products of a technical nature
e. Are none of the above

16. Cost of conformance include:

a. Training
b. Verification
c. Rework
d. Both **a** and **b**
e. Both **a** and **c**

17. The costs of nonconformance include:

a. Scrap
b. Rework
c. Warranty repairs
d. Product recalls
e. All of the above

18. Which of the following is/are internal failure cost(s)?

a. Training
b. Rework
c. In-process testing
d. Both **a** and **c**

19. Which of the following is/are an appraisal cost(s)?

a. Inspection of product
b. Pilot study
c. Surveys of vendor, contractor and suppliers after order placement
d. Vendor Inspection
e. Both **a** and **d**

20. Customer returns and allowances, evaluation of customer complaints, visits to customers to resolve quality complaints are examples of _____ costs.

a. Prevention
b. Appraisal
c. Internal failure
d. External failure
e. All of the above

21. Which of the following is/are true about quality costs when quality management principles are applied?

a. Prevention costs may actually rise over time
b. Prevention costs and failure costs (internal and external) are inversely related
c. Prevention costs and failure costs (internal and external) are directly related
d. Both **a** and **c**
e. Both **a** and **b**

22. Which of the following is a typical tool for improving process efficiency?

a. Pareto analysis
b. Process Map
c. Trend analysis
d. Process control chart
e. None of the above

23. Which of the following methods is / are best suited for identifying the "vital few"?

a. Pareto analysis
b. Cause-and-effect analysis
c. Trend analysis
d. Process control charts
e. All of the above

24. Quality may be defined as:

a. Continuous improvement of product or service
b. Appealing presentation to customer
c. Timely replacement under warranty
d. Satisfaction of customer requirements, as per his/her perception

25. Corrective Action involves:

a. Correcting the mistake that has occurred
b. Preventing mistake from happening in the first place
c. Hiding the mistake from colleagues and seniors
d. Both **a** and **c**
e. None of the above.

3. SSBB QUIZ - 3

1. The process capability goal should be :

a) the same as product specs.
b) independent of product specs.
c) looser than product specs.
d) tighter than product specs.

2. Count data follows:

a) Binomial Distribution
b) Normal Distribution
c) Tally Distribution
d) Poisson Distribution
e) None of the above

3. The diameter on five O – rings is checked every hour and the X bar and R chart is plotted. A roving inspector making a spot check, picks up 2 rings, measures their diameters and plots these 2 measurement on the X bar chart. He notices that both points fall just outside the control limits and pushes the alarm switch to stop the process.

a) the process is out of control
b) the roving inspector "did the right thing"
c) the roving inspector did not use the **X** bar chart correctly
d) X bar is out of control

4. The primary purpose of a control chart is to:

a) eliminate variation
b) reduce variation
c) detect assignable causes of variation
d) all of the above
e) none of the above

5. A process has $C_p = C_{pk}$, this means that:

a) the process is well under control
b) the mean and target values for the process are equal
c) process width is equal to the specification width
d) there is no significance attached to this situation

6. You are told that C_p= 2 but there is defect rate (fallout) of 50 %. Is that possible since we know that C_p = 2 means a six sigma process.

7. An inspector checks for the number of O - rings produced with black burn marks. He will be using:

a) variable control chart
b) moving range chart
c) attribute control chart
d) none of the above
e) all the above

8. In Question 7, the sample size is constant and he measured the number of defects. He should use:

a) C chart
b) np chart
c) X bar and R chart
d) Moving average chart

9. In Question 8, if he measures the number of defectives, he should use,

a) C chart
b) np chart
c) X bar and R Chart
d) Moving average chart

10. Process width is defined as:

a) 12 sigma
b) specification width
c) 3 sigma
d) 6 sigma

11. The upper and lower control limits are spaced:

a) + / - 3 sigmas from the process average line
b) + / - 4 sigmas from the process average line
c) + / - 5 sigmas from the process average line
d) none of the above

12. In a control chart, seven consecutive points above or below the process average line:

a) should be ignored
b) is an indication of a random trend
c) is an indication of an assignable cause

d) both **b** and **c** are correct
e) none of the above

13. A moving range chart is used when:

a) only averages are available
b) only one measurement is available at the instant of measurement
c) the range is too large
d) the average is too large

14. SPC is implemented when:

a) the output of a given process is deemed significant or critical
b) the output is a number
c) process variation is very large
d) process is out of control

15. Process width is one half of the Specification width. It means that:

a) process is in control
b) C_p is = 2.5
c) C_p is = 1.5
d) C_p is = 2

16. Process width is = Specification width. It means that:

a) process is in control
b) C_p is = 2
c) C_p is = 1
d) C_p is = 0

SSBB QUIZ – 4

1. SWOT is an acronym for:
A. strengths, weaknesses, opportunities, threats
B. statistics with out tables
C. sensory Weibull ordinal tools
D. success wields optimal teams
E. none of the above

2. A quality leader who did extensive work with Japanese industry is:
A. Juran
B. Ishakawa
C. Deming
D. Ohno
E. Taguchi
F. all of the above
G. none of the above

3. In a series of linked processes and associated feedback loops the product or service flows _____ and the information flows _____.
A. rapidly, slower
B. downstream, upstream
C. evenly, digitally
D. sooner, later
E. to the customer, from the supplier
F. none of the above

4. Causes in a cause and effect diagram often include management, measurement
systems, mother nature and the four standard causes:
A. man, material, methods, machines
B. man, manufacturing, methods, material
C. marketing, methods, material, machines
D. man, material, millennium, machines
E. none of the above

5. The word "champion" in the context of Six Sigma projects refers to:
A. the team that has had the most impact on the bottom line.
B. the person who has coordinated teams most effectively
C. the individual who has outpaced all others in six sigma knowledge
D. none of the above

6. George is an employee of Black, Inc. John is George's internal customer. Which statement is true?
A. John is employed by Black, Inc.
B. John is employed by another company that supplies material to Black, Inc.
C. John is employed by a company that purchases material from black, Inc.
D. John is employed by another company that has a fiduciary agreement with Black, Inc.
E. John is employed by another company as an internal auditor.

7. A team has been asked to reduce the cycle time for a process. The team decides to collect baseline data. It will do this by:
A. seeking ideas for improvement from all stakeholders
B. researching cycle times for similar processes within the organization
C. obtaining accurate cycle times for the process as it currently runs
D. benchmarking similar processes outside the organization

8. Customer segmentation refers to:
A. dividing a particular customer into parts that are more easily understood
B. grouping customers by one or more criteria
C. maintaining secure customer listings to minimize communication among them
D. eliminating or "cutting off" customers with poor credit history

Use the following for problems 9–10:

There are 14 different defects that can occur on a completed time card. The payroll department collects 328 cards and finds a total of 87 defects.

9. DPU =
A. 87 ÷ 328
B. 87 ÷ (328 × 14)
C. 14 ÷ 87
D. 87 ÷ 14
E. 328 ÷ 87
F. 87 × 1,000,000 ÷ (14 × 328)

10. DPMO =:
A. 87 ÷ 328
B. 87 ÷ (328 × 14)
C. 14 ÷ 87
D. 87 ÷ 14 × 1,000,000
E. 328 ÷ 87
F. 87 × 1,000,000 ÷ (14 × 328)

11. A random sample of 2500 printed brochures is found to have a total of three ink splotches. The rate of ink splotches in PPM is:
A. 1,000,000 ÷ 2500 × 3
B. 2500 ÷ 1,000,000 × 3
C. 3 ÷ 2500 × 1,000,000
D. 3 × 2500 ÷ 1,000,000

12. A team studies a coil steel banding process and makes five changes resulting in productivity improvements of 2%, 2.8%, 2.4%, 2% and 3% respectively. These improvements are best described by which approach to problem solving?
A. 5S
B. Poka yoke
C. Kaizen
D. PDCA
E. Re-engineering

13. The operators of a manufacturing cell work out a more orderly arangement for tool storage and establish a schedule to maintain cleanliness on a daily basis. These improvements are best described by which approach to problem solving?
A. 5S
B. Poka yoke
C. Kaizen
D. PDCA
E. Re-engineering

14. A quality engineer employed by a hospital is asked to improve the process of medication storage in locked cabinets near patient doors. One defect that occurs rarely is that the medication caddy is left out when the cabinet is re-locked. The engineer installs a gravity activated arm that will not permit the door to close when the caddy isn't inside. This improvement is best described by which approach to problem solving?
A. 5S
B. Poka yoke
C. Kaizen
D. PDCA
E. Re-engineering

15. A project that lacks a clear definition of its scope and boundaries runs the risk of:
A. straying from the intended path
B. trying to solve unrelated problems
C. having difficulty in collecting baseline data

D. suffering morale problems
E. none of the above

Use for Q.16 and Q.17: The primary metric for a project is reduced cost for process A.

16. A consequential metric could be:

A. reduced cycle time
B. reduced scrap rate
C. reduced set-up time
D. all the above
E. none of the above

17. Baseline data might include:
A. current maintenance costs
B. current selling price for the products or services output by process A
C. current suggestions from stakeholders of process A
D. all the above
E. none of the above

18. The median is a better choice than the mean for a measure of central tendency if the data:
A. is bimodal
B. often has outliers
C. is normally distributed
D. is exponentially distributed

19. A team wants a technique for determining and displaying priorities based on frequency of various defect types. They should use:
A. written and diagrammed work instructions
B. flow charts and process maps
C. cause and effect diagrams
D. Pareto chart
E. relationship matrix

20. A team wants a technique for improving consistency of assembly operations. They should use:
A. written and diagrammed work instructions
B. flow charts and process maps
C. cause and effect diagrams

D. Pareto chart
E. relationship matrix

21. A team wants a technique for doing an initial study of a process that not every team member is familiar with. They should use:
A. written and diagrammed work instructions
B. flow charts and process maps
C. cause and effect diagrams
D. Pareto chart
E. relationship matrix

22. A team wants a technique for displaying the connection between various customer needs and various features on a product. They should use:
A. written and diagrammed work instructions
B. flow charts and process maps
C. cause and effect diagrams
D. Pareto chart
E. relationship matrix

23. A team wants a technique for obtaining a large number of possible reasons for excess variation in a dimension. They should use:
A. written and diagrammed work instructions
B. flow charts and process maps
C. cause and effect diagrams
D. Pareto chart
E. relationship matrix

24. The Central Limit Theorem states that the distribution of sample means approximates a normal distribution if:
A. the population is normally distributed
B. the sample is normally distributed
C. the sample is randomly selected
D. the sample size is sufficiently large
E. the means are carefully calculated

25. The following data were collected on the diameters of turned shafts: 2.506 2.508 2.505 2.505. These values are:
I. Attribute data
II. Discrete data
III. Variables data
IV. Continuous data
A. I and II
B. I only
C. II only
D. I and IV
E. III and IV

26. A process shows the following number of defects. Each sample size for this process is 85.

3 8 2 7 7 6 8 8 9 5

What control chart should be used?
A. x-bar and R
B. median
C. individual and moving range
D. p
E. np
F. c
G. u
H. none of the above

27. A process shows the following number of defectives. Each sample size for this process is 85.

3 8 2 7 7 6 8 8 9 5

What control chart should be used?
A. x-bar and R
B. median
C. individual and moving range

D. p
E. np
F. c
G. u
H. none of the above

28. An assembly line has 3 ft × 3ft squares painted behind each person. Signs indicate the parts and quantities that should be placed there. This is an example of:
A. visual factory
B. kanban
C. poka-yoke
D. standard work
E. set up time reduction (SMED)

29. When Tricia empties a box of capacitors she places it at a designated spot on her work table. Sam notices the empty box and brings a full box of capacitors from the stock room. This is an example of:
A. visual factory
B. kanban
C. poka-yoke
D. standard work
E. set up time reduction (SMED)

30. A meeting is called for all three shifts to determine the settings to be used on machine #45. This is an example of:
A. visual factory
B. kanban
C. poka-yoke
D. standard work
E. set up time reduction (SMED)

31. There have been some instances in which 1.5 inch screws are used where 1.25 inch should have been used. This produces a critical defect. The decision is made to have all 1.25 inch screws have a square reduced head and all 1.5 inch screws be Phillips type head. This is an example of:
A. visual factory
B. kanban
C. poka-yoke
D. standard work
E. set up time reduction (SMED)

32. A helpful time to use a Quality Function Deployment matrix is:
A. while planning for a new or redesigned process
B. while planning for new or redesigned parts
C. while planning for a new or redesigned product
D. all of the above
E. none of the above

33. "Robust design" refers to the ability of the product or service:
A. to function the same in different conditions
B. to remain strong
C. to last a long time
D. to have a high reliability

34. For an FMEA, a team has established the following:
Cost: $82
Severity: 7
Occurrence: 9
Detection: 4
Target date: 7 days
What should the risk priority number (RPN) be for this line:
A. 144,648
B. 252
C. 1764
D. 63
E. none of the above

35. If item A is more likely to be detected than item B which will have the highest Severity value?
A. item A
B. item B
C. cannot be determined

36. If item A is more likely to be detected than item B which will have the highest Occurrence value?
A. item A
B. item B
C. cannot be determined

37. If item A is more likely to be detected than item B which will have the highest Detection value?
A. item A
B. item B
C. cannot be determined

38. A process using a p-chart has p-bar = 0.076 and n-bar = 4.86. Find the control limits.
A. 0.069 and 0.083
B. 0.072 and 0.080
C. 0.040 and 0.112
D. 0.0756 and 0.0764
E. none of the above

39. If _____ consecutive data points are continuously increasing or decreasing on a control chart, the process likely to go out of control

A. Five
B. Six
C. Seven
D. Nine
E. Ten

40. Cost of quality:

A. Increases when we invest on six sigma projects
B. Is not a very important factor
C. Is usually highest in respect of internal failures
D. Is usually highest in respect of external failures
E. Both C and D.

5. THE QUALITY GURUS

1. Dr. Walter A. Shewhart:

- Long experience at Western Electric & Bell Telephone labs (Both divisions of A T & T) Developed controls chart theory in 1924, which is considered as the beginning of statistical process control. The value of control charts was realized many years later (1950's) in Japan and much later in USA (1970's).

2. Dr. W. E. Deming:

- He learnt SPC (those days called SQC) from Shewhart.
- In 1950, he gave a series of lectures on statistical methods to Japanese engineers and on "responsibility for quality" to CEO's of large organizations.
- Deming is the best-known quality expert in the world. He provided the foundation for the Japanese Quality Miracle and resurgence of Japan as an economic power.
- By late 1970's and early 1980's U. S. Managers were making frequent visits to Japan to learn about the "Japanese Miracle".

3. Dr. Joseph M. Juran:

- Worked at Western Electric from 1924 to 1941. There he was exposed to the concepts of Shewhart.
- Made his first trip to Japan in 1954 to teach quality management.
- He stressed upon the importance of management at all levels to be committed to the quality effort, with hands-on involvement.
- Juran developed the "Juran Trilogy" as an approach for process improvement.

Planning	Control	Improvement
• Identify your customers • Identify their needs • Develop product features that meet there needs, using QFD • Develop the processes to produce the product (or service) features.	• SPC is the primary technique for achieving control while producing the products (or service) • Includes pareto Diagrams, flow charts, C & E Diagrams, Check Sheets, Histograms, Scatter Diagrams and Process capability information Cp and Cpk	• Process Improvement projects are undertaken by a team called "Quality Council" to achieve higher performance levels them current levels.

4. Dr. Armand V. Feigenbaum:

- Developed the concept of Company Wide Quality Control (TQM) which included "genuine involvement of management, employee-involvement, and first-line supervision leadership".
- Believed that CWQC (TQM) is necessary to achieve productivity, market-penetration and competitive advantage.

5. Dr. Kaoru Ishikawa:

- He studied under Deming, Juran and Feigen baum. He borrowed the CWQC concept and adapted it for the Japanese. He authored SPC texts in Japanese & English.
- Developed the Cause & Effect Diagram.
- Also developed the concept of "Quality Circles" in Japan, whereby work groups including their supervisor were trained in SPC concepts. The groups then met to identify and solve quality problems in their work environment.

6. Phillip B. Crosby:

- Authored his first book "Quality is Free" in 1979, which was translated into 15 languages and sold 1.5 million copies.
- He argued that "doing it right the first time" is less expensive than the cost of detecting non-conformities and correcting them.
- In 1984, he authored "Quality without Tears" which contained his **absolutes of quality management** like:

    i. Quality is conformance to requirements.
    ii. Objective is "Prevention of non-conformance" not "appraisal".
    iii. The performance standard is "Zero defects" and not "that's close enough".

6.1 DEMING'S 14 POINTS FOR MANAGEMENT

Point 1: Create a constancy of purpose to improve quality and service, to become competitive, and to stay in business.

Long-term planning is a necessity and must be based on an unshakable policy of high quality.

Continually investigate the possibility for new products, new markets, and new ways to compete efficiently in the present markets.

Point 2: Adopt the new philosophy.

Defects and defective items cost money to the organization.

The total cost of producing, finding and disposing of or repairing a defective item **exceeds the cost** of producing a good item.

Point 3: Stop dependence on mass inspection.

Scrap and rework do not correct the process: The process will keep producing the same proportion of defective items until improvements are made in the process itself.

Point 4: End the practice of awarding business on the basis of price tag alone.

Both government and industry are being cheated when they follow rules that award business to the lowest bidder without considering quality.

A large fraction of the problems that lead to poor quality and low productivity are due to poor-quality incoming parts and material and low-quality machines and tools.

