# Science of Improvement

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# Goals and Objectives

- Understand Profound Knowledge

- Introduce an "Improvement Model"

- How to set goals and objectives

- How to manage an improvement effort

- Understanding variation

- Sustaining improvement

# Profound Knowledge

- The System of Profound Knowledge helps us to see how complex organizations work. When we understand this we can then figure out what we have to do to get long-term improvements in quality and efficiency.

- Because everything nowadays comes from organizations. To get more of what we want the organizations involved in supplying it must work efficiently.

# Profound Knowledge

- For example, when we are ill we need two things:

    - we need a good doctor
    - we need that doctor to work in a good organization.

- The good doctor is not enough.

    - Need an adequate appointments system.
    - Need supplies of sterile equipment.
    - Lab results must be accurate and quick.
    - The treatments prescribed must be available and of good quality.
    - And it has to be provided at a cost we can afford.
    - All this needs good organizations - not just good individuals - to deliver them.

# Profound Knowledge

- Deming's Fourteen points for Management give guidance on good management practice.

- Some of these points will not make much sense to people who are tied up in the current management philosophy.

- They make a lot more sense with some understanding of the System of Profound Knowledge.

# Deming's 14 Points

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs.

2. Adopt the new philosophy. We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.

# Deming's 14 Points

3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.

4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.

# Deming's 14 Points

5.   Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.

6.   Institute training on the Job. Train workers formally and correctly, rather than by word of mouth.

# Deming's 14 Points

7. Institute leadership. The aim of supervision should be to help people and machines and gadgets to do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.

8. Drive out fear, so that everyone may work effectively for the company.

# Deming's 14 Points

9.    Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.

10.   Eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.

# Deming's 14 Points

11. Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.

12. Remove barriers that rob people in management and in engineering of their right to pride of workmanship. This means, among other things, abolishment of the annual or merit rating and of management by objective.

# Deming's 14 Points

13. Institute a vigorous program of education and self-improvement.

14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

# Other Quality "Gurus"

- Crosby
  - Phil Crosby was a highly successful quality manager within ITT, and rose to become an executive. Approaching retirement, he wrote "Quality is Free", which was an immediate best-seller, and he went on to establish a training and consulting company. One of the key features of Crosby's approach is the use of financial indicators of waste (e.g. the cost of poor quality) to capture management's attention.

# Other Quality "Gurus"

- Juran
  - Dr. Joseph Juran is a management consultant and a prolific author whose hallmark is a common-sense, practical approach. Like Deming he was instrumental in helping the Japanese to learn and apply quality management in the 1950's. He has written and edited a number of authoritative books and countless articles. He is also the founder of the Juran Institute, a research and consulting organization.

# Other Quality "Gurus"

- Baldrige
  - Malcolm Baldrige is not generally considered to be one of the quality management 'gurus' (he was the US Secretary of Commerce from 1981 to 1987) – but the creation of the award named for him was one of the landmark events in rekindling interest in quality management in North America. The Baldrige award criteria is an important tool that defines the elements of an effective, customer-focused management system based upon quality principles. It is widely used for educational and assessment purposes.

# Healthcare Framework

- Obtain Management commitment to support, understanding, involvement, provision of resources

- Define Key Improvement Objectives

- Identify and Map Organizational Processes, key as well as support. Address all imposed requirements.

# Healthcare Framework

- Develop the organization's Quality Policy and Quality Manual.

- Educate Staff on Quality Management System (QMS) documentation

- Fix deficiencies in the system.

# The DMAIC Improvement Model

- DEFINE

- MEASURE

- ANALYZE

- IMPROVE

- CONTROL

# DEFINE

- Refers to defining the goals of any given improvement effort. Top level improvement goals may include strategic efforts such as increasing the ROI or market share. Closer to the operations level, an organization's goal may involve bettering the output of a given department. On the projects level, the goals may involve decreasing defects and increasing production. Data mining methods are applied here for identifying prospective opportunities for enhancement.