Point 5: Constantly and forever improve the system of production and service.

Continually search for problems, reduce waste, and improve quality in every phase of the process.

Statistical leadership will be required to **separate special-cause** and **common-cause** variation and to design and analyze tests for reducing variation.

Point 6: Institute modern training methods on the job.

One of the greatest wastes in the United States is the failure to use the full abilities of the workforce.

Training must include a thorough understanding of the entire process and an individual's part in it.

Point 7: Institute modern methods of supervision.

Modern supervisors must be regarded as leaders and facilitators, not as overseers.

They must emphasize quality first and look for improvements in production quantity within the quality framework.

Point 8: Drive out fear.

Fear of asking questions, expressing ideas, and "reporting trouble" can lead to problems with quality and lagging improvements.

Fear puts an upper limit on improvement. Fear of failure, fear of supervisors, fear of voicing an opinion… are the chief enemies of timely action and flexibility.

Point 9: Break down barriers between staff areas.

People in research, design, purchasing, production and sales must work as a team to anticipate production problems.

Point 10: Eliminate numerical goals for the workforce.

Eliminate targets, slogans, posters, and unrealistic goals such as zero defects. That approach makes management appear to be dumping their responsibilities on the workforce.

The only way to achieve ambitious goals with a stable process, is to change the process itself. This has to be a **management's initiative** and mere motivation of employees will not work.

Point 11: Eliminate work standards and numerical quotas.

These guarantee inefficiency and high cost. Quotas encourage sporadic work habits such as working fast until the quota is almost met and then easing off for the remainder of the shift, which is detrimental to the quality effort. Piecework is even worse.

In this system, workers have no incentive to help management improve the process, be cause improvement of process will only lead to increase of the target.

A better alternative to MBO (Management By Objectives) is MBP i.e. "Management By Planning which focuses on improving the process with the involvement of the employees.

Point 12: Remove barriers that hinder the hourly worker.

Nothing should interfere with the worker's ability to do a good job.

Job instructions should be thorough, concise, and understandable, and problems with inspection or gauges should not reflect unfairly on the worker.

Point 13: Institute a vigorous program of education and training.

An organization needs not only good people but also people who are improving themselves with education.

Encourage education: eliminate the fear of layoffs. As quality and productivity increase, fewer people will be needed on some jobs

but education and re-training can move the displaced persons to other functions.

Point 14: Create a structure in top management that will push every day on the preceding 13 points.

Have the courage to break with tradition and explain to employees via seminars and other means, such as newsletters and meetings, why the change is necessary and why everyone must be involved.

Educate the people in simple, but powerful statistical techniques to be used in every functional area.

6.2 CROSBY'S FOUR ABSOLUTES OF QUALITY

a. The definition of quality is "conformance to requirements."

Be sure the requirements are clear, understandable and, when necessary, accepted. Emphasize a "do it right the first time" attitude.

b. The system of quality is "prevention."

The prevention method features corrective changes in the process when problems occur with the product. SPC is used as an integral part of the prevention system.

c. The performance standard is "zero defects."

If you do not insist on zero defects from your suppliers, you are telling them in effect that it is acceptable for them to send non-conforming parts and materials. Same thing is true for employees.

People are conditioned to believe that "to err is human, so human beings are bound to make mistakes." **This is faulty logic.**

Crosby claimed, "Mistakes are caused by two factors: **lack of knowledge and lack of attention."**

- ✓ Education and training will eliminate lack of knowledge

- ✓ Commitment to excellence (zero defects) and attention to detail will prevent lack of attention.

d. The measure of quality is the "price of nonconformance."

Quality, as a management concern, has not traditionally been taught in management schools.

Quality has been considered to be a technical function, not a management function, because it has not traditionally been evaluated in financial terms.

(The price of non-conformance is the total cost of doing things wrong. It can go upto 25 % of sales-turnover in manufacturing and 35 % in service businesses).

7. PITFALLS IN THE QUEST FOR QUALITY (RICHARD McKEE):

Companies should avoid the following situation as they introduce their new strategies.

1. Expecting Instant results

Remember, the Japanese were first introduced to the concepts of applying statistical methods in 1950, and their dominating influence on world markets was not really felt until the late1970s.

These is no "quick-fix" to the quality problems.

2. Lack of commitment by management

The quality effort is a coordinated process that involves everyone, and management has to lead the way.

3. Lack of long-term planning

Too often management is looking for results in time for the next quarterly report. Short-term impatience leads to a waste of time, effort, and money.

A haphazard approach produces no meaningful change in the syste

4. Limited application

When SPC is started in an industry in a limited way, it should be applied to a complete process, not just a part of a process, from start to finish. Then it should be established in another complete process, and another until the entire company uses SPC.

5. No market research

The customer is the most important part of the process. Management must know the level of quality that is expected by customers.

6. Lack of funds committed to the quality process

Do not “pinch pennies.” The initial monetary outlay in education costs and in production time lost for on-the-job training may seem extensive, but keep the long-term plan in mind.

Remember, Price of Non-conformance is about 25 % of sales, and Price of Conformance is about 3 to 4 % of sales.

7. Underestimating the workforce

The best competitive effort can occur only when everyone in the organization is actively contributing to the quality process.

Make sure that all employees are aware that their input is important, is wanted, and is expected.

8. Failure to involve the suppliers

The quality of incoming goods must equal the quality of your products. Garbage in, garbage out (GIGO)!

8. A History of Managing for Quality in the United States

by Dr. J.M.Juran

Until the voyage of discovery by Christopher Columbus in 1492, the North American continent was populated by numerous native American tribes. These tribes mostly lived off the land as food gatherers, farmers, fishermen, and hunters. What is now the United States was colonized mainly by Great Britain, Spain and France. These European countries subdued the natives through superior weaponry and took possession of the continent. In due course, the colonists revolted against foreign rule, declared their independence in 1776 and formed the United States of America.

Following independence, the United States became a haven for large numbers of immigrants, at first mainly from Great Britain and northern Europe, and later from southern and eastern Europe. It also expanded its territory, by purchase and conquest, to reach its present boundaries.

Early systems of managing for quality:

The origins of managing for quality in the United States are to be found in Europe rather than in North America. At first, the principal industries in the colonies were agriculture plus production for self-use. The British government favored retaining for the British Isles the roles of manufacture and sale of finished goods while using the colonies as a source of materials and as a captive market for manufactured goods. The colonists resisted these restricted roles and sought to create their own manufacturing capabilities.

The early colonists and immigrants also faced the problems and opportunities associated with exploiting the immense natural resources of their new world. An innovative spirit emerged and became a driving force when the new nation undertook to industrialize. Self-reliance and risk taking became major and respected traditions. These traditions in turn raised individualism and entrepreneurship to a state of respect.

Craftsmanship:

In their approach to manufacture, the colonists and immigrants tended to follow the craftsmanship concept prevailing in their respective European countries of origin. A boy learned a skilled trade as an apprentice to a master. The master trained the apprentice in how to produce the product. The master also maintained a form of quality control by inspecting the goods before sale.

Once the apprentice had learned his trade, he became self-employed or employed by the master of a small shop. Quality under craftsmanship was usually in good hands --

the hands of the craftsmen. Achievement of quality was one of the essential skills learned by the apprentice. Most goods were sold locally, so the craftsman had a large personal stake in meeting his customers' needs for quality.

The Industrial Revolution:

The Industrial Revolution, which originated in Europe, created the factory system. The factory system usually subdivided former trades into multiple, specialized tasks. It soon out-produced the craftsmen and the small independent shops, and made them obsolete. It forced many craftsmen to become factory workers, and many shop owners to become production supervisors. (The factories employed many semiskilled and unskilled workers as well).

Managing for quality remained a production function:

Large production departments employed full-time inspectors, who reported to the respective production supervisors. Quality was assured through the skills of the workers, supplemented by supervisory audit or by departmental inspectors. When the Industrial Revolution was exported from Europe to North America, the United States again followed European practice, with further damage to craftsmanship.

The Taylor system and its impact:

Late in the 19th century, the United States broke sharply with European tradition by adopting Frederick W. Taylor's system of scientific management. Taylor's goal was to increase production and productivity without increasing the number of skilled craftsmen. His concept was to separate planning from execution.

In those days, planning of factory work was done largely by factory supervisors and workers who, in Taylor's view, lacked the necessary technological literacy. Taylor's solution was to assign the planning to engineers and to limit the supervisors and workers to executing the plans. This approach became the basis for a remarkable rise in productivity. In fact, the Taylor system was a major contributor to making the United States the world leader in productivity.

The emergence of independent inspection departments:

The Taylor system also had negative consequences. The new emphasis on productivity had a negative effect on quality. To restore the balance, factory managers created central inspection departments, headed by a chief inspector.

The various departmental inspectors were then transferred to the new inspection departments. This was done with the bitter opposition of the production supervisors. The major job of the new inspection departments was to keep defective products from reaching the customers. This was done by inspection in various forms. Raw materials and goods in process were commonly sampled. The results of the sampling

determined the disposition of the lot. Finished goods were usually detail-inspected to separate the good from the bad.

In many companies, the assignment of responsibility for quality took a curious turn. If defective goods did get out to clients, it was common for the upper managers to ask the chief inspector, "Why did you let this get out?" It was less common to ask the production manager, "Why did you make it this way?"

In due course, there evolved a widely held belief that quality was the responsibility of the inspection department.

Quality during World War II:

U.S. involvement in World War II began as a supplier to the Allies during the late 1930s. The Japanese attack on Pearl Harbour in December 1941 then brought the United States into the war as a combatant. Legislation was enacted to put the country on a war footing. A War Production Board was created to gear the civilian economy to the war machine and to produce enormous quantities of military products, many of which used new, sophisticated technology.

Regulations were established to give the war effort priority in allocation of facilities, materials, skilled personnel and services of all sorts. Production of a wide range of civilian products came to a halt. These included automobiles, household appliances, entertainment products and many others. A massive shortage of civilian goods developed while defence factory employees were working overtime and building up a great hoard of purchasing power.

The effect on quality of military products:

The traditional approach had been to award military contracts based on competitive bidding, the contract usually going to the lowest bidder. Upon delivery, the products were inspected and tested for conformance to specifications. **Often this involved inspecting and testing every single unit of product.**

This same basic approach was retained during World War II. It required a huge expansion of the inspection forces, with massive problems in recruitment, training, employee turnover and so on. The armed forces tried to reduce these problems by greater use of sampling inspection. In doing so, they decided to replace their empirical ways of sampling with methods based on the laws of probability.
Despite this progress in improving the inspection process, the top priority was on meeting the delivery schedules. This was underscored by the system of awarding the coveted Army-Navy "E" to government contractors. **The award was for meeting delivery schedules.**

The effect on quality of civilian products:

World War II ended in 1945, but meanwhile a massive shortage of goods had built up. It then took the rest of that decade to refill the pipelines and for supply to catch up with demand. During those years, the quality of products declined severely (quality always goes down during shortages.) The traditional, experienced manufacturers gave top priority to volume of production in order to secure maximum share of market. The shortage also attracted new competitors, and their inexperience contributed further to the decline in quality.

The most subtle effect of the shortages was to create a habit of giving top priority to meeting schedules. As the years went on, this priority found its way into company policies and procedures. This resulted in the formation of a habit of giving top priority to delivery dates, which persisted long after the shortages were gone. The role of the Quality –Control inspectors became unimportant in this scenario and quality suffered for many years.

Managing for quality at mid-20th century:

By the middle of the 20th century, managing for quality in the United States was carried out largely as follows:

* Each functional department in the company carried out its assigned function and then handed off the result to the next function in the sequence. This was often called "throwing it over the wall."

* At the end of the sequence, the quality department separated the good products from the bad.

* For defective products that escaped to the customer, redress was to be provided through customer service based on warranties.

This approach contained numerous deficiencies, such as:

* Training in how to manage for quality was limited to members of the quality department.

* Quality had top priority in the quality department, but not in other departments.

* The over-the-wall concept permitted departments unilaterally to create quality problems for their customers, internal and external.

* This kind of reliance on inspection and testing fostered the belief that quality was the responsibility of the quality department.

* The upper managers were detached from the quality function. In their mind, they had delegated quality to the quality managers.

*** There was no organized approach for quality improvement -- for improving the processes so as to reduce the incidence of defects and field failures. The responsibility for prevention was vague.**

Despite the deficiencies inherent in this concept, many U.S. goods came to be well regarded as to quality. In some product lines, U.S. companies became the quality leaders.

In addition, the U.S. economy grew to super-power size. The domestic economy was unified by the laws governing movement of goods in interstate commerce; these laws avoided the obstacles inherent in the national boundaries then prevailing in Western Europe. The American belief in a market-based economy and the spirit of entrepreneurship stimulated investment to bring new and improved products to market. Additionally, managers were willing to invest in facilities to improve productivity. Some of those investments (for example, in machines, tools and instruments) improved quality as well.

The emerging forces

During the second half of the 20th century, some massive forces emerged to challenge the adequacy of quality in the United States. The chief forces included:

* The growth of consumerism. Consumerism is a popular name for the movement to help consumers solve their problems through collective action.

* The growth of legislation in respect of unfair or deceptive practices in commerce.

* The growth of government regulation of quality such as the right to investigate product failures, user complaints, inspect the companies' processes and systems, test products in all stages of distribution and inform users of deficiencies.

* The Japanese quality revolution.

The Japanese quality revolution and its impact:

The major manufacturers in Japan, who had been extensively involved in military production, converted to civilian products after the second world war. They then found that **a major obstacle to selling these products in international markets was Japan's reputation as an exporter of shoddy goods.**

This major obstacle convinced the Japanese of the need to improve their quality reputation. The shock of losing the war made them willing to explore new ways of thinking about quality, including learning from other countries. They sent teams abroad to visit foreign companies and study their approaches to managing for quality.

They translated selected foreign literature into Japanese. They invited foreign lecturers to come to Japan and conduct training courses.

These lecturers, Dr. Edwards Deming on statistical methods and Dr. J.M. Juran on managing for quality, provided courses that became influential inputs to the quality revolution in Japan.

Building on these and other inputs, the Japanese adopted some unprecedented strategies for creating their revolution in quality: The **senior managers personally took charge of leading the quality revolution**.

The companies trained their engineers and the work force in how to use statistical methods as an aid to control of quality.

They trained the entire managerial hierarchy in how to manage for quality and undertook quality improvement at a revolutionary rate, year after year. They evolved the **QC circle concept** to enable the work force to participate in quality improvement. They enlarged their business plans to include quality goals.

During the 1960s and 1970s, many Japanese manufacturers greatly increased their share of the U.S. market. A major reason was superior quality. Numerous industries were impacted: consumer electronics, automobiles, steel, machine tools and so on.

The impact of the Japanese exports on the United States was considerable. Consumers benefited greatly by access to goods of superior quality at competitive and even lower prices. However, great damage was done to other areas of the U.S. economy: The impacted manufacturing companies were damaged by the resulting loss of market share. The work force and the unions were damaged by the resulting export of jobs. The national economy was damaged by the resulting unfavorable trade balances. Collectively, these impacts called for responsive action.

In due course, U.S. managers evolved responses to those massive forces, but not before much damage had been done to the economy.

Responses to the Japanese quality revolution-Price competition:

In the early post-war period, the impacted U.S. companies logically considered Japanese competition to be in price rather than in quality. (Japanese wages were far below those in the United States.) So one major response was to move the production of labor-intensive products to low-wage areas, often off-shore.

Block the imports:

Some of the impacted companies tried to solve their problem by blocking the imports. They urged legislation that would establish restrictive import quotas and tariffs. They

filed civil lawsuits on the grounds of unfair trade practices. They appealed to the public to "Buy American."

These efforts yielded some relief but did nothing to improve U.S. capability in terms of quality.

Lack of early warning:

As the years unfolded, price competition declined while quality competition increased. At the outset, Western companies were clearly the quality leaders. Moreover, they continually improved their products, but at a gradual rate.

In contrast, Japanese automotive quality was at the outset well below that of the West. However, the Japanese undertook to improve their quality at a revolutionary rate, enabling them to overtake the West during the mid-1970s.

The U.S. senior managers were generally unaware of these trends. The reports available to them consisted mainly of financial information. In those days, the executive instrument panels lacked information on customer satisfaction, competitive quality, cost of poor quality and the like. **So the managers continued to believe that Japanese competition was primarily price competition rather than quality competition.**

The major initiatives of the 1980s:

By the end of the 1970s, the U.S. quality crisis had reached major proportions. It attracted the attention of national legislators and administrators. It was featured prominently in the media- it was regularly on the front page. It increasingly forced company CEO's to provide personal leadership in managing for quality.

During the 1980s, a great many U.S. companies undertook initiatives to deal with the quality crisis. These initiatives focused largely on three strategies: exhortation, project-by-project quality improvement and statistical process control.

Exhortation:

Some consultants proposed a sweeping solution by exhorting the work force to make no mistakes, "Do it right the first time." This simplistic approach was persuasive to those managers who, at the time, believed that the primary cause of their company's quality problems was the carelessness and indifference of the work force. Actually, the bulk of the quality problems had their origin in the managerial and technological processes. In due course, this approach was abandoned, as an ineffective one.

Quality improvement, project by project:

One of the consulting companies, Juran Institute Inc., created and published a series

of videos titled Juran on Quality Improvement. These were tested by many companies. Some achieved notable quality improvements; others did not. **The decisive variable was the extent of personal leadership provided by the senior managers**.