# MEASURE

- Refers to measuring the current process. Reliable and valid metrics need to be established so that the different steps towards achieving the goal can be defined. This starts with the definition of the current baseline. Exploratory and descriptive data analysis are applied here for assisting with the understanding of the data.
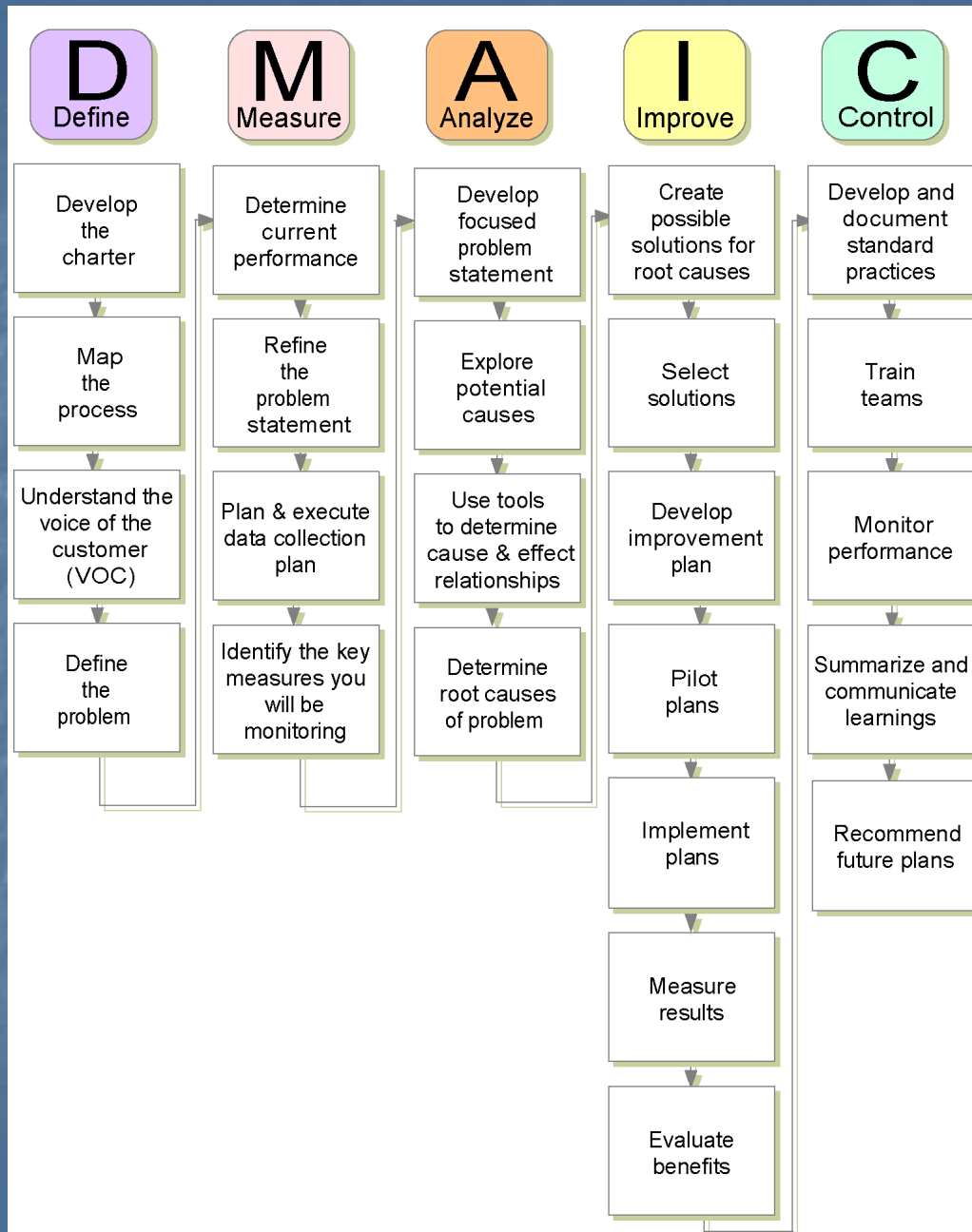
# ANALYZE

- Refers to the analysis of the system in order to recognize the disparity between the current system performance and the goal. Statistical tools are applied here for guiding the analysis.

# IMPROVE

- Refers to the improvements made to the system. Creativity must be employed in order to discover fresh ways of doing things cheaper, faster, and better. Project management and other management and planning tools are used here in order to facilitate the implementation of the new methodology. Statistical methods are also used in order to validate improvements that have been made.

# CONTROL

- Refers to controlling the new system. The enhanced system must be institutionalized through the modification of compensation and incentive programs, policies, MRP, procedures, operating instructions, budgets, and other systems of management. You can choose to use such systems as ISO 9000 in order to ensure accuracy of the documentation.

**D** Define

**M** Measure

**A** Analyze

**I** Improve

**C** Control

| Define | Measure | Analyze | Improve | Control |
|--------|---------|---------|---------|---------|
| Develop the charter | Determine current performance | Develop focused problem statement | Create possible solutions for root causes | Develop and document standard practices |
| Map the process | Refine the problem statement | Explore potential causes | Select solutions | Train teams |
| Understand the voice of the customer (VOC) | Plan & execute data collection plan | Use tools to determine cause & effect relationships | Develop improvement plan | Monitor performance |
| Define the problem | Identify the key measures you will be monitoring | Determine root causes of problem | Pilot plans | Summarize and communicate learnings |
| | | | Implement plans | Recommend future plans |
| | | | Measure results | |
| | | | Evaluate benefits | |

| 1. **Define** | 2. **Measure** | 3. **Analyze** | 4. **Improve** | 5. **Control** |
|---|---|---|---|---|
| Define the Project<br>Define the project's purpose and scope and get background on the process and customer | Measure the Current Situation<br>Focus the improvement effort by gathering information on the current situation | Analyze to Identify Causes<br>Identify root causes and confirm them with data | Implement Solutions and Evaluate Results<br>Develop, try out, and implement solutions that address root causes; use data to evaluate both the solutions and the plans used to carry them out | Standardize and Make Future Plans<br>Maintain the gains by standardizing work methods or processes; anticipate future improvements and preserve the lessons from this effort |
| **Tools**<br>•Affinity Diagram<br>•Brainstorming<br>•CTQ (Critical to Quality) Tree<br>•Project Selection Criteria<br>•SIPOC (Suppliers, Inputs, Process, Outcomes, Customers) High Level Flowchart<br>•Team Charter<br>•Team Communication Plan<br>•VOC (Voice of the Customer) Data Collection Plan | **Tools**<br>•Check Sheets<br>•Control Chart<br>•Cycle-Time<br>•Data Collection Plan<br>•Flowcharts<br>•Pareto Charts<br>•Run Charts and Finding Runs | **Tools**<br>•5 – Why's<br>•Brainstorming<br>•Cause and Effect Diagram<br>•Might-Cause Check<br>•Problem Statement<br>•Scatter Diagram<br>•Tree Diagram | **Tools**<br>•Brainstorming<br>•Commitment Planning<br>•Control Chart<br>•Elevator Speech<br>•FMEA Analysis<br>•Force Field Analysis<br>•From-to-Matrix<br>•Gantt Chart<br>•Involvement Matrix<br>•Losses and Gains Chart<br>•Pareto<br>•Planning Grid<br>•Prioritization Matrix<br>•Standard Practice Development Worksheet<br>•SWOT (Strength, Weakness, Opportunity, Threat) Analysis | **Tools**<br>•Closure Checklist<br>•Control Charts<br>•Process Management Check<br>•Storyboard |

# Definitions

- **Metrics** are a system of parameters or ways of quantitative and periodic assessment of a process that is to be measured.