Wave of Statistical Process Control:

The 1980s also witnessed a broad movement to train company personnel in application of statistical methods to quality problems. The stimulus came from a widely viewed video titled “If Japan Can, Why Can't We?”

It implied strongly that Japanese success in quality had resulted solely from use of statistical methods. The video helped persuade many companies to train numerous employees in basic statistical methods. Such training had merit - it provided trainees with a useful set of tools. Yet it was premature. It was done before the companies had defined their quality goals and the strategies needed to reach those goals.

In a sense, the personnel were trained in remedies when the diseases were not yet known. During the 1980s, many US companies limited their quality initiative to SPC, assuming it to be “the solution”. **These companies lost precious years before learning that quality leadership comes from a mixture of strategies, no single methodology is the magic.**

Results of the initiatives of the 1980s:

In retrospect, the results of the quality initiatives of the 1980s were deeply disappointing. Most of the initiatives fell well short of their goals. The disappointing results were due mainly to poor choice of strategies and poor execution of valid strategies. In turn, these were largely traceable to the limitations of leadership by senior managers, who lacked training and experience in managing for quality.

The role models:

However, during the same disappointing decade, **a few companies’ initiatives achieved stunning results.** Such companies attained quality leadership i.e. "worldclass quality" and became the role models for the rest of the U.S. economy.

The role models were few in number. They included the Balridge Award winners plus other companies that had achieved similar results. Together they made up only a tiny part of the U.S. economy. **Yet there were enough of these companies to prove that world-class quality is attainable within the U.S. culture.**

The **successes achieved by the role-model companies stimulated great interest among senior managers and others who sought to learn how such stunning results had been achi**eved. The role models were quite willing to share information about the strategies they had used to achieve those results. In addition, they took steps to share the lessons learned through company visits, conferences, publications

and so on.

Lessons learned:

Each role model is different. In groping for ways to attain world-class quality, each serves as a laboratory, testing out various strategies, adopting some, modifying others, rejecting still others.

Nevertheless, **analyzing these collections shows that they include considerable commonality**. There is a core list of strategies that achieved adoption by most of the role model companies. These core strategies deserve careful study. They form the central body of lessons learned.

Customer focus:

All role models adopted the concept that the customer has the last word on quality. Adoption of this concept then led to intensified action to identify: who are the customers, internal as well as external; what are the customers' needs; what product features are required to meet those needs; how do customers decide which of the competing products to buy; and so on.

For example, it is now widely recognized that many past quality problems can be traced to failure to meet the needs of internal customers. The customer focus concept led to broader acceptance of the participation concept i.e. "internal customers should participate in those planning activities that will impact the quality of their operations."

Senior managers in charge:

One element present in all successes and absent in most failures was the personal involvement of the top management. In effect, the senior managers took charge of quality **by accepting responsibility for certain roles** like:

* Establishing the quality goals,
* Providing the needed resources,
* Providing the quality-oriented training,
* Stimulating quality improvement,
* Reviewing progress,
* Give recognition to performers.

The lessons learned from the role models are that the above roles cannot be delegated. They must be carried out by the senior managers personally.

Strategic quality planning:

The role models recognized that the new priority given to quality **required that the business plan included quality-related goals.**

These goals are then deployed to identify the actions and resources needed, to establish responsibility for taking the actions, and so on. The resulting plans are similar to those used for meeting goals for sales and profits. A common name for this concept is strategic quality planning.

The concept of "Big Q":

The role models grasped the concept that managing for quality should not be limited to manufacturing companies and manufacturing processes. **It should also include service companies and business processes.** This concept broadens the area under the quality umbrella. It bears the name **"Big Q,"** to distinguish it from the traditional "little Q."

Quality improvement:

Without exception, the role models went extensively into quality improvement and most of the stunning results came from the projects to improve quality.
These projects extended to all activities **under the Big Q umbrella.** They reduced costs, raised productivity, shortened cycle times, improved customer service and so on.

The role models also adopted the concept that quality improvement must go on year after year - it must be woven into the company culture. To this end, **they mandated that goals for quality improvement be included in the annual business plans.** They also redesigned the systems of recognition and reward to give added weight to performance on quality improvement.

Business process quality management (reengineering):

A major extension of quality improvement was to the area of business processes. This extension resulted from fresh thinking relative to the multifunctional processes prevalent in functional organizations.

Each horizontal macro-process consists of numerous steps or micro-processes that thread their way through multiple functions. Every micro-process has an owner, but **there is no clear ownership of the macroprocess.**

The role models concluded that **each key macro-process should have an owner, and they took action to create such owners (individuals or teams).**

They also defined the responsibilities of an owner, involving responsibility for improving the macro-process. An important part of the stunning results achieved by the role models came from improvements made in the business processes.

Measurement of quality:

Measurement of quality at the technological level has been used for many centuries. **What is new is the need for measuring quality at the business level** such as,

measures of customer satisfaction, competitors' quality, performance of key business processes and so on. To meet such needs often requires inventing new measures as well as creating related methods of analysis and presentation.

Benchmarking:

The benchmarking concept grew out of the need to establish quality goals based on factual analysis rather than empirical judgment. For example, in one company the warehouse takes an average of five working days to fill customers' orders. The leading competitor takes an average of three days. A company in a totally different industry takes only two days. Then the benchmarked goal becomes two days. There may well be a reaction that "It can't be done," and this may be valid as applied to the present process. However, the fact is that the goal is already being met. So the problem is then to create (or recreate) a process that can meet the benchmark.

Human resources and quality: Empowerment

As of the early 1990s, many U.S. companies still retained the separation of planning from execution inherent in the Taylor system of scientific management. As a result, those companies failed to make use of a huge underemployed asset, i.e. the education, experience and creativity of the work force. It is generally agreed that the Taylor system is obsolete and should be replaced, but there was no consensus on what should replace it.

Replacing the Taylor system required transfer of tasks from specialists and supervisors to non-supervisory workers. The word **empowerment** has become a label for such transfer, i.e. establish worker self-control. This requires providing workers with all the essentials for doing good work; means of knowing what are the quality goals; means of knowing what is the actual process performance; and means for adjusting the process in the event that quality does not conform to goals.

A state of self-control makes it possible to empower workers to make decisions on the process such as, "Is the process in conformance?" and "Should the process continue to run or should it stop?" **Ideally, the work force should make such decisions. There is no shorter feedback loop i.e. establish worker self-inspection.** This empowers workers to make decisions on whether the product conforms to the quality goals.

The concept of self-directing teams has been widely tested. The published results indicate that quality and productivity improve significantly. The ratio of workers to managers rises sharply. Jobs cross functional lines and become team jobs. Workers

become team members.

Because empowerment involves extensive transfer of work from supervisors and specialists to the work force, it can meet much cultural resistance. .

The ISO 9000 series of standards:

During the 1980s, the countries of Western Europe began to use the International Organization for Standardization's ISO 9000 series of standards as the basis for judging the adequacy of the quality assurance systems of companies.

The ISO 9000 standards define a comprehensive quality assurance system. The certification process may well get rid of the plague of multiple assessments that have burdened suppliers in the past.

Total quality management:

As the quality crisis deepened during the last half of the 20th century, more and more prerequisites were identified as essential to achieving world-class quality. A need then arose for a short label for this list of pre-requisites. As of the 1990s, the most popular label was the term total quality management, or TQM. Although TQM became a popular label, there was no agreement on what the essential elements of TQM are.

Six Sigma Methodologies:

Six Sigma involves achieving a goal of very few defects, down to 3.4 defects per million. In the past, we used to think in terms of percent defects.

For example 1 % defects is 10,000 defects per million units, a far cry from 3.4. It originally started with Bob Galvin, the former CEO of Motorola and a very ardent follower of excellence in quality. In 1987, he gave his organization the job of improving quality and reducing the defect level by an order of magnitude - to reduce it from a few percent defective to three per million.

The name Six Sigma comes from a measure of what we call process capability, measuring the inherent uniformity of the process. **One of the things that is inherent in tools used to achieve improvement under the label of Six Sigma is the concept of process capability.**

Like Motorola, GE went into quality improvement, encouraged by what Bob Galvin had done at Motorola. Jack Welch personally went into this and achieved huge savings running into the billions of dollars.

Prognosis for the 21st century:

Until the 1980s, the prognosis for the United States was gloomy. Japanese

companies had successfully invaded the U.S. market with products that offered superior quality and value. The resulting public perception then became a force in its own right, continuing to damage those U.S. companies that had been slow to respond.

During the 1980s, the quality crisis deepened despite initiatives taken by many companies. However, a small number of companies distinguished themselves by raising their quality to world-class levels. The results they achieved have been publicized. The methods they used to get those results have also been publicized. **The fact that such results were achieved proved that world-class quality is achievable within the U.S. culture. (If those companies did it, it is "do-able".)**

More recently, some U.S. companies have narrowed or eliminated the gap between Japanese and U.S. quality. That action enabled those companies to regain some of the market share they had lost.

Of course, quality is a moving target, and competitors do not stand still. But the trend remains clear. **The revolution in quality will persist into the next century. The 20th century has been the Century of Productivity, but the 21st century will be the Century of Quality.**

:Questions:

Q1. In due course, there evolved a widely held belief that quality was the responsibility of the inspection department. What are the drawbacks of such a belief?

Q2. What was the initial response of American companies to the success of Japan in 1970's?

Q3. What lessons did the Americans learn from the "role models"?

Q4. What would be your views on the author's comment: "The 20th century has been the Century of Productivity, but the 21st century will be the Century of Quality". Why?

9. SOME APPROACHES TO QUALITY OVER THE YEARS

Quality Approach	Approximate Time Frame	Short Description
Quality Circles	1979 - 1981	Quality improvement or self-improvement study groups composed of a small number of employees (10 or fewer) and their supervisor. Quality circles originated in Japan, where they are called “quality circle.”
Statistical Process Control (SPC)	Mid – 1980s	The application of statistical techniques to control a process. Called “statistical quality control” in Japan.
ISO 9000	1987 - present	A set of international standards on quality management and quality assurance developed to help companies effectively documents the quality system elements to be implemented to maintain an efficient quality system. The standards, initially published in 1987, are not specific to any particular industry, product, or service. The standards were developed by the International Organization for Standardization (ISO), a specialized international agency for standardization composed of the national standards bodies of 147 countries.
Reengineering	1996 - 1999	A breakthrough approach involving the restructuring of an entire organization and its processes.

Benchmarking	1988 - present	An improvement process in which a company measures its performance against that of best-in-class companies, determines how those companies achieved their performance levels, and uses the information to improve its own performance. The subject that can be benchmarked include strategies, operations, processes, and procedures.
Balanced Scored-card	1990s - present	A management concept that helps managers at all levels monitor their results in their key areas like People Development, Customer Satisfaction, Internal Business Processes, and Financial Metrics.
Baldrige Award Criteria	1987 – present	An award established by the U.S. Congress in 1987 to raise awareness of quality management and recognize U.S. companies that have implemented successful quality management systems. Two award may be given annually in each of five categories: manufacturing company, service company, small business, education, and health care. The award is named after the late Secretary of Commerce Malcolm Baldrige, a proponent of quality management. The U.S. Commerce Department's National Institute of Standards and Technology manages the award
Six Sigma	1995 - present	----
Lean Thinking	2000 – present	

10. Differences between Traditional Management and Six Sigma Management

Criteria	Traditional Management Practices	Six Sigma Management
1. Organisation Structure	Views an enterprise as a collection of separate, highly specialized individual performers and units, linked within a functional hierarchy	Views the enterprise as a **system of interdependent processes**, linked laterally, over time, through a network of collaborating (internal and external) suppliers and customers.
2. Role of People	Views people as a commodity, virtually interchangeable and to be developed based on the perceived need of the organization. People are passive contributors with little autonomy.	Views people as the **organisation's true competitive edge.** Leadership provides people with opportunities for personal growth and development. People are active contributors, valued for their creativity and intelligence.
3. Definition of Quality	Quality is the adherence to specifications and standards (i.e. absence of defects). Inspection (Appraisal) is required to control defects.	Quality is defined as products and services that satisfy the present & future needs of customers. Innovation is a necessary expectation.
4. Goals and Objectives	People do not co-operate unless it serves their own or their section's best interests. They compete among themselves.	Self-interest and the greater good are served simultaneously by achieving the Q. C. S. goals. **Cooperation takes the place of internal competition.**
5. Focus of Quality	Focus of Quality is mainly to improve operational and engineering, processes.	Focus of Quality is to **improve all the processes in the** organization.
6. Management Systems	Managers oversee departments and collection of individuals. Quality problems occur when individual people or departments do not do their best.	Managers oversee interdependent systems & processes and exercise **managerial leadership through participative management.** Quality results from the organisation's systems and individuals working together.
7. Management's Role	Management is reluctant to change its success formula.	Management provides leadership for **continual and breakthrough**

	Maintains status-quo by preventing change.	**improvement. Innovation** in processes systems, products and services, is a goal.
8. Teamwork	A hierarchial organization structure promotes department – wise thinking and tends to create competition and conflict.	Formal and informal mechanisms **encourage & facilitate team work** and team development across the entire organization.
9. Supplier Relationships	Suppliers are pitted against each other to obtain the lowest price. Customer encourages competition among its suppliers.	Suppliers are treated as partners by their customers. Partnership aims to **encourage innovation and** cost reduction. Focus is on reducing the number of suppliers and establishing long-term relationships.
10. Control	Control is achieved by pre-established, inflexible responsive patterns laid down as per rules and procedures.	Control results from **shared values and beliefs**, as well as knowledge of organization's vision, purpose and customer- requirements.
11. Customers	Customers are considered outsiders to the organisation and are within the domain of marketing and sales.	Customers and employees all need to be satisfied by some internal or external supplier, as a route to achieving "zero – defect"
12. Motivation	People are motivated through a combination of financial and non – financial incentives.	Managers provide leadership rather than intervening in the processes of their subordinates. Subordinates are viewed as **process – owners.**
13. Competition	The belief is that competition is inevitable and inherent in human nature.	Competitive behaviour is encouraged towards, pleasing the customer, eliminating waste, and defect – reduction.

Q. List the cultural changes required for an organization to move from Traditional Management style to Lean Six Sigma Management style.

Yellow Belts: Creating a Corporate Sense of Inclusion

By Bryan Carey

As the Lean and Six Sigma evolution makes its way throughout the financial services industry and organizations make decisions on how to best spend training dollars, an interesting trend is emerging.

Many companies looking at ways to more broadly incorporate Lean and Six Sigma into their cultures are finding that a general knowledge across the organization may pay bigger dividends than deeper knowledge in a few individual experts.

In other words, a second or third wave of training – following the initial teams of Black Belts or Green Belts – for the remainder of the associate population can effectively foster a broader culture. This approach, often referred to as Yellow Belt training, creates a corporate sense of inclusion.

Conventional thought in the Lean and Six Sigma world has been that an organization should certify one percent of its associate population as Black Belts and five percent (this percentage varies slightly depending on the source) as Green Belts.

Thus, in a company of 1,000 associates this would mean the certification of 10 Black Belts and 50 Green Belts. Assuming that the executive team for this hypothetical organization is made up of 20 Champions and Sponsors, **this leaves more than 900 associates or 90 percent potentially in the dark when it comes to understanding Lean and Six Sigma.**

Such lack of knowledge can be a considerable impediment to successful Lean and Six Sigma rollout at a company level – even, to a certain degree, to the success of the first wave of Black Belt/Green Belt projects. Improvement initiatives do not happen in a vacuum or with mysterious project gurus magically using statistical tools. The projects are carried out in the lines of business and affect the people who make up those businesses as well as the processes and the technology.

Acceptance of Lean and Six Sigma by associates on the line allows the Black Belt / Green Belt to lead the change effectively. Practical knowledge of Lean and Six Sigma at an appropriate level for all associates allows the cultural change to occur from the grassroots.

Far too often this human or cultural infrastructure for Lean and Six Sigma is not addressed.

Addressing the Missing 90 Percent:

Within this construct for deploying Lean and Six Sigma, much effort and emphasis are placed on the methodology itself, the building of a critical mass of expertise in terms of Black Belts and Green Belts, management participation and sponsorship, and an infrastructure defined in terms of tools and governance. Meanwhile that 90 percent of the people-part of the equation gets little or no attention. **The answer to this dilemma is found in a Yellow Belt strategy.**

Utilizing a Yellow Belt strategy prior to building a strong group of Black Belts and Green Belts is not a practical approach. However, if the goal of Lean and Six Sigma is to drive positive change and breakthrough improvement across the entire organization, then using Yellow Belt training as a key component of a well-defined infrastructure is important.

Black Belts and Green Belt project leaders must be on point for making critical-to-customer change at a project level. But they can only be successful over time when the culture of the organization creates a context for such successful change. This occurs within a Lean and Six Sigma infrastructure of tools (project management office, quality management office, data availability, metrics, scorecards, etc.) and cultural support and knowledge (executive sponsorship, Champion training, Yellow Belt training).

In this sense Yellow Belts become the "cultural infrastructure" to support Lean and Six Sigma in the organization. They become allies for Black Belts and Green Belts executing sponsored projects. And they demonstrate Lean and Six Sigma principles in how they carry out their jobs and how they deal with customers.

What Every Associate Should Know:

Understanding what an associate should be able to accomplish after attending Yellow Belt training gives insight into what should be part of the Yellow Belt curriculum. Yellow Belts should think and act differently than they did before training.

They should:

- Understand that data analysis drives business decisions, root cause analysis drives implementation of solutions, and Lean and Six Sigma are all about quality

in terms of voice of the customer.

- Understand the basics of metrics, process capability and process performance.
- Understand the use of data and a scientific approach to goal setting.
- Understand the application of cost-of-poor-quality methodology.

Understand the application of control mechanisms to sustain improvements over time and the continuous process improvement mantra.

Conclusion - Moving to the Next Level of Success:

Some companies limit themselves to a half-day awareness program for their non-certified population of associates. Such an approach is preferable to nothing at all.

However, to best develop a strong infrastructure to support company-wide deployment of Lean and Six Sigma, a more rigorous Yellow Belt training program is a better choice. It is a commitment of time, money and resources, but the payback is well worth the investment. **Priming these associates – 90 percent of the company – to become active partners in change instead of impediments to it will take the organization to the next level of success.**

Q.1. Why is it necessary to address the missing 90% in respect of yellow belt training in an organization implementing Six Sigma?

12. The Malcolm Baldrige National Quality Award

1. The MBNQA is an annual award to recognize U. S. organizations for **performance excellence.** It was instituted in August 1987.

Three awards are given every year in each of the following five categories:

- Manufacturing
- Service
- Small Business
- Health
- Education.

2. The Award is derived from the eight principles of quality management which are also borrowed by ISO – Geneva for establishing the ISO 9001:2008 QMS.

3. Similar awards have been instituted in India by different organizations under names like "Tata Quality Award" and "IMC Ramarkrishna Bajaj National Quality Award".

Leadership thru' Business Excellence

ASCB(E) Accrediting Certifying Bodies UK

Award Categories and Item Listing with Point Values

1	**Leadership**		**110**
	1.1	Leadership System 80	
	1.2	Company Responsibility and Citizenship 30	
2	**Strategic Planning**		**80**
	2.1	Strategy Development Process 40	
	2.2	Company Strategy 40	
3	**Customer and Market Focus**		**80**
	3.1	Customer and Market Knowledge 40	
	3.2	Customer Satisfaction and Relationship Enhancement 40	
4	**Information and Analysis**		**80**
	4.1	Selection and Use of Information and Data 25	
	4.2	Selection and Use of Comparative Information and Data 15	
	4.3	Analysis and Review of Company Performance 40	
5	**Human Resource Focus**		**100**
	5.1	Work Systems 40	
	5.2	Employee Education, Training, and Development 30	
	5.3	Employee Well-Being and Satisfaction 30	
6	**Process Management**		**100**
	6.1	Management of Product and Service Processes 60	
	6.2	Management of Support Processes 20	
	6.3	Management of Supplier and Partnering Processes 20	
7	**Business Results**		**450**
	7.1	Customer Satisfaction Results 125	
	7.2	Financial and Market Results 125	
	7.3	Human Resource Results 50	
	7.4	Supplier and Partner Results 25	
	7.5	Company-Specific Results 125	
		TOTAL POINTS	**1000**

Q. Compare the requirements of Balance Scorecard with the Malcolm Baldrige Assessment Criteria for Business Excellence.

Business Process Reengineering

1. The New World Of Business :

From the end World War II to nowadays, the market structure has changed tremendously. With trade barriers falling, competition from overseas suppliers is increasing.. The market is driven by customers because of excess suppliers. Customers take charge and demand products and services that are designed for their unique need. **As the needs and tastes of the customers change constantly, the nature of change has also changed; it has become both pervasive and persistent.**

Under the of notion of the division of labour principle that divides process into small and clearly defined tasks, classical business structures are no longer suitable in a world where competition, customers and change demand flexibility and quick response.

A good example to show this is order – fulfillment:

It starts when a customer places an order and ends when the goods are delivered. The process **typically involves a dozen steps that are performed by different people in different departments.**

There is no single department who can respond to special requests. No-one is responsible for the whole process and can tell a customer when the order will arrive. **Furthermore, the order passing across different departments makes the process error-prone and also delays progress at every hand-off.**

There are still many other problems. In particular, ***people working in different departments look inward and upward toward their boss and department, rather than outward toward their customers.***

The notion of **business process re-engineering** addresses the problems of the way we should work and the hierarchical structure of organizations.

2. Definition of the Business Process Reengineering(BPR):

The term 'reengineering' was first introduced in 1990 in a Harvard Business Review article: Reengineering Work: Don't Automate, Obliterate. The article's author was Michael Hammer, a former Computer Science professor at the Massachusetts Institute of Technology. Hammer then went on to develop the concept further in a book: Reengineering the Corporation, written jointly with James Champy. **They provided the following definition:**

Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed.

This definition comprises **four keywords**: fundamental, radical, dramatic and processes.

a) Keyword: *Fundamental*

Understanding the fundamental operations of business is the first step prior to reengineering.

Business people must **ask the most basic questions about their companies and how they operate:**

* Why do we do what we do?

* Why do we do it the way we do?

Asking these basic questions lead people to understand the fundamental operations and to think why the old rules and assumptions exist. **Often, these rules and assumptions are found to be inappropriate and obsolete.**

b) Keyword: *Radical*

Radical redesign means disregarding all existing structures and procedures, and inventing completely new ways of accomplishing work.

Reengineering is about **business re-invention**, begins with no assumptions and takes nothing for granted.

c) Keyword: *Dramatic*

Reengineering **is not about making marginal improvements or modification but about achieving dramatic improvements in performance.**

There are <u>three kinds of companies</u> that undertake reengineering in general.

i) Companies that find themselves in deep trouble. They have no choice.

ii) Companies that foresee themselves in trouble because of changing economic environment.

iii) Companies that are in the peak conditions. They see reengineering as a chance to further their lead over their competitors.

d) Keyword: *Processes*

Process is the most important concept in reengineering. In the classic business structure, organizations are divided into departments, and process is separated into simplest tasks distributing across the departments.

The preceding order-fulfilment example shows that the fragmented tasks - receiving the order form, picking the goods from the warehouses and so forth - are **delayed by the artificial departmental boundaries**.

This type of **task-based thinking** needs to shift to **process-based thinking** in order to gain efficiency.

The following example is taken from Hammer and Champy to illustrate the characteristics of reengineering - fundamental, radical, dramatic, and especially process.

3. Example: IBM Credit Corporation

IBM Credit Corporation is in the business of financing the computers, software, and services that the IBM Corporation sells. The IBM Credit's operation comprises of **five steps** as follows:

a) When an IBM field sales representative called in with a request for financing, one of the operators in the central office wrote down the request on a piece of paper.

b) The request was then dispatched to the credit department where a specialist checked the potential borrower's creditworthiness, wrote the result on the piece of paper and dispatched to the next link in the chain, which was the business practices department.

c) The business practices department was in charge of modifying the standard loan covenant in response to customer request. The special terms to the request form would be attached to the request if necessary.

d) Next, the request went to the price department where a "pricer" determined the appropriate interest rate to charge the customer.

e) Finally, the administration department turned all this information into a "quote letter" that could be delivered to the field sales representative.

This entire process consumed seven days on average.

From the sales representative's point of view, this turnaround was so long that the customer could be seduced by another computer vendor. Furthermore, no-one would tell where the request was and when it could be done.

To improve this process, **IBM Credit tried several fixes**:

i) They decided, for instance, to install a control desk, so they could answer the sale representative's question about the status of the request. That is, instead of forwarding the request to the next step in the chain, each department would return the request to the control desk where an administrator logged the completion of each step before sending out the request again.

This fix did indeed solve the problem, however, at the expense of adding more time to the turnaround.

ii) Eventually, two senior managers at IBM Credit took a request and walked themselves through all five steps. They found that performing the actual work took in total only ninety minutes.

Clearly, the problem did not lie in the tasks and the people performing them, but in the structure of the process itself.

In the end, IBM Credit replaced its specialists - the credit checkers, pricers and so on - with generalists. Now, a generalist processes the entire request from beginning to end. **i.e. No handoffs.**

4. How could one generalist replace four specialists?

The old process design was, in fact, found on a deeply held(but deeply hidden) assumption: that every bid request was unique and difficult to process, thereby requiring the intervention of four highly trained specialists.

In fact, **this assumption was false; most requests were simple and straightforward:**

- Finding a credit rating in a database,
- Plugging numbers into a standard model,
- Pulling clauses from a file.

These tasks fall well within the capability of a single individual when he or she is supported by an easy-to-use computer system.

IBM Credit therefore developed a new, sophisticated computer to support the generalists. In most situations, the system provided guidance and data to the generalists. In really tough situations, he or she colud get help from a small pool of real specialists who are assigned to work in the same team.

The new turnaround time was four hours instead of seven days!

The company achieved a dramatic performance breakthrough by making a radical change to the process, which is the definition of reengineering.

IBM Credit did not ask questions like:

- "How do we improve the calculation of a financing quote?
- "How do we enhance credit checking?"

Instead It asked, "How do we improve the entire credit issuance process?"

Moreover, in making this radical change, IBM Credit **shattered the assumption that every request needed specialists to perform.**

5. Defining the challenges:

The preceding example appears simple and attractive. However, the more closely we look at it, the more questions about the benefits of reengineering arise.

a) What are the underlying costs for the implementation of the radical change?

People **need intensive training for their new skills and their styles** - the ways in which they think and behave - and their attitudes - what they believe is important about their work.

b) What are the implications of the radical change to the organization, especially the human issues?

Organizations are communities of people who cannot be treated as machines. **People may resist the change and fear losing their jobs.** Inspirations and cultures may therefore get disturbed during reengineering.

Furthermore, reengineering requires people to **take more responsibilities**

and to learn and change constantly. These may contradict the majority people who seek for stability for their lives.

c) Even if the company provides intensive training, can people change their styles?

People who are used to think that the purpose of their work is to perform the same task over and over again, may feel uncomfortable to change to the new style which focuses on "creating value for the customer and taking responsibility for the performance of an entire process."

6. Major Steps in the Reengineering Process:

a) Make the customer the starting point for change

b) Identify the process to be redesigned – focus on critical processes

c) Establish a cross-functional team

d) Understand and measure the existing process

e) Develop the process objectives

f) Redesign the process, looking at the objectives to be achieved

g) Study the suitable technology options and identify the one most appropriate in the situation

h) Design and build a prototype of the process

i) Verify the process

k) Implement the reengineered process.

7. The Enabling Role of Information Technology:

Information technology (IT) can play a crucial role in business reengineering as an essential enabler.

However, most people misuse the technology. **They look at the technology through the lens of their existing tasks.** i.e. they only computerize the old existing tasks.

Consider the case in IBM Credit. It might have tried to digitalize the request application and to send it to different departments by a computer network. Such computerization would have accelerated the time that required to move pieces of paper from one department to another, but it also would have increased the queuing time in each departments. **Hence, it would have done nothing to the overall process.**

The structure of the old process was still unchanged. In contrast, the company attained more than 90% improvement through reengineering.

State of the art information technology allows to break conventional rules / assumptions of processes. **These rules were designed when the processes were created.** Therefore, the rules may be no longer valid nowadays. As the preceding example has been showed, IBM Credit used the sophisticated computer system to break the assumption that every request has to be examined by different specialists.

IT should not be involved in the redesign process. Redesigning process is like programming. When solving a problem, we first outline and design the solution at the top level, then implement it by a suitable language, e.g. C or Prolog. **The language itself should never constrain the design.**

It is the same concept here: IT should not constrain the redesign in reengineering. After the redesign, we can look for the best technology to implement it. Similarly, past investments in IT should not be allowed to constrain the redesign.

Reengineering is about reinventing processes while IT is just a tool.

8. Concluding Remarks:

Reengineering can lead to breakthrough changes for the business and the people.

It may be easy to change the process by reinventing a way to work. However, the other part i.e. people, is very difficult to change. **In particular, it requires not only jobs and skills change but also people's styles - the ways in which they think and behave - and their attitudes - what they believe is important about their work.**

These are very important factors to determine whether reengineering succeeds or not. Leaders have to, therefore, help people to cope with these changes.

Self - Study (BB) Question Set

Q. 1. What are the major steps required in Business Process Re-engineering (BPR)?

Q. 2. What is the role of I. T. and technology in BPR

Q. 3. How is BPR different from DMAIC?

Managing Six Sigma Change Resistance

By Richard Bellanca

A critical component of any successful Six Sigma project is to overcome resistance to change. The reason: Without user acceptance, any process improvement is doomed to fail.

Therefore, proper anticipation and understanding the approaches to various resistance tactics is essential to success.

People resist change in the workplace in many ways, but among the **more common examples** are to:

- Ignore the new process
- Fail to completely or accurately comprehend
- Disagree with the validity of benefits
- Criticize tools or software applications
- Grant exceptions
- Delay the implementation

Here are several approaches that can be used to counter these occurrences.

1. Ignore the new process:

Those who react this way to change simply believe the new process will go away if no one uses it. There is validity to this approach. Any process change will certainly fail if it is not indoctrinated into business behavior. It is imperative for the process champion to provide examples that the process is ingrained with other existing business processes.

Make the process impossible to ignore. This can be accomplished by **tying the success of the process to personal training plans, annual review, and other well-established business processes.**

2. Fail to completely or accurately comprehend:

Proper training is critical for ensuring people adapt to a new process, especially when they have become accustomed and experienced in another process. Specifically, try using:

* Clarifying communication: Examples include newsletters, email, and articles

* One-on-one training: Some absorb change better in a smaller setting, this allows them to ask questions and gain acceptance at their pace.

* Check-lists: These offer helpful advice and guidance to those who may be unclear about the process. The tools can be small enough to place as a postcard next to the PC or located on the Intranet as a quick reference.

3. Disagree with the validity of benefits:

The validity of the change can be strengthened by recommendations from independent sources. Evidence that other companies or departments have been successful with similar efforts can assist in gaining acceptance. It becomes difficult to argue against change when there is a proven track record in place by others. **Before rolling out the new process, do your research and be prepared to cite examples of success stories.**

4. Criticize tools or software applications:

Another common point of resistance is to cite the inflexibility with the software tool or application that supports the process. Ensuring that there is a feedback loop for tool enhancements is important. This allows for user suggestions and continuous improvements. It provides a level of participation and input when the changes that are recommended. A sense of ownership and contribution becomes apparent. **This does not necessitate that all recommendations be implemented but it does allow for win-win scenarios to develop.**

5. Grant exceptions:

Allowing exceptions to the change in process typically is a way to ensure failure. This has the potential to spiral out of control as others attempt to be granted the same exceptions. Worse yet, others will attempt to expand exceptions. Soon the process is left dangling as an exception; in essence the exceptions become the process.

Additionally, once exceptions are granted, many business case assumptions are thrown into disarray. In most instances the business case assumptions are based on full usage of the process improvement, not exceptions. Once exceptions are allowed less than 100 percent benefit potential is realized.

6. Delay the implementation:

Others attempt to delay the implementation with suggestions that this is not the right time for change. **Honestly, there is never a right time for change.** There will always be internal and external factors that will have competing influence with the process improvement.

If the process improvement truly has business benefits, the sooner the implementation is established the sooner business value can be realized.

Here are a few other ideas to help blunt resistance to change.

1. If your organization is going through a great deal of change, acknowledge the fact. Change is a constant in most organizations and many times its instigation is not the choice of management. Changes can be caused by employee and management turnover, changes in market conditions or economic fluctuations.

2. Keeping people informed about upcoming change is critical. This avoids the surprise and fear that arises from uncertainty. A formal communication plan should be created that includes the message, frequency of the message, audience and feedback. Vary the message vehicle; don't just send emails, present to small groups and larger groups, use newsletters and other available forms of communication.

3. It is essential to assure people that the change process is well planned, and that a variety of contingencies have been thought through.

This article may provide insight into change resistance, but the best way to address the issue is to be ready with ways to counter it in your Six Sigma project - because it will be there.

About The Author:
Richard Bellanca is employed at Bank of America. He has a BS in accounting from St. John Fisher College, an MBA from Syracuse University and more than 12 years experience in the financial services industry.

Self - Study (BB) Question Set

Q. 1. How do people in the organization react to new initiatives like Six Sigma?

Q. 2. What strategies can be used to reduce the resistance to change?

SIX SIGMA: BENEFITS TO AN ORGANIZATION

1. Generates Sustained Success:

Six Sigma creates the skills and culture for continued innovation and sustained growth, for all times to come. It is not a short-lived programme or a fad.

2. Sets a Performance Goal for Everyone:

Six Sigma ensures that everyone in the organization works in the same direction and focuses on a common goal. This is a real challenge as the organization grows in size.

Each function, business unit, and individual has different objectives and targets. But everyone has to achieve the Q.C.S goals for the organization and this is common to all.

Six Sigma uses the **common business framework -** the process and the customer – to create a consistent goal i.e. the Six Sigma performance.

3. Enhances Value to Customers:

Six Sigma ensures that people in the organization try to understand exactly what is "value" to their customers (existing and future).

This leads to a more concentrated effort for delivering value to the customers.

4. Accelerates rate of improvement:

Six Sigma borrows the tools and ideas from many disciplines and enables the organization not only to improve, but to improve in leaps & bounds.

5. Promotes Learning & Cross – Pollination:

Six Sigma increases and accelerates the development and sharing of new ideas throughout the organization. People in one division may be shifted to another for faster deployment of ideas.

Best practices may be picked up from one industry and applied in another e.g. Motorola improved their delivery schedules by studying the methods used in Dominos.

6. Executes Strategic Change:

A better understanding of the organization's processes and procedures improves its ability to introduce new products, launch new ventures, enter new markets with lower risks and better chances of success.