- **Management review** is an executive responsibility to review the suitability and effectiveness of the quality system at defined intervals and with sufficient frequency according to established procedures.

- **Balanced scorecard** is a management system (not only a measurement system) that enables organizations to clarify their vision and strategy and translate them into action.

- **Dashboards** are tools used for collecting and reporting information about customer requirements and/or your business' performance in meeting these requirements.

# The Balanced Scorecard
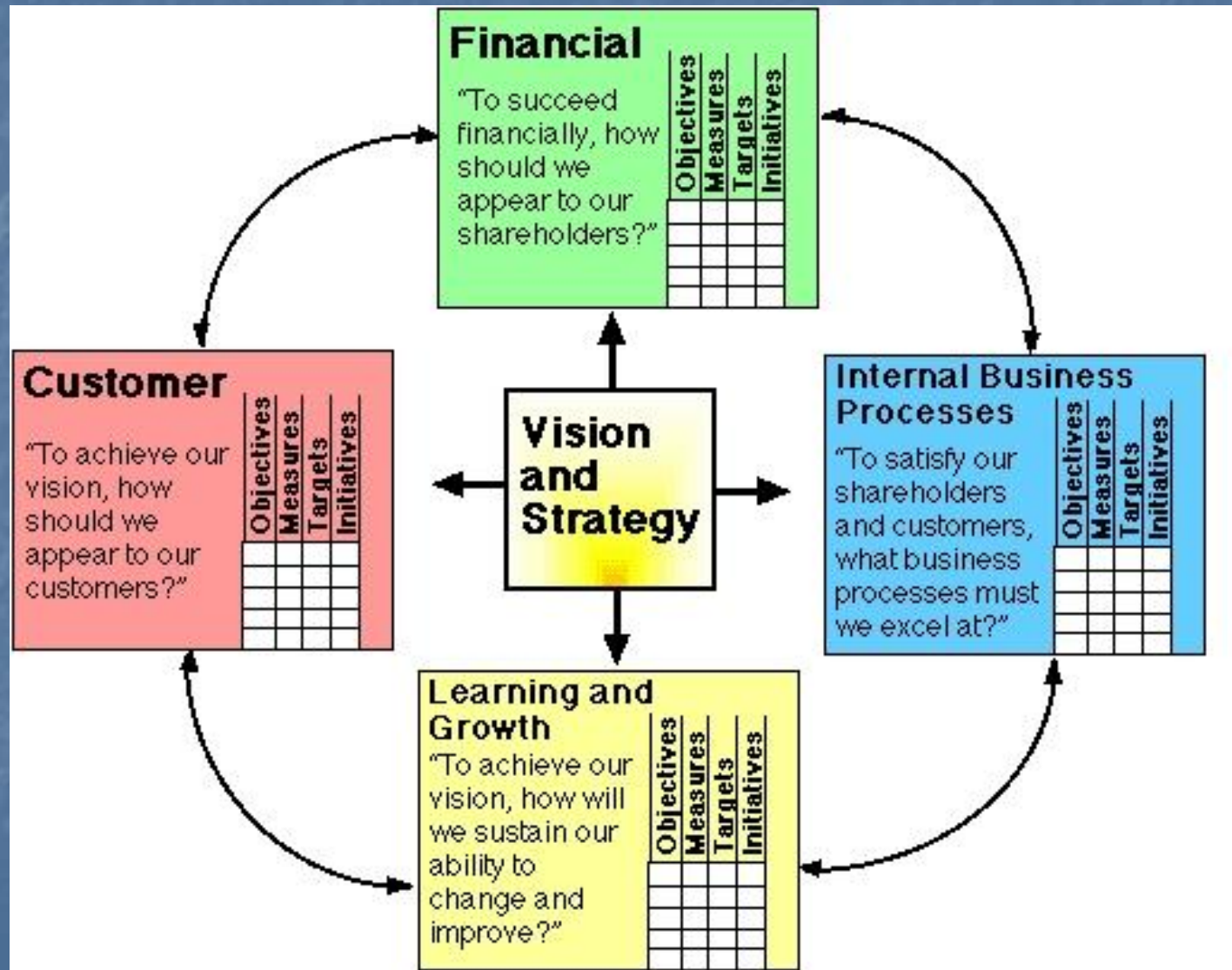
# Balanced Score Card

- The value of metrics is in their ability to provide a factual basis for defining[1]:

  - Strategic feedback to show the present status of the organization from many perspectives for decision makers.

  - Diagnostic feedback into various processes to guide improvements on a continuous basis

  - Trends in performance over time as the metrics are tracked

  - Feedback around the measurement methods themselves, and which metrics should be tracked

  - Quantitative inputs to forecasting methods and models for decision support systems

[1] Balanced Scorecard Institute

# Dashboards

- Business dashboards communicate complex information quickly. They translate information from your various corporate systems and data into visually rich presentations using gauges, maps, charts, and other graphical elements to show multiple results together.