SECTION – B

(ADDITIONAL MATERIAL)

1. DPMO (PPM) Changes when sigma quality level changes

Sigma quality level	**Process Mean Coinciding with Target of Specifications**		**Process Mean <u>with 1.5 sigma shift</u>**	
	Non-defect rate (%)	**DPMO (ppm)**	**Non-defect rate (%)**	**DPMO (ppm)**
1.0	68.26894	317,311	30.2328	697,672
2 .0	95.44998	45,500	69.1230	308,770
3.0	99.73002	2,700	93.3189	66,811
4.0	99.99366	63.4	99.3790	6,210
5.0	99.999943	0.57	99.97674	233
6.0	99.9999998	0.002	99.99966	3.4

2. Relationship between C_p, C_{pk} and Sigma level

C_p	C_{pk} (Assuming 1.5 Sigma Shift)	Quality level (Sigma Level)
0.50	0.00	1.5
0.67	0.17	2.0
0.83	0.33	2.5
1.00	0.50	3.0
1.17	0.67	3.5
1.33	0.83	4.0
1.50	1.00	4.5
1.67	1.17	5.0
1.83	1.33	5.5
2.00	1.50	6.0

3. Productivity Vs Quality - Approach to Improvement

	(a) Company A	
	Before demand for 10 % productivity increase (By Management)	After demand for 10 % productivity increase (By Management)
Parts produced	100 units	110 units
Parts defective	10 units	22 units
Good parts	90 units	88 units
	(b) Company B	
	Before improvement	**After improvement**
Parts produced	100 units	100 units
Parts defective	10 units	5 units
Good parts	90 units	95 units

Deming (1986), looking at the relationship between quality and productivity, **stressed upon improving quality in order to increase productivity.**

To become an excellent company, the management should find ways to improve quality as well as productivity simultaneously. The Benefits:

- Productivity rises
- Quality improves
- Cost per good unit decreases.
- Price can be cut
- Workers' morale improves because they are not seen as the problem.

a) Stressing upon productivity alone may mean sacrificing quality and possibly decreasing output.

b) Stressing upon quality one may mean sacrificing productivity and possibly leading to high cost.

Therefore quality and productivity should go together, and neither one should be sacrificed.

Overview of Six Sigma

What is Six Sigma?

A statistical concept that says that a process is operating so well that it allows for less than **3.4 defects per million** opportunities.

The Greek letter ó in statistics measures the variation of all the outputs in a process. If a process allows for outputs to be acceptable only if they fall within Six Sigma or Six standard deviations from the average for all outputs in the process, then you have a process that is practically delivering no defective outputs.

Six Sigma is a long-term strategy and can take 3 to 10 years to implement. It is applicable to all types of industries and companies in both, manufacturing and services.

Objective of Six Sigma:

The objective of the `Six Sigma' approach is to move towards zero defect level. It **includes all business processes** such as planning, purchase, operations, quality control, maintenance, human resources, sales, delivery, etc. which could lead to dissatisfaction of customer (internal or external).

It creates a better process by eliminating opportunities for defects even before they can occur. This has a direct impact on the organization's profitability in terms of:

- Reduced defects / mistakes,
- Waste elimination,
- Improved customer –satisfaction.

When we say a process is `Six Sigma', we are saying that it is the best in its class. Such a level of capability will result in having less than 3.4 non-conformances (defects) in a million opportunities.

Six Sigma – Impact on Cost:

Studies have shown that Six Sigma has a direct impact on Cost of Quality by increasing cost of conformance and substantially reducing the cost of non-conformance, in turn.

Why Six Sigma?

Lets take an example. In a factory manufacturing edible oils, the nozzle filling up the cans often fills either excess or less than the specified quantity. In the first case, oil overflows out of the cans thus soiling the cans as also as the conveyor belt. For cans that are less-filled, oil is poured manually into the cans, and in this process too

the result is sticky cans. To clean the cans, hot water needs to be sprayed on the cans and then the cans have to be wiped.

Thus we see that a single error often goes unnoticed or is not given much importance. But when all the possible errors that exist in a system are considered, the combined impact on overall productivity, customer satisfaction and profitability multiplies dramatically.

Six Sigma helps us to identify what we might not be knowing, indicates what we should know, and helps us to reduce the errors and rework thereby saving us time and money.

Why Process Focus?

Six Sigma's focus is on the process rather than on the final outcome.

But why should an organization focus on the process rather than on the final outcome? Because, final outcomes or results are dictated by what happens during the process.

You may have developed a new type of software in say, 3 months. But if your emphasis was on the final outcome, you would not have kept a check on the process. In case you are asked to develop the same software again, you might repeat the same mistakes, and come across the same problems as on the previous occasion since you have only your memory to fall back upon.

On the other hand, if the process was documented, you or anyone else can repeatedly achieve the same output again and again. You would also avoid making the same mistakes.

An Executive Overview of Six Sigma: A Powerful Strategy for Sustained Success

THE MOST CHALLENGING question confronting business leaders and managers in the new millennium is not "How do we succeed?" It's: **"How do we stay successful?"**

Business today offers the spectacle of a succession of companies, leaders, products, and even industries getting their "15 minutes of fame" and then fading away. Even corporate powerhouses-the IBMs, Fords, Apples, Kodaks, and many others-go through dramatic cycles of near-death and rebirth. It's like riding the wheel of fortune as consumer tastes, technologies, financial conditions, and competitive playing fields change ever-more-quickly. In this high-risk environment, the clamor for ideas on how to get the edge, stop the wheel (while on top, of course), or anticipate the next change gets louder and louder. Hot new answers are almost as common as hot new companies.

Six Sigma can seem like another "hot new answer." But looking closer, you'll find there is a significant difference: Six Sigma is not a business fad tied to a single method or strategy, but rather **a flexible system for improved business leadership and performance. It builds on many of the most important management ideas and best practices of the past century,** creating a new formula for 21st-century business success.

It's not about theory, it's about action. Evidence of the power of the Six Sigma Way is already visible in the huge gains tallied by some very high-profile companies and some not-so-high-profile ones. Just as important, though, is the role Six Sigma plays in building new structures and practices to support sustained success.

Some Six Sigma Success Stories:

Seeing the impact that Six Sigma is having on some leading companies sets the stage for understanding how it can impact your business. As we relate some of these results, we'll also be reviewing the history that has brought Six Sigma to the forefront.

General Electric:

Jack Welch was told that Six Sigma, the quality program pioneered by Motorola, could have a profound effect on GE quality.

Although skeptical at first, the GE Chairman initiated a huge campaign - **in the GE Way, a way that had never been done before - to infuse quality in every corner of the company. He made quality the job of every employee**. Senior manager's bonuses were tied to Six Sigma results. All professional level employees were informed that they had to get Six Sigma training or they would not be considered for a promotion – no belt,

no promotion. Welch credits the Six Sigma quality initiative with "changing the DNA of the company", meaning that it has had a greater impact on the productivity of GE than any other program.

The hard numbers behind GE's Six Sigma initiative tell just part of the story. From an initial year or so of break-even efforts, the payoff has accelerated: $750 million by the end of 1998, a forecasted _$1.5 billion by the end of 1999, and expectations of more billions down the road. Some Wall Street analysts have predicted $5 billion in gains from the effort, early in the decade. GE's operating margins-for decades in the 10 percent range-continue to hit new records quarter after quarter.

The numbers are now consistently above 15 percent, and even higher in some periods. **GE leaders cite this margin expansion as the most visible evidence of the financial contribution made by Six Sigma.**

Improvements from Services to Manufacturing:

The financial "big picture," though, is just a reflection of the many individual successes GE has achieved through its Six Sigma initiative. For example:

- A Six Sigma team at GE's Lighting unit repaired problems in its billing to one of its top customers- WalMart -cutting invoice defects and disputes by 98 percent, speeding payment, and creating better productivity for both companies.

- A group led by a staff attorney-a Six Sigma team leader-at one of GE Capital's service businesses streamlined the contract review process, leading to faster completion of deals-in other words, more responsive service to customers-and annual savings of $1 million.

- GE's Power Systems group addressed a major irritant with its utility company customers, simply by developing a better understanding of their requirements and improving the documentation provided along with new power equipment. The result: Utilities can respond more effectively to their regulatory agencies, and both the utilities and GE have saved hundreds of thousands of dollars a year.

- The Medical Systems business-GEMS-used Six Sigma design techniques to create a breakthrough in medical scanning technology. Patients can now get a full-body scan in half a minute, versus three minutes or more with previous technology. Hospitals can increase their usage of the equipment and achieve a lower cost per scan, as well.

- GE Capital Mortgage analyzed the processes at one of its top performing branches and-expanding these "best practices" across its other 42 branches-improved the rate of a caller reaching a "live" GE person from 76 to 99 percent. Beyond the much greater convenience and responsiveness to customers, the improved process is translating into millions of dollars in new business.

The Actions behind the Results GE's successes are the result of a "passionate" commitment and effort. Notes Welch: "In nearly four decades with GE I have never seen a Company initiative move so willingly and so rapidly in pursuit of a big idea."

Tens of thousands of GE managers and associates have been trained in Six Sigma methods - a hefty investment in time and money (which is appropriately deducted from the gains cited earlier). **The training has gone well beyond "Black Belts" and teams to include every manager and professional at GE** - and many front-line people as well. They've instilled a new vocabulary revolving around customers, processes, and measurement.

While dollars and statistical tools seem to get the most publicity, the emphasis on customers is probably the most remarkable element of Six Sigma at GE. As Jack Welch explains it:

The best Six Sigma projects begin not inside the business but outside it, focused on answering the question-how can we make the customer more competitive? What is critical to the customer's success? **One thing we have discovered with certainty is that anything we do that makes the customer more successful inevitably results in a financial return for us.**

Motorola:

Today, the very existence and success of electronics leader Motorola is tied to Six Sigma. It's the company that invented the concepts that have evolved into this comprehensive management system. **And while GE has used Six Sigma to strengthen an already thriving company, for Motorola it was an answer to the question: How do we stay in business?**

In the 1980s and early 1990s, Motorola was one of many U.S. and European corporations whose lunch (along with all other meals and snacks) was being eaten by Japanese competitors. Motorola's top leaders conceded that the quality of its products was awful. They were, to quote one Motorola Six Sigma veteran, "In a world of hurt." Like many companies at the time, Motorola didn't have one "quality" program, it had several. But in 1987, a new approach came out of Motorola's Communications Sector-at the time headed by George Fisher, later top exec at Kodak. The innovative improvement concept was called "Six Sigma."

Facing stiff competition by Japanese manufacturers, Motorola reversed its fortunes with the Six Sigma strategy instituted by its Chairman, Bob Galvin. These programs were led by corporate and then institutionalized. Motorola's Six Sigma quality program was so radical that it forced managers to think about the business differently. As a result, they smashed the old inspection paradigm.

As it spread throughout the company-with the strong support of Bob Galvin-Six Sigma gave Motorola extra "muscle" to drive what at the time seemed like impossible improvement goals. While the objective of "Six Sigma" was important, much more attention was paid to the rate of improvement in processes and products.

What Six Sigma offered Motorola - though it involves much more today-was a simple, consistent way to track and compare performance to customer requirements (**the Sigma measure**) and an ambitious target of practically-perfect quality (the Six Sigma goal).

Motorola's "turnaround" has been just as remarkable over the long term as GE's results in just a few years. Only two years after launching Six Sigma, Motorola was honored with the Malcolm Baldrige National Quality Award. The company's total employment has risen from 71,000 employees in 1980 to over 130,000 today. Meanwhile, in the decade between Six Sigma's beginning in 1987 and 1997, achievements have included the following:

- Five-fold growth in sales, with profits climbing nearly 20 percent per year
- Cumulative savings based on Six Sigma efforts pegged at $14 _billion
- Motorola stock price gains compounded to an annual rate of 21.3 percent.

All this, in a business whose future was in jeopardy in the early 1980s. (While the late 1990s presented some tough challenges for Motorola-based largely on setbacks and competition in the cellular and satellite telephone businesses-the company seems to be turning the corner in late 1999, with most areas back in the black.)

The results Motorola has achieved at the corporate level again have been the product of hundreds of individual improvement efforts affecting product design, manufacturing, and services in all its business units. Alan Larson, one of the early internal Six Sigma consultants at Motorola who later helped spread the concept to GE and AlliedSignal, says projects affected dozens of administrative and transactional processes. In customer support and product delivery, for example, improvements in measurement and a focus on better understanding of customer needs-along with new process management structures-made possible big strides toward improved services and on-time delivery.

More than a set of tools, though, Motorola applied Six Sigma as a way to transform the business, a way driven by communication, training, leadership, teamwork, measurement, and a focus on customers (themes we'll be seeing plenty of throughout this book). As Larson notes: "Six Sigma is really a cultural thing-a way of behavior."

AlliedSignal/Honeywell:

AlliedSignal-with the new name of "Honeywell" following its 1999 merger-is a Six Sigma success story that connects Motorola and GE. It was CEO Larry Bossidy -a longtime

GE executive who took the helm at Allied in 1991- who convinced Jack Welch that Six Sigma was an approach worth considering. (Welch had been one of the few top managers not to become enamoured of the TQM movement in the 1980s and early 1990s).

Allied began its own quality improvement activities in the early 1990s, and by 1999 was saving more than $600 million a year, thanks to the widespread employee training in and application of Six Sigma principles.

Not only were Allied's Six Sigma teams reducing the costs of reworking defects, they were applying the same principles to the design of new products like aircraft engines, reducing the time from design to certification from 42 to 33 months. The company credits Six Sigma with a 6 percent productivity increase in 1998 and with its record profit margins of 13 percent. Since the Six Sigma effort began, the firm's market value had- through fiscal year 1998-climbed to a compounded 27 percent per year.

Allied's leaders view Six Sigma as "more than just numbers-it's a statement of our determination to pursue a standard of excellence using every tool at our disposal and never hesitating to reinvent the way we do things." As one of Allied's Six Sigma directors puts it: ***"It's changed the way we think and the way we communicate. We never used to talk about the process or the customer; now they're part of our everyday conversation."***

The Six Sigma Wave:

As we've noted, it might be easy to dismiss Six Sigma as a fad - if it weren't for the caliber of the results it's producing and the companies adopting it.

In almost an antifad mentality, in fact, a number of prominent companies in industries from financial services to transportation to high-tech are quietly embarking on Six Sigma efforts. They're joining others who have been more vocal about their efforts, including Asea Brown Boveri, Black & Decker, Bombardier, Dupont, Dow Chemical, Federal Express, Johnson & Johnson, Kodak (which had taken in $85 million in savings as of early 2000), Navistar, Polaroid, Seagate Technologies, Siebe Appliance Controls, Sony, Toshiba, and many others.

6. EXERCISE: QUALITY FUNCTION DEPLOYMENT

Example: Call Center Services

1. High Caller Satisfaction Rating
2. No. of transfer during a service call to be minimum
3. Lowest possible wait-time during a service call
4. Service-time during call (time spent on answering questions, giving problem-solving advice, etc.) should be low
5. Call-cost to be most economical.

Technical Requirement:

1. Caller Satisfaction rating must be more than 80% (Industry Trend: 73 – 86%)
2. No. of transfers (to different agents and help systems) must not exceed 3 nos. (Industry Trend: 2 to 5)
3. Wait-time not to exceed 45 secs. (Industry trend: 30 secs to 2 mins.)
4. Service-time during call not to exceed 5 mins (Industry trend: 4 to 8 mins.)
5. Support-cost per call targeted as Rs.150/- (Industry Trend: Rs.130/- to Rs.170/-).

7. EXERCISE: QUALITY FUNCTION DEPLOYMENT

Example: Synthetic Carpet for Car

Customer Requirements:

1. Bridge colour
2. Washable
3. Quick to dry
4. Must not attract dust
5. Should last at least for 2 years
6. Must not support flames in case of a burning matchstick falls on carpet

Technical Requirements:

1. Synthetic Fibre (Polypropylene grade – A)
2. Non woven type technology (80 needle punches per sq. cm.)
3. Thickness 4 mm + / - 0.3mm
4. Minimum density 500 gm per sq. metre
5. Tear strength greater than 3 Kgf.
6. Melting point above 140 degree Celsius.

CASE STUDY – Credit Card fraud for businesses who accept credit cards over the Net

There has been a tremendous increase in the number of merchants who have been scammed by crooks who place fraudulent orders using stolen credit card information. Unfortunately, merchants are not provided the same protection as consumers when it comes to credit card fraud. In fact, merchants are completely at risk.

HIFI Departmental Stores experienced its first encounter with credit card fraud last month. Someone stole a credit card account number, then used the stolen number to purchase a Rs.4000/- product from HIFI. The crook knew the cardholder's correct address, provided HIFI with that information, but requested that the product be shipped to a different address.

Since it's quite common for customers to request a "ship to" address which is different than the "bill to" address, HIFI didn't think much of it. As per policy, HIFI sent the invoice to the "bill to" address. A few days later HIFI got a call from the customer (whose card number was stolen) informing that he never purchased anything from them.

This particular scamster used one of the free email services (like hotmail) to open an email account in the stolen cardholder's name -- which made the transaction appear more legitimate. HIFI informed the e-mail service's security department of the fraud taking place. They confirmed that they have shut down the scamster's account after receiving HIFI's complaint.)

HIFI contacted the banks and the merchant providers involved, and even contacted the police. The banks, merchant providers and police were not able to help -- mainly because they were too busy or felt that the amount involved (Rs.4000/-) was not significant enough to warrant further action.