# Proactive vs. Reactive

| TOP MANAGEMENT REVIEW TOPICS OF ADVANCED PERFORMERS (WITH NO AUDIT FINDINGS) | TOP MANAGEMENT REVIEW TOPICS OF OTHERS (WITH AUDIT FINDINGS) |
|---|---|
| **Proactive:** | **Proactive:** |
| • Quality improvement projects | • Internal inspection findings |
| • Internal inspection findings | |
| **In process:** | **In process:** |
| • Corrective and preventive action | • Corrective and preventive action |
| • Nonconformance report data | |
| **Reactive:** | **Reactive:** |
| • Customer complaint data | • Customer complaint data |
| | • FDA and regulatory inspection results |

MDDI, May 2004 (Jennifer Parkhurst and Beth Shaw)

# Data versus Information

- Most companies have plenty of data, but little information.

- How can you turn data into information?
  - Data mining
  - Collecting only data you "need"
  - Use statistical modeling to create predictive relationships

- Dashboards and scorecards alone do not provide the information required for monitoring and improvement of the system.

# Key Performance Indicators

- Metrics should reflect the organizational goals set during management review.

- Metrics should be quantifiable.

- SMART
  - Specific
  - Measurable
  - Actionable
  - Relevant
  - Timely

- Typical KPI are errors per admission, patient satisfaction and new admissions

# Healthcare Metrics

- Leading healthcare organizations have implemented real-time dashboards and alerts to reduce costs, billing errors, and increase efficiency.

- For example, a pediatric healthcare system allows more than 440 physicians to monitor performance based on more than 887,000 patients' feedback.

- A hospital delivers unit performance and variance trends of patient volume, average stay length, and service speed to hospital administrators

# Examples

- Hospital or healthcare facility
    - Physician and nurse evaluation scorecards
    - Patient satisfaction
    - Facility and unit efficiency
    - Electronic medical record metric

- Billing
    - Claim processing
    - Plan performance and member information
    - Network monitoring and service level agreements (SLAs) objective

- HMO or PPO
    - Payer report cards
    - Auditing managed care contracts
    - Best practice denials prevention program metrics

# Change  Management

- There are several tools that can be used to facilitate change in a healthcare environment.

    - 7S Model
    - PESTELI
    - Force Field Analysis
    - Influence Diagram

- Each tools looks at the "readiness" of the organization to change.

# McKinsey 7S Model

# Hard S's

- Strategy: The direction and scope of the company over the long term.

- Structure: The basic organization of the company, its departments, reporting lines, areas of expertise, and responsibility (and how they inter-relate).

- Systems: Formal and informal procedures that govern everyday activity, covering everything from management information systems, through to the systems at the point of contact with the customer (retail systems, call centre systems, online systems, etc).

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# Soft S's

- Skills: The capabilities and competencies that exist within the company. What it does best.

- Shared values: The values and beliefs of the company. Ultimately they guide employees towards 'valued' behavior.

- Staff: The company's people resources and how they are developed, trained, and motivated.

- Style: The leadership approach of top management and the company's overall operating approach.

# PESTELI

- Analyzes the environment of an organization or its subunit.

- Political factors – both big and small 'p' political forces and influences that may affect the performance of, or the options open to the organization

- Economic influences – the nature of the competition faced by the organization or its services, and financial resources available within the economy

- Sociological trends – demographic changes, trends in the way people live, work, and think

- Technological innovations – new approaches to doing new and old things, and tackling new and old problems; these do not necessarily involve technical equipment – they can be novel ways of thinking or of organizing.

# PESTELI

- Applied to the inside of an organization it is PESTELI.

- Ecological factors – definition of the wider ecological system of which the organization is a part and consideration of how the organization interacts with it

- Legislative requirements – originally included under 'political', relevant legislation now requires a heading of its own

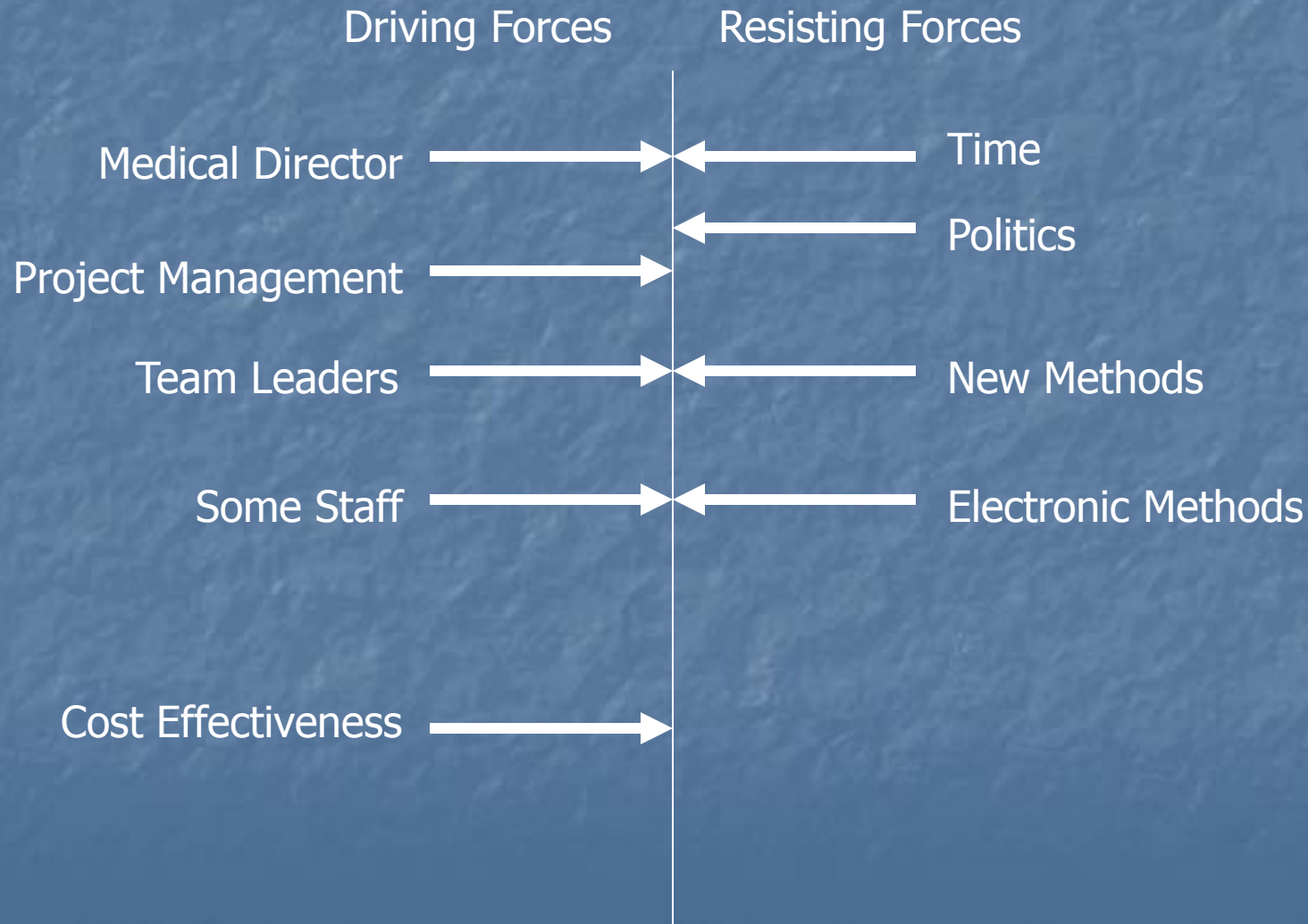- Industry analysis – a review of the attractiveness of the industry of which the organization forms a part.

# Force Field Analysis

- Force field analysis (Lewin, 1951) is diagnostic technique that has been applied to ways of looking at the variables involved in determining whether organizational change will occur. It is based on the concept of 'forces', a term which refers to the perceptions of people in the organization about a particular factor and its influence.

# Force Field Analysis

- Driving forces are those forces affecting a situation and which are attempting to push it in a particular direction. These forces tend to initiate change or keep it going

- Restraining forces are forces acting to restrain or decrease the driving forces

- A state of equilibrium is reached when the sum of the driving forces equals the sum of the restraining forces

# Example

|  Driving Forces | Resisting Forces |

# Example

Driving Forces          Resisting Forces

Medical Director  ———→  ←——— Time

←——— Politics

Project Management ———→

Team Leaders ———→  ←——— New Methods

Some Staff ———→  ←——— Electronic Methods

Cost Effectiveness ———→

# Influence Diagram

- An influence diagram is a simple visual representation of a decision problem. Influence diagrams offer an intuitive way to identify and display the essential elements, including decisions, uncertainties, and objectives, and how they influence each other.

- For example, an influence diagram for the atrial fibrillation HDA we can evaluate the maximal expected utility based on a set of utility values, predefined probabilistic relationships, and patient-specific factors.