On further research as to how other merchants handle this problem, HIFI discovered that credit card fraud has become (and is quickly becoming) a serious problem for many Internet merchants. In fact, given the scope of this problem, HIFI were surprised this issue has not received much publicity.

HIFI also discovered that crooks can now create fictitious credit card numbers based on the algorithms used to produce authentic numbers. These fictitious credit card numbers pass through verification and could be given approval codes. Further, there are newsgroups which post stolen credit card data (so if your card number is stolen, it may be posted to the world in a matter of minutes).

Suppose, that your bank is planning to enter the credit-card business. Perform a Design FMEA to minimize the risk for merchants. Also develop a quality control plan for the process.

Some Steps To Minimize Credit Card Fraud For Merchants

1) Validate each order i.e. don't accept orders unless complete information is provided (including full address and phone number). Address Verification for all credit card orders is alos useful.

2) Be wary of orders with different "bill to" and "ship to" addresses. For anyone who uses a different "ship to" address, ask him send a fax with his signature and credit card number authorizing the transaction.

3) Be especially careful with orders that come from free email services – there is a much higher incidence of fraud from these services (hotmail.com, yahoo.com etc.). Many businesses won't even accept orders that come through these free email accounts anymore. That's because it's so easy for a scamster to open a free, anonymous email account in another person's name and then send the merchant an order using the fake email account with a fraudulent credit card number.

What precautions should you take with orders from free email accounts? We recommend sending an email requesting additional information before you process the order. More specifically, ask for: a non-free mail address, the name and phone number of the bank that issued the credit card, the exact name on credit card, and the exact billing address. Often, you won't get a reply. If you do, you can easily verify the information (which you should take the time to do).

4) Be especially wary of orders that are larger than your typical order amount, and orders with next day delivery. Crooks don't care what it costs, since they aren't planning on paying for it anyway.

5) Pay extra attention to international orders. Do everything you can to validate the order before you ship your product to a different country. Never ship international orders which have different "bill to" and "ship to" addresses.

6) If you're suspicious, pick up the phone and call the customer to confirm the order. It will save you a lot of time, and money, in the long run.

7) If you (as a merchant) do have the misfortune of being scammed by a credit card thief, you should contact your merchant processor immediately and inform them of the situation. They might be able to give you the name and number of the cardholder's bank. Then you can contact the cardholder and inform him that his card number has been stolen. (Many people aren't even aware that their card number has been stolen).

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CASE STUDY

FMEA Workshop Exercise : Bottling Operation

a) Perform a Process FMEA on the soft drink bottling operation outlined below and illustrated in the block diagram on Page 61.

b) Based on the FMEA performed per Part (a) above, develop a Quality Control Plan for the process.

PROCESS :

1. Water filtered to remove any particulate matter that may be present. Filter material (membranes in tandem) has been found to degrade with use.

2. Water boiled for 5 minutes (tolerance : 0.5 minutes) in 1000 gallon stainless steel chamber which is electrically heated.

3. Water then mixed with syrup and fruit juice. 80% water, 10% syrup and 10% fruit juice (all tolerances 0.5%) and subsequently transferred to the filling station (filler).

4. Addition of preservative : 0.05% by weight (0.5 gms. per 1000 grams of liquid. Tolerance : $\pm$ 0.005%)

5. Glass bottles sterilized in heat chamber. 150^{0}F for 7 minutes (tolerance 10% on time and temperature)

6. Filler must dispense 12oz. (tolerance $\pm$ 0.5 oz.) of liquid (soft drink) into glass bottle

7. Carbonation : Gas pressure : 10 psi $\pm$ 0.5 psi

8. Bottle is capped robotically. 7 inch pounds (tolerance $\pm$ .2 inch pounds) of torque is required. Excessive torque will induce crack in bottle, low torque will allow leakage.

9. Bottles labeled manually. Self adhesive labels purchased from outside supplier. Two separate (different) labels placed on each bottle.

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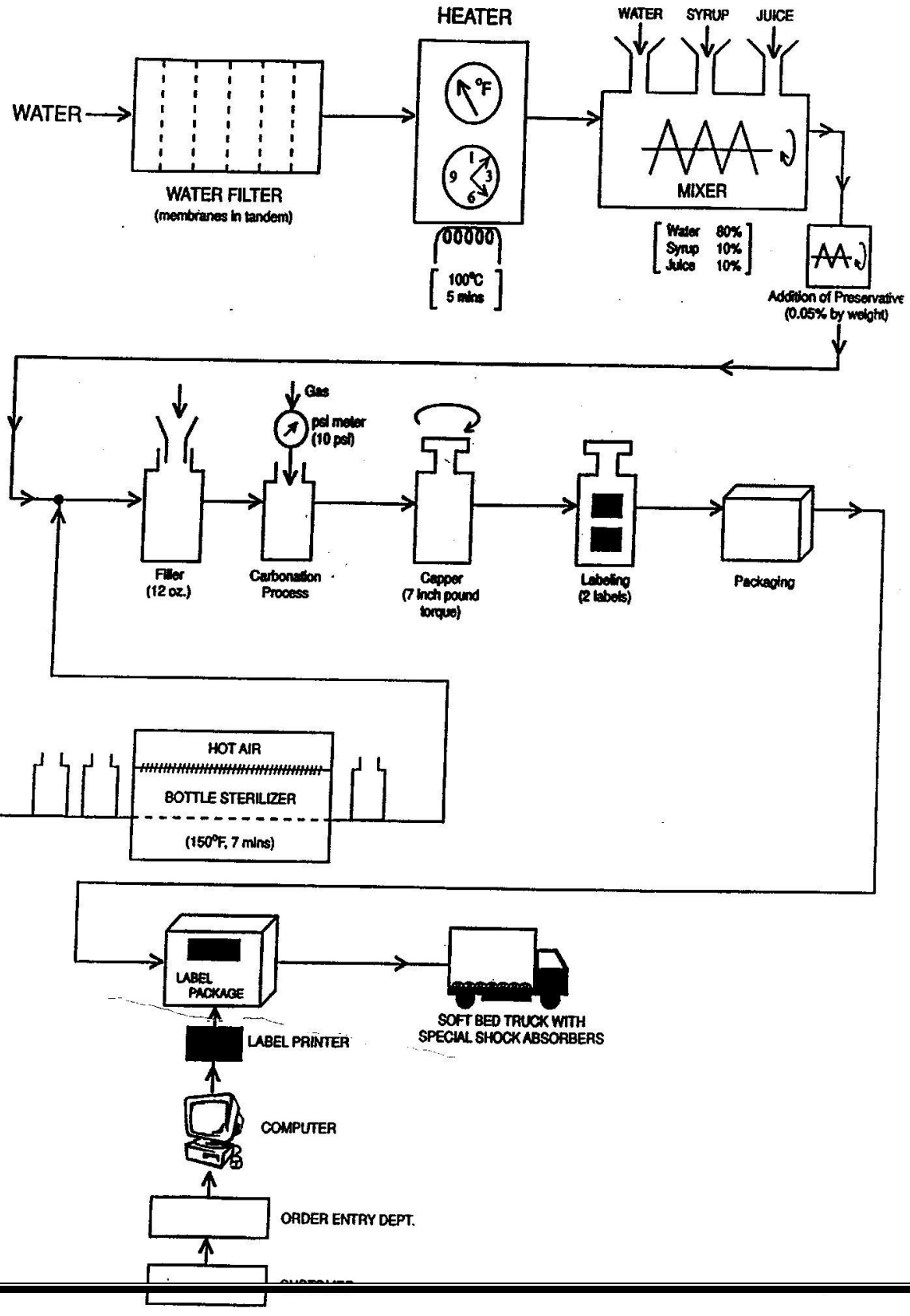
Process FMEA Workshop Exercise : Bottling Operation (continued)

10. Bottles packaged in cardboard containers which are then sealed. 20 bottles per container.

11. Container labeled (shipping label). The label is self adhesive and information on label is generated from a computer based on customer order which specifies quantity, address, etc.)

12. Containers are shipped in company's own trucks which are equipped with a "soft bed" rubber liner and special "air shocks" to reduce mechanical shock to the shipped product. Previously, when when "regular" trucks were used, approximately 2 to 4 % of shipped product arrived damaged at its destination.



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DESIGN FMEA WORKSHEET - PART 1

Process Steps	Potential Failure Mode (What can go wrong or fail)	Potential Effect/s of the Failure Mode	Severity	Critical or Significant	Potential Causes of the Failure Mechanism	Occurrence	Design Verification. (Actions taken to ensure good design)	Detection	RPN	Any anticipated "abuse" by customer that will increase RPN (risk)	Revised RPN

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DESIGN FMEA WORKSHEET - PART 2

Recommended Action/s to Improve RPN (if possible)	Responsibility for completing action (name*)	Actions actually taken	Severity	Occurrence	Detection	Revised RPN

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Control Plan

Process Step	Requirement	Control Imposed	Equipment Used	Checked by	Action Plan if Out of Control Condition Occurs

Healthcare Organizations: What To Do When The Low-Hanging Fruit Is Gone

By Tom Long, MBA, RT(R), CCVT, CCPT

The cost of providing high quality services within the healthcare organization has increased significantly over the past one or two decades, primarily due to decreased payments and the increased cost of doing business.

This has led many organizations to seek outside help in order to find and develop additional methods of reducing costs and increasing revenues. In addition, customer satisfaction has remained, appropriately so, as a non-negotiable component of providing care.

This article will describe in very general terms one extremely successful method utilized to achieve reduction of cost, increased revenues and heightened customer satisfaction while maintaining high levels of quality.

Healthcare Organizations And Consultants:

Over the past decade, the need and desire for healthcare institutions to operate more efficiently has been driven largely by financial concerns. With decreasing reimbursements and the rising cost of labor and supplies, healthcare organizations have been driven to look within to find savings.

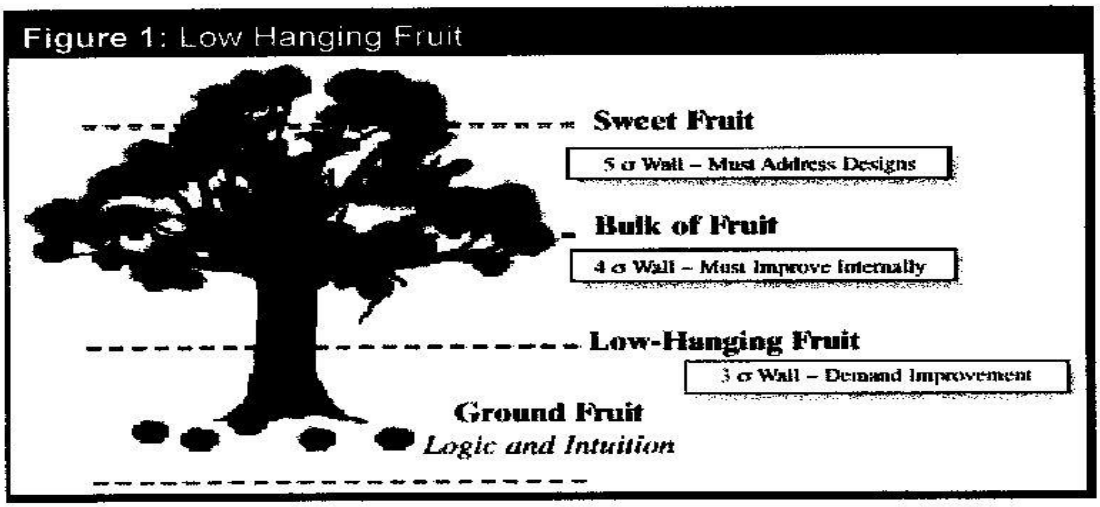
Generally, the accepted rule has been that there are two primary areas to find savings, either through reductions in labor costs or by reducing the high cost of supplies. With the continuing shortage of qualified healthcare professionals, registered nurses, registered radio-technologists, etc., the opportunities to reduce expenses by reducing labor costs are neither advisable nor generally accepted as the answer to cost reduction initiatives. Morale and productivity potentially fall victim to this tactic. Additionally, pursuing all revenue growth opportunities can serve to offset many of the factors associated with increased costs. As one CEO said, "revenue growth cures many sins associated with cost."

Revenue growth aside, **cost reduction measures associated with inventories are seemingly the only opportunity left to find much-needed dollars.** Liquidity of monies associated with inventory has improved over the last decade; however, so has the increased cost of those supplies. A perfect example of this

may be found in the cost of stents for coronary and peripheral use and now drug-eluting stents. As better management of inventories has occurred, the associated savings have been negated by the increased cost of technologies, i.e., stents. This may make it seem like a catch-22 for a healthcare organization.

However, with good management, improved physician cooperation in the purchasing process and enhanced relationships with the suppliers, many institutions have kept slightly ahead of the curve in cost containment.

Figure 1: Low Hanging Fruit



These measures have harvested what many refer to as "the low-hanging fruit" of cost containment (see Figure 1).

Seasoned managers and administrators, through experience, logic and intuition, have harvested the low-hanging fruit of cost efficiency and productivity. The demand for more efficient use of capital dollars as well as labor has driven many organizations to ask whether they can continue to provide these potentially life-saving procedures. This obviously has a negative impact on public perception of the healthcare organization. How do we continue to provide these services, remain competitive and at the same time not lose dollars on the service in question? The answer may lie in Six Sigma.

Six Sigma:

First, what Six Sigma is not. It is not a secret society, a slogan or a cliché. Six Sigma is a highly disciplined process that helps an organization focus on developing and delivering near-perfect products and services. Why "Sigma" (s)? It's a statistical term that measures how far a given process deviates from

perfection. The central idea behind Six Sigma is that if you can measure how many "defects" you have in a process, you can systematically figure out how to eliminate them and get as close to "zero defects" as possible. More about that later.

For many years, healthcare consultants have been perceived as a four-letter word, yet a necessary evil in the operations of the modern healthcare organizations. Up until the middle of the 1990s, many healthcare-consulting firms relied on recruiting the "best of the best" with healthcare backgrounds. Their process for providing recommendations regarding improvement came from personal experiences and some limited benchmark data. However talented these consultants, to a great degree even today, they still rely on personal experience to make recommendations and drive change.

Although there is much to be said for personal experience, it is still relatively subjective in nature. This is where Six Sigma began to make an impact on healthcare organizations. To achieve Six Sigma quality, a process must produce no more than 3.4 defects per million opportunities. An "opportunity" is defined as a chance for nonconformance, or not meeting the required specifications. This means we need to be nearly flawless in executing our key processes

Key Concepts Of Six Sigma:

At its core, Six Sigma revolves around a few key concepts.

1. Critical to Quality: Attributes most important to the customer
2. Defect: Failing to deliver what the customer wants
3. Process Capability: What your process can deliver
4. Variation: What the customer sees and feels
5. Stable Operations: Ensuring consistent, predictable processes to improve what the customer sees and feels
6. Design for Six Sigma: Designing to meet customer needs and process capability

Organizations Feel the Variance, Not the Mean:

Often, our inside-out view of healthcare is based on average or mean-based measures of our recent past. Healthcare organizations and patients don't feel averages; they feel the variance in each transaction or procedure. Six Sigma

focuses first on reducing the variation in a process and then on improving the process capability. **Organizations value consistent, predictable business processes that deliver world-class levels of quality. This is what Six Sigma strives to produce.**

Six Sigma was born to answer the question of how to improve efficiencies in manufacturing processes.

General Electric, under the leadership of Jack Welch and others, implemented this process across all GE businesses, achieving impressive results in cost and quality improvement. Over a short period of time, the Six Sigma methodology has also migrated to the healthcare environment. In the current climate at GE, Six Sigma is no longer simply a process, but has become ingrained as part of the company culture.

Here is a simple illustration of this concept. Let's assume your company is manufacturing styrofoam cups. Each cup costs $1.00 to produce, which is inclusive of all costs, including equipment, supplies, and labor. At the 2 Sigma (2s) level, your firm would discard 308,537 of the one million cups manufactured due to defects. The higher the sigma level, the better the performance. If your company were moved to the 6s level, you would only discard 3.4 defective cups per million. It is easy to see what that would mean to your profit margin!

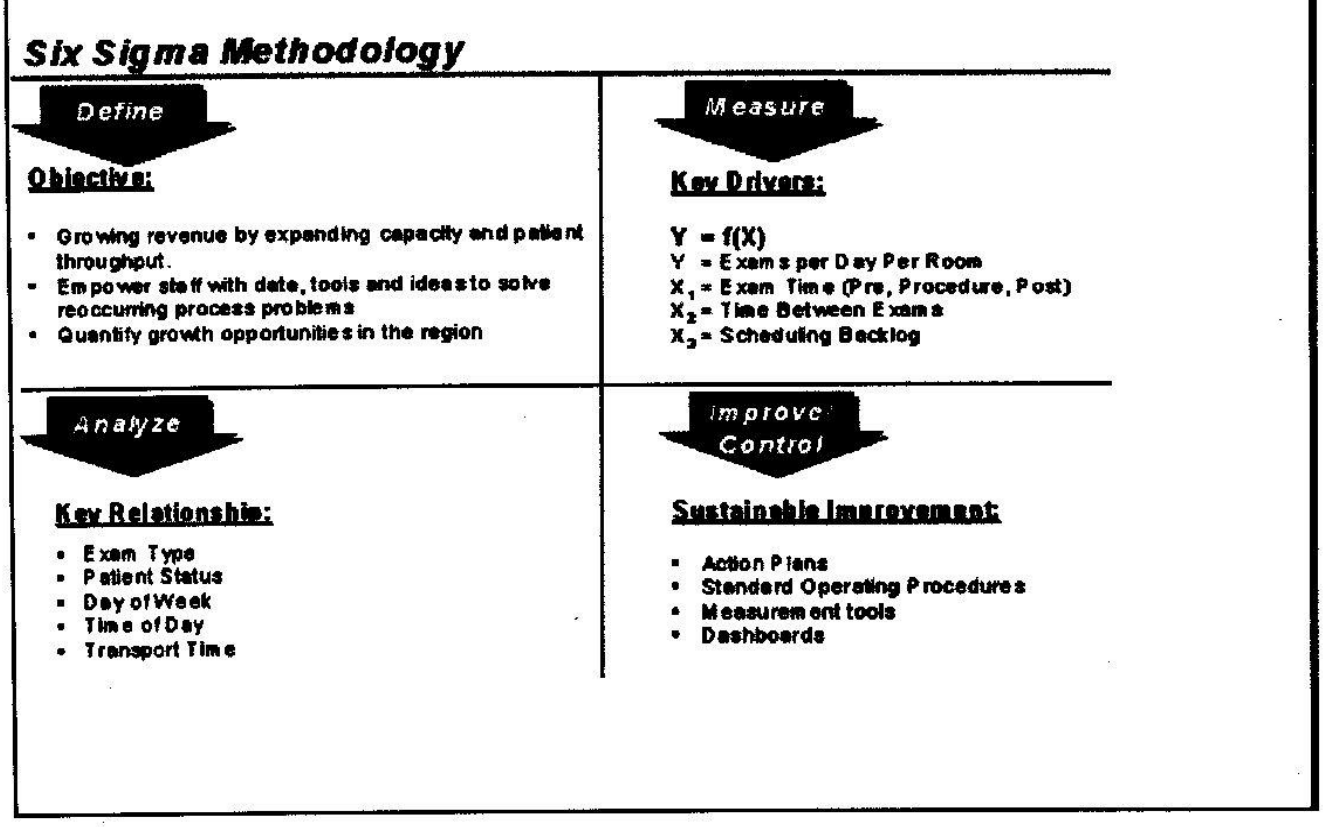
Let's move this scenario into the healthcare environment. It is relatively easy to see what transforming an operational department (like a cardiac catheterization lab) operating at a low sigma level up to a higher sigma level would mean to the overall organization.

Patient satisfaction, physician satisfaction, reduced overtime, reduced patient wait times, increased revenues and an enhanced quality of life for staff are some of the outcomes of moving to the higher sigma level. The goal is to move from the current state to a future, more productive state. Integrating the Six Sigma culture into entire organizations can multiply the positive effects and make a significant impact at all levels.

The primary methodology of Six Sigma functions in what is referred to as the DMAIC Define / Measure / Analyze / Improve & Control process.

Figure-3 identifies this process and the functions that occur in each phase.

Figure 3: Six Sigma Methodology Overview



DMAIC, or Define, Measure, Analyze, Improve & Control are the **five phases** that must be rigorously and systematically scrutinized in order to provide answers to the big "Y" question. Determining what the customer CTQ (Critical To Quality) issues are is accomplished in the **Define** stage. That is referred to as the "big Y." The big "Y" in our example is patient throughput.

In **Measure**, the "X's" are identified. "X's" in our example are identified as exams per room per day, procedure times, time between patients, etc.

In the **Analyze**, we identify the key relationships to throughput.

In the **Improve** phase, action plans and standard operating procedures (SOPs) are identified.

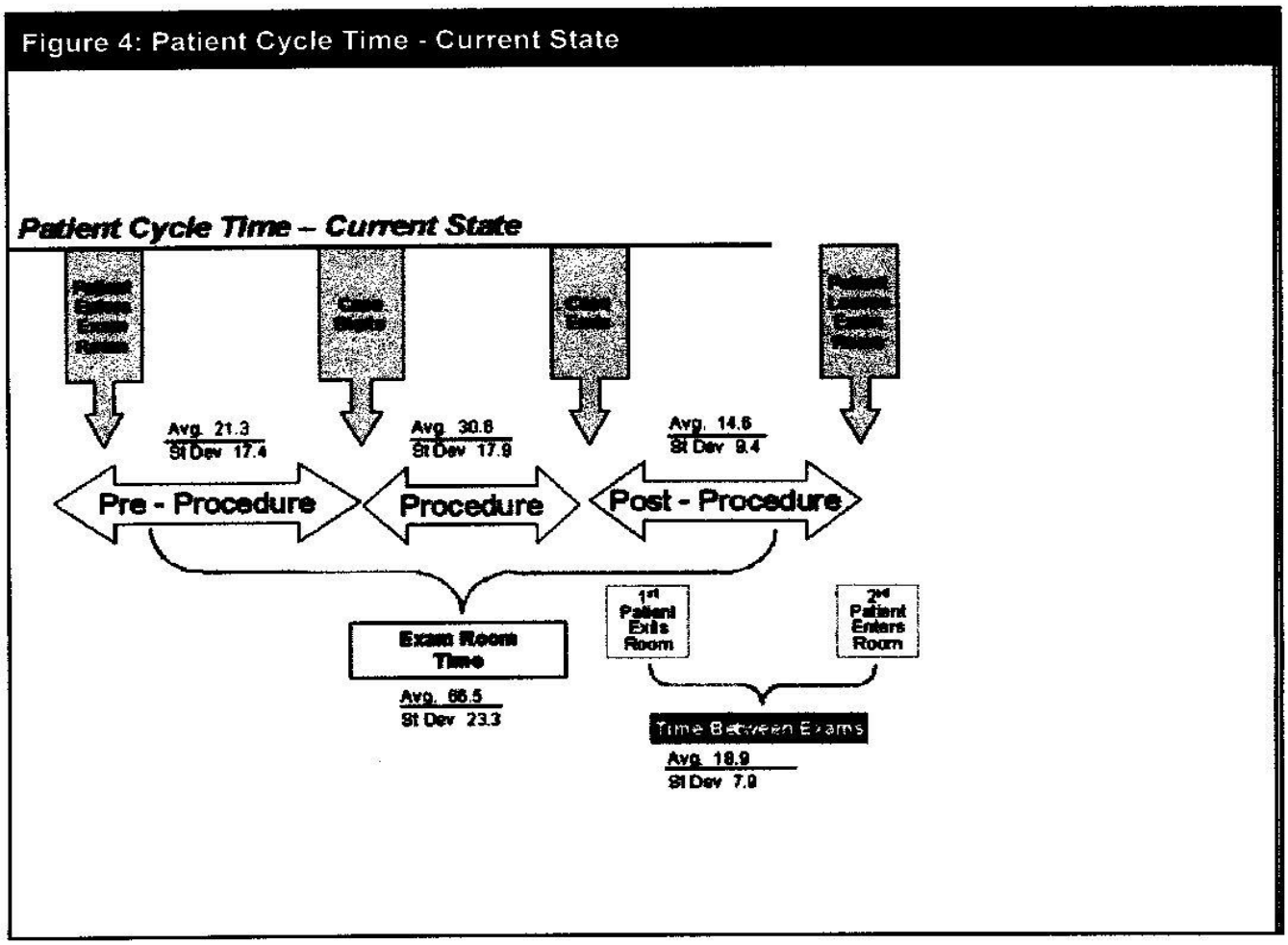
In the **Control** phase, the implemented changes based upon the Six Sigma methodology are continued and monitored. This is a significant phase of the DMAIC process, as the sustainability of the changes from the current state to the future improved state is important to the long-term success of the project and thus the financial health of the organization. **Merely changing is not enough. Changes, no matter how significant, tend to drift back to the prior state after time.** With Six Sigma and utilizing DMAIC, the change is moved from that current state to the improved future state along with mechanisms to sustain those changes.

To better understand this process at a very simple level, the **below example demonstrates how using the Six Sigma methodology in healthcare would move certain metrics to enhance the productivity and efficiency of a cardiac catheterization lab.**

Our example department has a single cath suite that operates routinely on a twelve- (12) hour day with a single shift of staff. Physicians often cite their top concern as getting patients into the lab. That makes throughput the big "Y." One of the important areas of this process is gaining the insights of the customers, in this case, the physicians. This is called the Voice of the Customer, or VOC. In our scenario, the VOC indicates the physicians are very happy with the dedication and experience of the staff. Their primary concern is access. So the big "Y," or throughput, is the product the team focuses on. Increased throughput equals enhanced access.

After data gathering on the operations of the department, a significant volume of data is provided to the organization as well as the physicians who practice in the catheterization lab. In Figure 4, the data depicts the cycle time of procedures in the cath lab, defined as the time the patient enters the lab to the time they exit the lab, plus the time between patients.

Figure 4: Patient Cycle Time - Current State



The **cycle time is divided** into essentially four segments:

- Pre-procedure time
- Procedure time
- Post-procedure time, which equals...
- Total room time and time between patients.

By scrutinizing the times as well as the standard deviations, the team will begin determining where improvement might be achieved. Let's briefly review what generally occurs in each phase.

In the **pre-procedure time**, the patient is brought into the cath suite, and moved from the cart to the cath table. ECG, blood pressure, and Sp02 monitors are all applied. Sterile drapes are applied and the appropriate equipment for the procedure is prepared. In this example, at some point the physician performing the procedure is notified. When he or she arrives, they will generally review the patient's chart for pertinent information, labs, etc. and speak to the patient. They will then commence the procedure.

When the physician begins the procedure, the pre-procedure clock stops and the procedure clock begins. Now we are in the **procedure phase**. The procedure is performed per protocol. When the procedure ends, the post procedure time begins.

The **post- procedure phase** is usually when the patient is discontinued from monitoring, drapes are removed, etc. Depending on the findings of the cath procedure, family members may, on occasion, be brought into the suite to discuss these findings with the physician. The patient is then removed from the suite and the post procedure clock stops.

In the example above, these three times are 21.3, 30.6, and 14.6 minutes, respectively. **The total case time or cycle is the sum of the segments: 66.5 minutes.**

The **fourth segment** is the time between patients or the time the patient leaves the room until the time the next patient enters the room.

Utilizing the Six Sigma methodology, the team will break down each segment to look for opportunities for time savings. There are many opportunities or "X's" in each segment that may provide time savings. These savings per procedure multiplied by the number of procedures accomplished per day will undoubtedly provide enhanced throughput.

It is important to remember that the data provided is an aggregate of all the procedures performed in the lab, so averages are used. Departments not performing interventions or pacemakers might see their procedure times lower on average then other facilities performing those procedures.

It is possible, using the Six Sigma methodology, to identify areas of opportunity by comparing how an institution varies from a benchmark value. It may be that routine diagnostic procedures are, on average, meeting benchmark numbers whereas the interventions are far exceeding those benchmarks. This type of information might provide the team their first evidence on where change can be initiated.

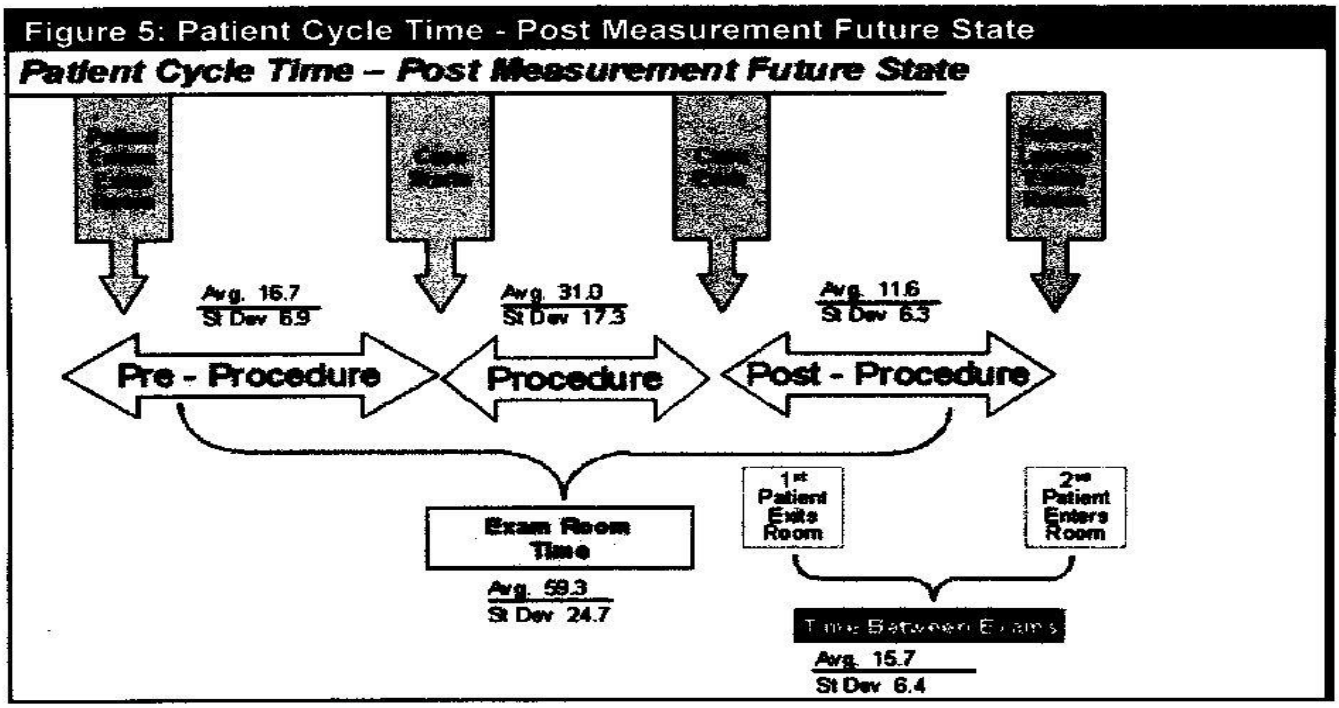
Utilizing the DMAIC format, the organized scrutiny of each equation segment can lead to several action plans that will help the team find additional time per procedure.

In operations that have a backlog of scheduled non-emergent patients, the opportunity exists to reduce backlog and increase patient and physician satisfaction. Additionally, the potential reduction in overtime will enhance the quality of life issues for staff, providing more time away from a high stress environment.

From an administrative perspective, implementing Six Sigma-derived plans can lead to increased revenues through added capacity and reduced costs through the reduction of overtime.

In Figure 5, we see the impact the Six Sigma methodology has had on throughput in our example department. Pre-procedure time went from 21.3 minutes with a standard deviation of 17.4, to the improved state of 16.7 minutes with a standard deviation of 6.9. Simply put, throughput is increased, thus increasing capacity. If the example scenario were to yield capacity for two additional patients per day at the average reimbursement, one can see how revenue would be enhanced, as well as customer satisfaction.

Figure 5: Patient Cycle Time - Post Measurement Future State



One other significant area relating to enhanced catheterization lab operational efficiency that the process of Six Sigma focuses on is the role the cardiologist and how his / her practice patterns impact operations. This is a very complex issue in the department. Due to that complexity and the potential sensitivity of this issue, we will discuss that portion in greater detail in a future article.

However, there is significant evidence that the Six Sigma process lends itself very well to identifying methods that improve this process as well.

Summary:

In healthcare consulting, the more measurable and objective the data provided, the more receptive the customer will be in accepting the variance from where they want to be and in considering alternative strategies. Change is difficult for us all. Utilizing the Six Sigma methodology, however, and understanding where this process comes from and where it will take us, makes it easier to accept.

About The Author:

Tom Long is a Customer Black Belt Consultant for General Electric Medical Systems Performance Solutions. He holds a Masters Degree in Business and a Bachelors Degree in Management. He also is credentialed in Radiography, Cardiovascular Technology and Cardiopulmonary Technology. He currently resides in Birmingham, Alabama.

Case Study: Online Banking

The Black Belt began working at online bank, and his first project involved the process of how deposits were made to this bank. Since it was an "online" bank, there were no branches for customers to use. Instead, deposits were mailed using the United States Postal Service (USPS). Savings resulting from the lack of branches and tellers were passed along to the customer in the form of higher rates, free services, etc.

Customer surveys indicated that the process of making a deposit is of critical importance to a customer. The process from the customer's viewpoint is very straightforward – they sign a check, fill out a deposit slip, and mail both to the bank. Deposits were the second largest driver of inquiries to the customer call center (13% of all calls). Customers expressed frustration in mailing delays and couldn't understand why their checks took so long to post to their account.

The Deposit Process

The bank's mission was to receive the deposits as quickly as possible and begin the deposit and check clearing cycle. When the bank originally set up the processes, a decision was made to establish 'local' deposit locations around the United States. These local deposit locations received the deposits and overnight express reshipped them to a central processing location daily.

This local receipt and express reshipment to a central location was done for two main reasons:

1. A deposit being mailed to a local location would take less time than mailing to a centralized, national location.
2. Customer input indicated that mailing within a state or to a neighboring state would make customers more comfortable than mailing to a centralized, national location somewhere across the United States.

The DMAIC Project

The Black Belt hit the ground running. A project charter was created identifying exactly what the process entailed. The business case was written, the problem statement crafted and the scope

clearly identified. The team was formed and quickly moved into the measurement phase. Data surrounding the deposits was collected and the analyze phase began to yield some alarming results.

Intuition led the leaders of the business to set up a system that locally collected deposits for express reshipment to a centralized, national location for processing. How could mailing to a centralized, national location be quicker than mailing locally and express reshipping? Why wouldn't customers feel more comfortable mailing locally than to a centralized, national location?