# Example
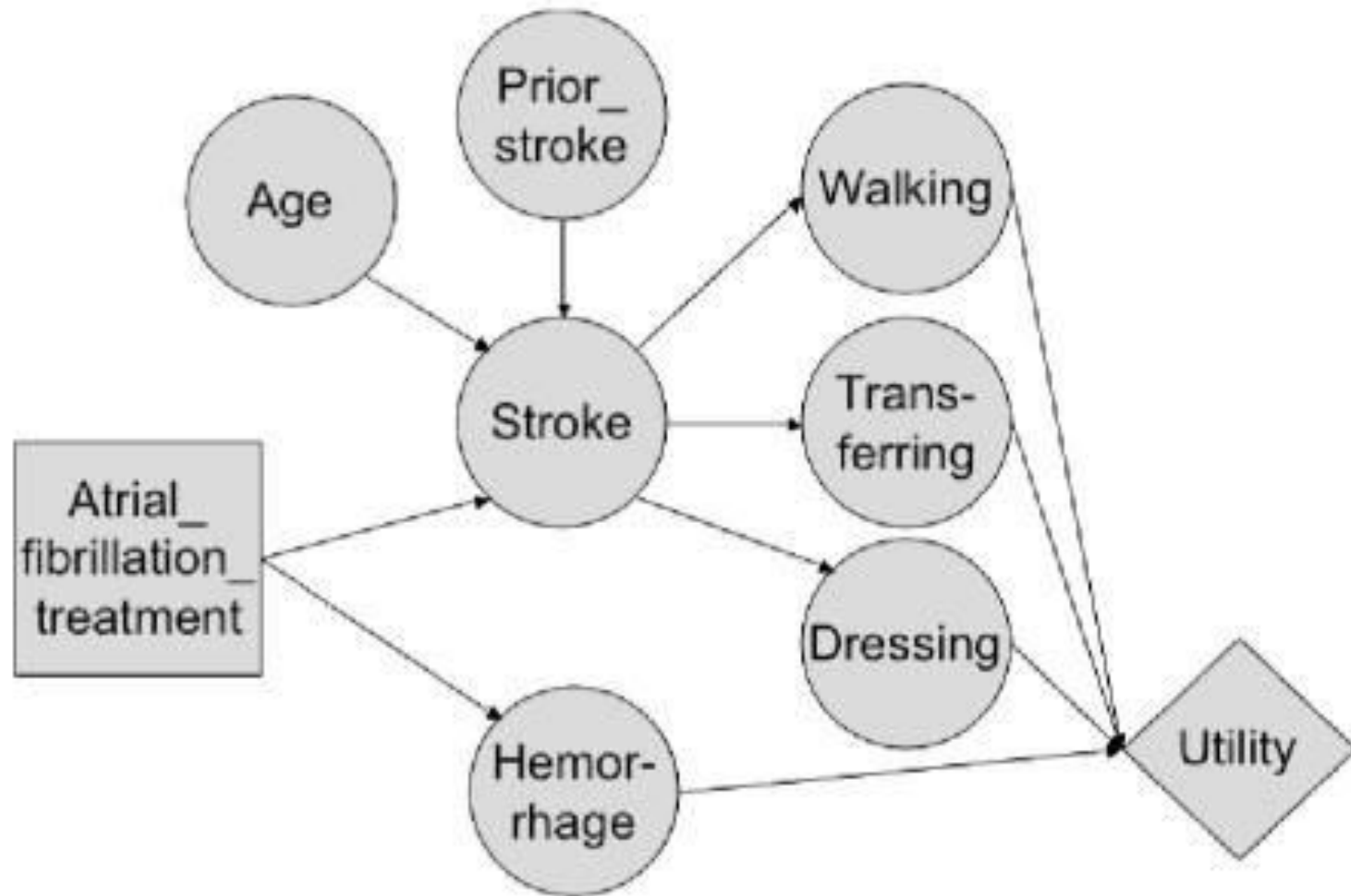
# Measuring Quality Improvement

- What quantitative methods are available for measuring improvement?

- What is improvement?

- Graphical and statistical techniques

  - Pareto Chart
  - Line Charts
  - Trend Analysis

# Pareto Chart

- A pareto chart is used to graphically summarize and display the relative importance of the differences between groups of data.

  - 80% of process defects arise from 20% of the process issues.

  - 80% of delays in schedule arise from 20% of the possible causes of the delays.

  - 80% of customer complaints arise from 20% of your products or services

# Pareto
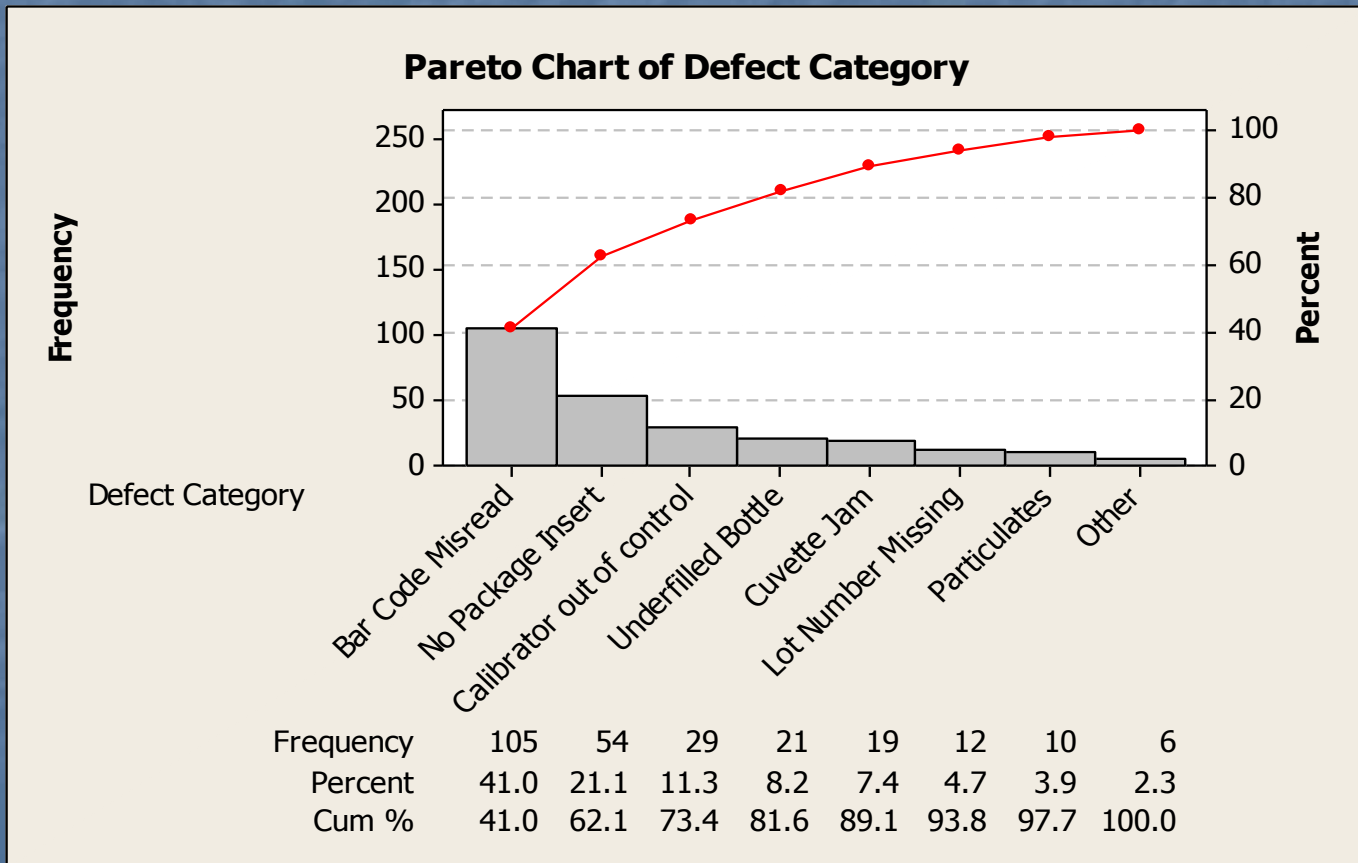
# Cause and Effect

- Sometimes called an Ishikawa diagram or fish bone diagram.

- It is used to associate multiple possible causes with a single effect. Thus, given a particular effect, the diagram is constructed to identify and organize possible causes for it.

- The primary branch represents the effect (the quality characteristic that is intended to be improved and controlled) and is typically labeled on the right side of the diagram.

- Each major branch of the diagram corresponds to a major cause (or class of causes) that directly relates to the effect.

- Minor branches correspond to more detailed causal factors. This type of diagram is useful in any analysis, as it illustrates the relationship between cause and effect in a rational manner.

# Cause and Effect



**Cause-and-Effect Diagram**

Measurements

Accuracy

Number of Scans

Material

Paper Stock

Ink

Personnel

Customers

QC

Bar Code Misreads

Humidity

Heat

Dirt

Environment

Processing Procedure

Location of Bar Code

Methods

Software

Computer

Scanners

Printer

Machines
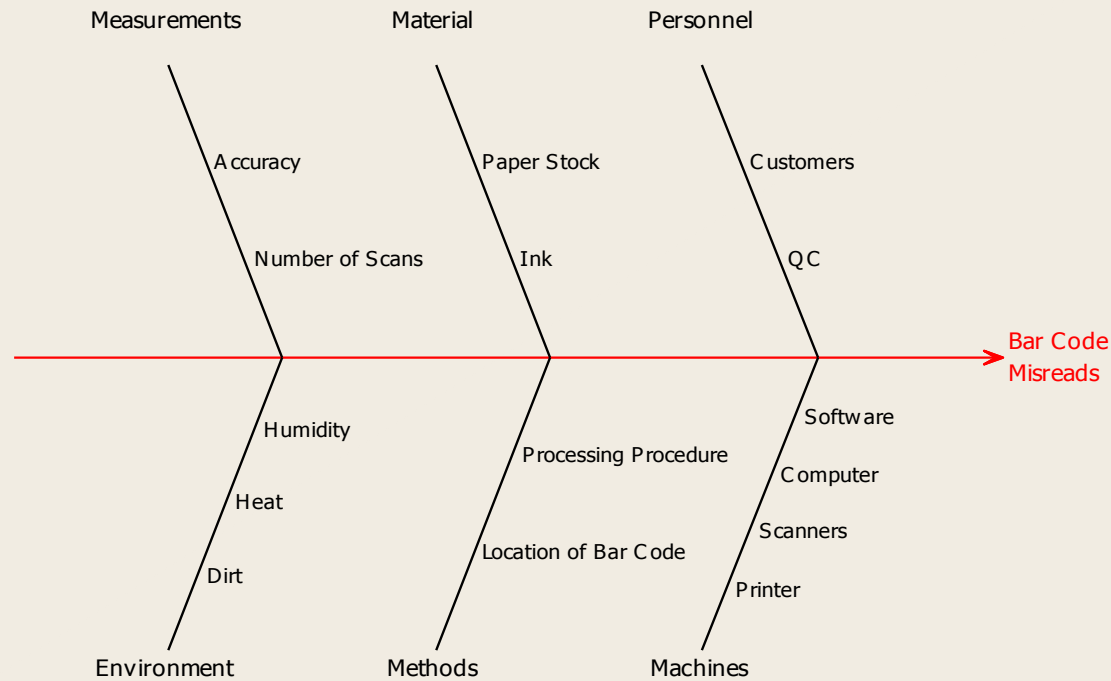
# Flow Chart

- Flowcharts are pictorial representations of a process.

- By breaking the process down into its constituent steps, flowcharts can be useful in identifying where errors are likely to be found in the system.

# Flow Charts
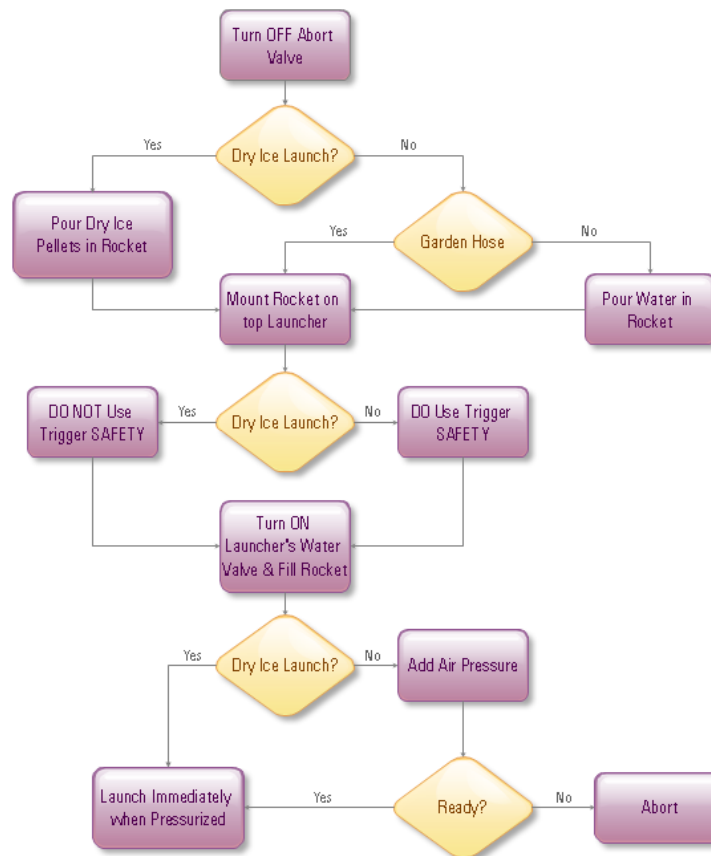
# Line Plots

- **What is it?**
  - Two dimensional plot of data usually over time.