Data and Root Causes

Data collection, however, revealed a few flaws that weren't originally identified:

- The express reshipment process was manual. Manual processes that are not reinforced daily and that do not have adequate control plans tend to break down. That is exactly what occurred with the local deposit locations. Some locations wouldn't receive deposits on a daily basis. When deposits were received, they sometimes wouldn't be express reshipped that night because of a lack of engrained process.
- For deposits that were received during the week, the express reshipment process functioned properly. On the weekend, however, express reshipment wasn't possible, so deposits arriving on Saturday were not express reshipped until Monday evening.
- Because of USPS processes, some deposit mailings to 'local' deposit locations took as long as three days. Tack on a weekend stay for the above listed bullet, and you can see how a deposit made via mail to a 'local' deposit location may take longer than five days just to be received by the bank.

Additional Findings

An additional analysis of deposits made to a 'local' deposit location with express reshipment to a national location versus mailing directly to a centralized, national location yielded the following results:

- The 'local' process operates at a 2.1 sigma level, while the centralized, national process operates at a 2.5 sigma.

- The centralized, national process is faster (2.6 average days) than the local express reshipment process (4.6 average days).
- An additional survey conducted with focus groups indicated that the deposit mailing location is not a significant factor for a majority of respondents. As an aside, the original data indicating that customers were more comfortable mailing deposits within their state could not be found.
- A benchmarking analysis of direct competitors indicated that all utilized a centralized, national deposit process.

Project Conclusions

It didn't take further data collection to convince the leaders of the business to modify their deposit process and move to a centralized, national process. The facts spoke for themselves. Cost savings resulting from only printing one address envelopes (instead of numerous local), reduced overhead associated with processing, fewer customer inquiry calls and investigations, and a more stable process resulted in savings of $4MM per year. Not bad for a six month Black Belt project.

DMAIC – CASE STUDY (LOAN-PROCESSING)

1. Hope Financial Services is in the primary business of granting loans. The President decided to use Six Sigma (DMAIC) Methodology to improve net income by 25%. They wanted to reduce the wastes in their processes.

2. To find out which processes generated the most variation, the very first step was to ask the fundamental question: " Where was money being lost in the loan process?"

3. Six Sigma Methodology begins by identifying the critical-to-quality (CTQ) elements of a process. In the residential loan department, the manager Mr. Gandhi defined the CTQ metric as the loan approval process time. Specifically, he determined that the process should take only two days from receipt of the application. Anything else would be considered a "defect." The department was not meeting the specification, since the average loan approval took a full seven days. The "five-days variance" was the defect-the waste in the process.

Gandhi's loan processing department processed about 10,000 loans per month, with an average loan value of Rs. 4,00,000/-. The department was not measuring the money value of time lost in processing loans, which according to his specification meant losing five days of interest in

a month i.e. 60 days a year. Given an average interest-rate yield of 10%, this meant the department was losing approximately Rs. 55,55,500/-per year because of the critical-to-quality factor of variance in loan processing time.

4. Once Gandhi identified the CTQ factor, he could specify the project "The way he would root out that waste by examining every process step and measuring the results. The goal was to identify what steps were causing this time variance".

5. There are three important components that characterize a Six Sigma project:

1. A critical –to-quality metric

2.An actual cost associated with a defect affecting the CTQ metric

3.A specific time frame for eliminating the defect to attain the CTQ metric

Now that Gandhi had his project parameters, he could assemble a team and lead them in his black belt role, focusing solely on determining the vital few factors standing between the process and its target performance.

His boss acted as the Champion, ensuring that Gandhi and his team received all the necessary resources, removing any barriers, and informing upper management about the project's progress. Gandhi had

a vested interest in the project's outcome: his division would benefit and so would he, since his performance bonus was tied to and measured by the project's results!

6. The Six Sigma five-phase sequence of DMAIC (Define, Measure, Analyze, Improve, and Control) was about to begin.

A) In the Define phase, Gandhi determined that the project goal was to reduce the time for approving a loan to two days.

B) In the Measure phase, Gandhi started to map the loan application process. He identified four key areas:

(1)Application form process,

(2)Credit checking,

(3) Management approval,

(4) Rechecking and Re-approving the loan application.

C) Once process mapping was complete, components were further broken down into the vital few inputs in the Analyze phase. In the case of the loan application form, the "output" was 100% completion of all form information. That created a baseline for defining a defect, as "missing vital information on the form".

Other process outputs causing waste were the" four approval layers" and "unnecessary inspection points". That may sound minor, but consider the rework and time value of "fixing" information at a later

point in the process and then multiply that by the volume of loans. Once again, the exponential cost of a small defect soars.

D) In the Improve phase, the team developed the relationship equation between the application form (inputs) and loan funding (outputs) and prepared the way for the Control phase, which implemented changes.

E) One of those changes in the Control Phase was in the software. Now employees had to complete each field on the form before moving on to the next: the software would not let them skip ahead until they got the right information the first time.

Gandhi achieved his goals: by stopping rework on the application form, he reduced staff overtime, increased productivity, satisfied applicants with faster funding and met the break through goal-reducing monthly operational costs by Rs.10.0 Lakh, Prior to the project, monthly loan processing costs were about Rs.24.0 Lakh by removing Rs.10.0 Lakh of waste, Gandhi trimmed that to Rs. 14.0 Lakhs and achieved a 4 days reduction in process time-yielding another Rs. 44.4 Lakhs in additional interest payments. Now, that's a significant financial result!

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Six Sigma Case Study: Prompt CC Services

Prompt is a call center that has implemented a number of six sigma projects.

Their first project started with "the elementary processes, such as duration of calls and determining how much time to spend on each type of call."

Subsequent projects tackled more complex processes. A good example would be the "Service Ownership Project."

"Service Ownership" was a Six Sigma initiative in Prompt designed to give agents more authority— and more tools — to ensure that every caller is satisfied with their service.

Here's the process that a Six Sigma team followed to develop and implement just one aspect of Service Ownership:

- **Define:**

  The project-team first worked on identifying the CTQs for caller satisfaction
  (i.e., what makes a client happy or unhappy with a call).

- **Measure:**

  The team listened to a number of sampled calls that had received either high or low satisfaction ratings and rated the calls along several dimensions.

- **Analyze:**

  The team noticed that if a client's tone of voice indicates uncertainty, that caller is more likely to be dissatisfied.

  As the Project Leader (Black Belt) remarked: "if you read the transcripts, the agents said the right things, but when you listen to the calls, you will realize the difference."

  The team re-confirmed this hypothesis with a number of sets of sampled calls.

- **Improve:**

  The team conducted focus groups to develop ideas for improving the experience of "uncertain" callers.

  Some suggestions were as simple as asking agents to offer to elevate a call to a supervisor if the caller does not seem comfortable with the answers.

  They tested and refined these ideas using a small group of agents, then rolled out the process improvements that yielded improved satisfaction scores to all agents.

- **Control:**

  The Project Leader trained supervisors and agents in the updated procedures, and documented the new procedures in a **control plan** that the group revisits periodically.

Outcome:

The changes gave Prompt an immediate improvement and it's still trending upward.

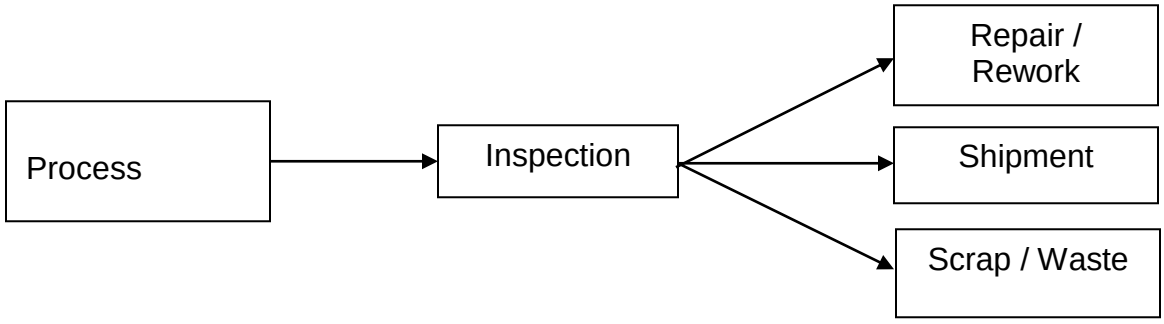
Mr. Thomas - CEO of Prompt, however, cautions that a full-scale Six Sigma implementation requires considerable resources. He says, "You don't wake up and decide you're going to apply Six Sigma. You need the process team and a culture that will embrace the program."

His 600-agent group has one Master Black Belt and seven Black Belts devoted full time to the Six Sigma program. Every section manager and supervisor has earned a Six Sigma Green Belt Certification.

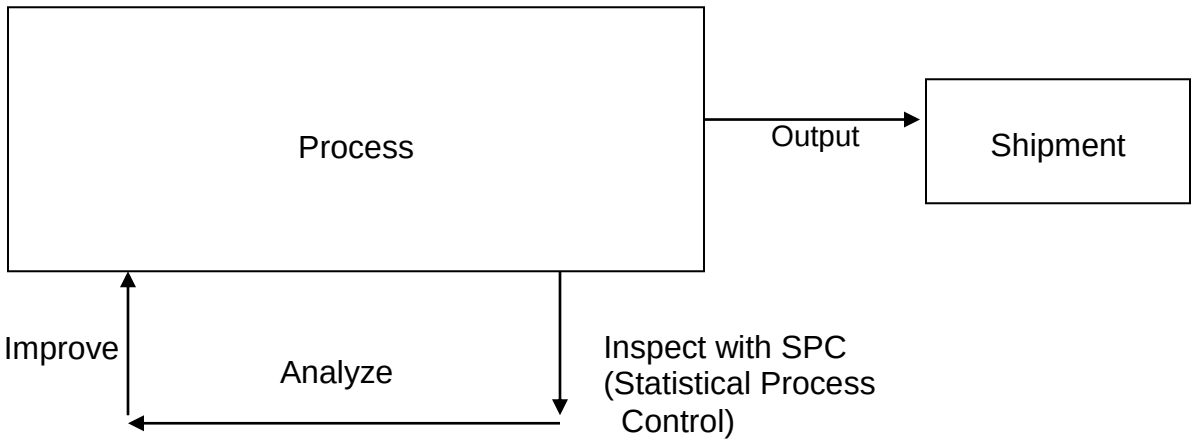
So the dedication of resources is significant - but Thomas is convinced that the results more than justify the investment.

11. THE INSPECTION MODEL Vs PREVENTION MODEL

A) The Inspection Model:



B) The Prevention Model:



12. MORE ON SPC

A) Definition: SPC is a procedure in which data is collected, organized, analyzed, and interpreted so that a process can be **maintained at its present level of quality** or improved to a higher level of quality.

B) SPC GOALS:

The following are the **primary goals** of SPC:

1. **Minimize production/operational costs:** This is accomplished with a "make it right the first time" program. This type of program can eliminate costs associated with repair, rework and scrap.

2. **Attain a consistency of products and services** that will meet production / operational specifications and customer expectations.

   This is achieved by reducing product variability to a level that is well within specifications so that the process output will match the desired design quality.

   This consistency leads to **process predictability**, so managers are in a better position to plan for achievement of their "quality" and "quantity" targets.

3. **Create opportunities for all members** of the organization to contribute to quality improvement. Employees and management are able to pin-point the bottlenecks and quality problems, leading to permanent corrective actions.

4. Help both management and employees **make economically sound decisions about actions affecting the process.** Analysis of control charts can lead to decisions regarding training, re-training, re-assignment of operators, etc.

Capability studies can lead to decisions regarding overhaul (refurbishing) or replacement of machines.

C) SPC TECHNIQUES:

Essential techniques in SPC include the use of:

1. **Process Control Charts** to achieve and maintain statistical control at each phase of the process.

2. **Process Capability Studies** using control charts, to assess process capability in relation to product specifications and customer requirements.

3. **Gauge capability studies,** to increase reliability of the measurement system.

4. The **Seven QC Tools** for problem solving, (i.e. Flowchart, Check sheet, Pareto Chart, C & E Diagram, Histogram, Scatter Plot and Control Chat).

D) APPLYING SPC TO AN EXISTING MANUFACTURING PROCESS

The **following steps** briefly outline the SPC procedure.

Step 1: Decide the process (es) where SPC is to be applied.

Brainstorming sessions with representatives from all levels – from the shop floor to management – can be effectively used to create a thorough picture of the process.

This would **include** use of flow-charts, Pareto, C & E diagram, and analysis of Appraisal Reports to

(a) Identify CTQs,

(b) Determine how to control these CTQs

Step 2: Decrease any "obvious variability" in the target process (es), identified for application of SPC.

Step 3: Conduct a Gauge Capability Study, to check for "repeatability" and "reproducibility"

Step 4: Make a sampling plan. Determine the size of the sample and when the sample are to be taken.

Step 5: **a)** There are two main sources of variation: One is embedded in the system and is referred to as *common-cause* variation, and the other, **which should be eliminated at this step, is *special- or assignable-cause* variation** and can be eliminated by the process control team.

b) The team uses the control chart to find an out-of-control situation, evaluates what happened at that specific time to cause it, and then works to prevent that assignable cause.

c) This procedure continues until the control chart indicates that there are no more assignable-cause variation problems.
By this time the process is running as well as it possibly can without process modifications and is said to be in *statistical control.*

Step 6: Put the operator in charge. (Step-6 and step-5 will actually occur simultaneously because the operator should be doing the control charting and attaining statistical control with the help of the process control team at the same time).

Operator Training on following aspects will be required:

The operator must be taught what is “right”,

- The operator should be able to determine if that phase of the process is right,
- The operator should be able to change what is wrong, in order to achieve statistical control,
- The operator is made *responsible* for that specific phase in the process.

Meeting these four criteria is referred to as ***ownership.*** When operators are given ownership of their part of the process, a sense of pride and responsibility may be generated, which often results in higher quality work.

Step 7: Once statistical control is achieved through implementation of steps 5 and 6. We move to step - 7

This step is used to determine how capable the process is according to product specifications and customer expectations.

A **process capability study** will measure the extent of common-cause variation, or the inherent variability in the process, for comparison with the allowable variation given in the product specifications.

Step 8: The eighth step is designed to improve the process.

Nearly eighty-five percent of the process problems need to be handled at this stage, according to Dr. Deming. Changes in the process mostly require management action, since it involves decisions and investment in resources.

a) Teamwork and brainstorming sessions involving representatives from all levels of the operation can determine probable causes of excessive (inherent cause) variation in the process.

b) Process changes can again be analyzed on control charts either singly or in variable interaction studies for signs of process improvement.

c) D. O. E. may also be used in the search for improvements.

When improvements are found, management must follow through and see that the appropriate changes are incorporated in the process without backsliding.

Step 9: Continue use of the control chart but increase the time interval between samples.

Step 10: We know that Quality improvement is a continual process. Hence **two things** should be done at this step.

a) Continue to look for ways to improve the process at hand ,

b) Return to step – 1 for the next critical measurement.

13. SWOT ANALYSIS:

With the aid of the SWOT Analysis, you can use it to identify your organization's strengths and weaknesses in their departmental and functional aspects. On the other hand, you use the same framework to identify the external factors like Opportunities and Threats. The Internal Strengths and Weaknesses combined with External Opportunities and Threats **creates the basis for establishing short and long term strategies.** It is normal that an organization cannot be equally strong in all areas. Therefore SWOT analysis helps us to develop a better understanding.

SWOT Strengths	**SWOT Weaknesses**
List your **internal strengths** in relation to your competitors	List **weaknesses** in relation with your competitors
SWOT Opportunities	**SWOT Threats**
Establish **potential opportunities** from external factors or tools (positive factors) that can help to boost your sales and revenue	Establish **potential risks** from external factors or tools (negative factors) that can cause harm to your business

SWOT STRENGTHS

The strengths of your organization if realized, would be able to provide a comparative advantage against its competitors. However, you need to identify the SWOT Strengths that are

relative to the competitors.

Its internal strengths that cannot be matched or imitated by competitors are widely referred to as distinctive core competencies.

SWOT WEAKNESSES

The SWOT weaknesses of your organization refers to a situation when your competitors have potentially advantages over you in their capabilities such as deliveries, profit margin, market spread, customer base etc.

Generally, a perceived internal weaknesses may include negative images / reputation, poor quality products, long lead time, poor delivery, incompetent marketing personnel, slow responsive customer service, inconsistent vendor support, poor financial management.

These are examples of Weaknesses that has direct impact to the customers hence the revenue and it should take priority over the rest of weaknesses.

SWOT OPPORTUNITIES

SWOT Opportunities refers to **external environmental factors** that provide additional avenues to increase revenue. It is the normal and unknown factors and only based on certain assumptions. These perceived opportunities may include a growing market segment, acquisition and mergers, joint ventures and strategic alliances with others players.

Included in this SWOT Opportunities factor are the positive aspects of external forces such as economic situation, social and cultural aspect, demographic changes, political and governmental stability, technological changes and competitive forces.

SWOT THREATS

External Threats are **environmental factors that can hinder you in achieving your business objectives and goals**. Generally, perceived threats can include the entrance of new competitors directly or indirectly, erosion of profit margin due to price wars, impending negative legislation, buyers market, suppliers form informal cartel seek to increase their bargaining power, emergence of new technology could made your product obsolete, introduction of innovative products by competitors, competitors open more new sales channels, change of tax structure, removal of incentive schemes etc.