- **Example of Use**
  - Example 1: Admissions by Month
  - Example 2: Chart errors by Week

- **Statistical Improvement**
  - Plot the mean, look for trends.

# Plot of Errors Over Time



Chart Errors
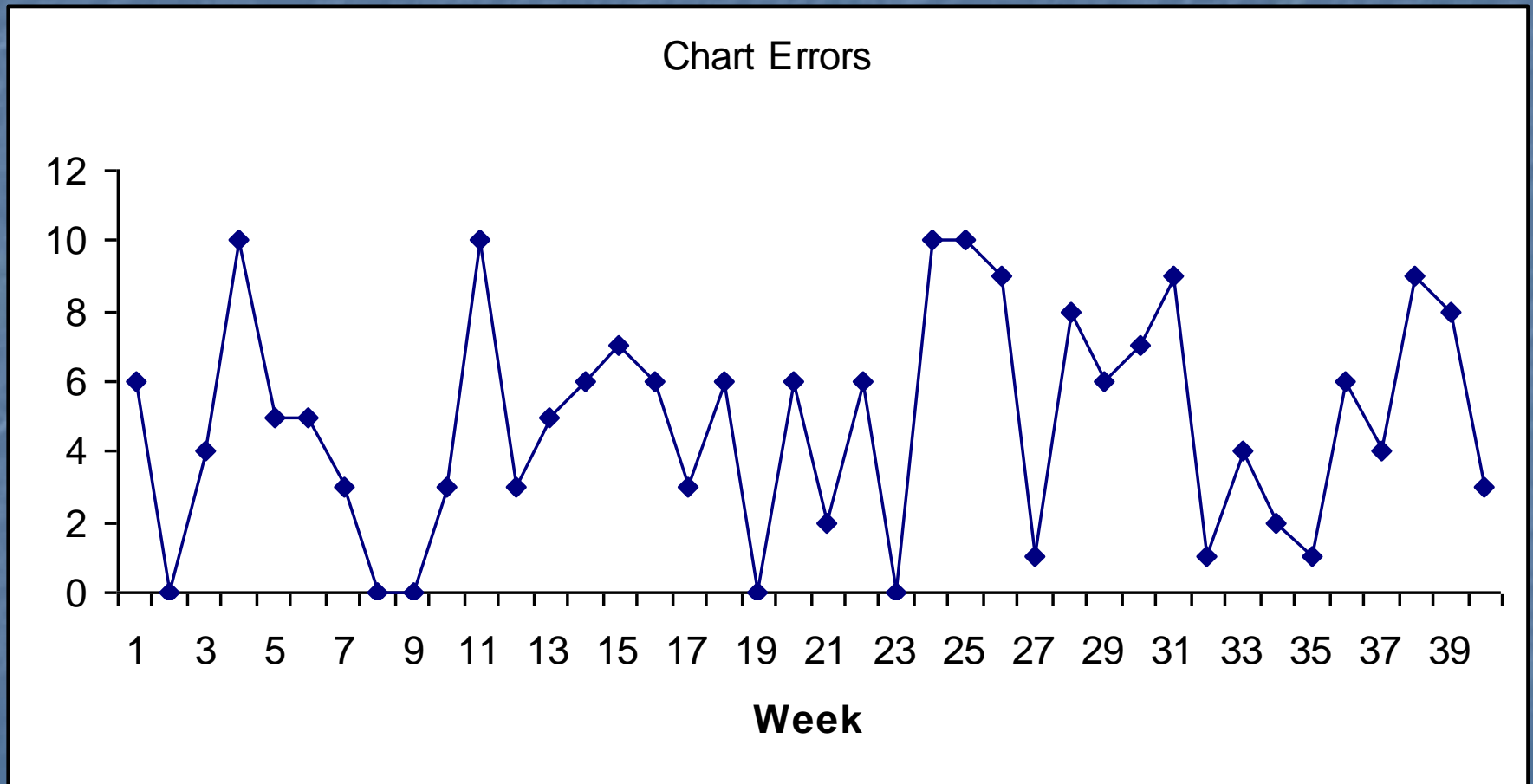
# Trending Analysis

- Plots of process data over time

- Can be developed for individual measurements, means, standard deviations and ranges

- Can be developed for attribute data

# Trending

- How can you detect a trend in the data?

- When is a trend significant?

- Is it a single point that is aberrant?

- How much variability is acceptable?

# Out of Trend

1. Look for trends
   - 5 or more decreasing or increasing
   - 7 or more "drifting" in the same direction (i.e. looks like a line through these would have a significant slope)

2. Look for consecutive points on one side of the mean (7 or more points on one side – should happen less than 1% of the time)

3. Look for too much variability
   - Subgroup means oscillate across the center line and are close to the limits

4. Look for cycles in the chart

# What Does A Trend Look Like
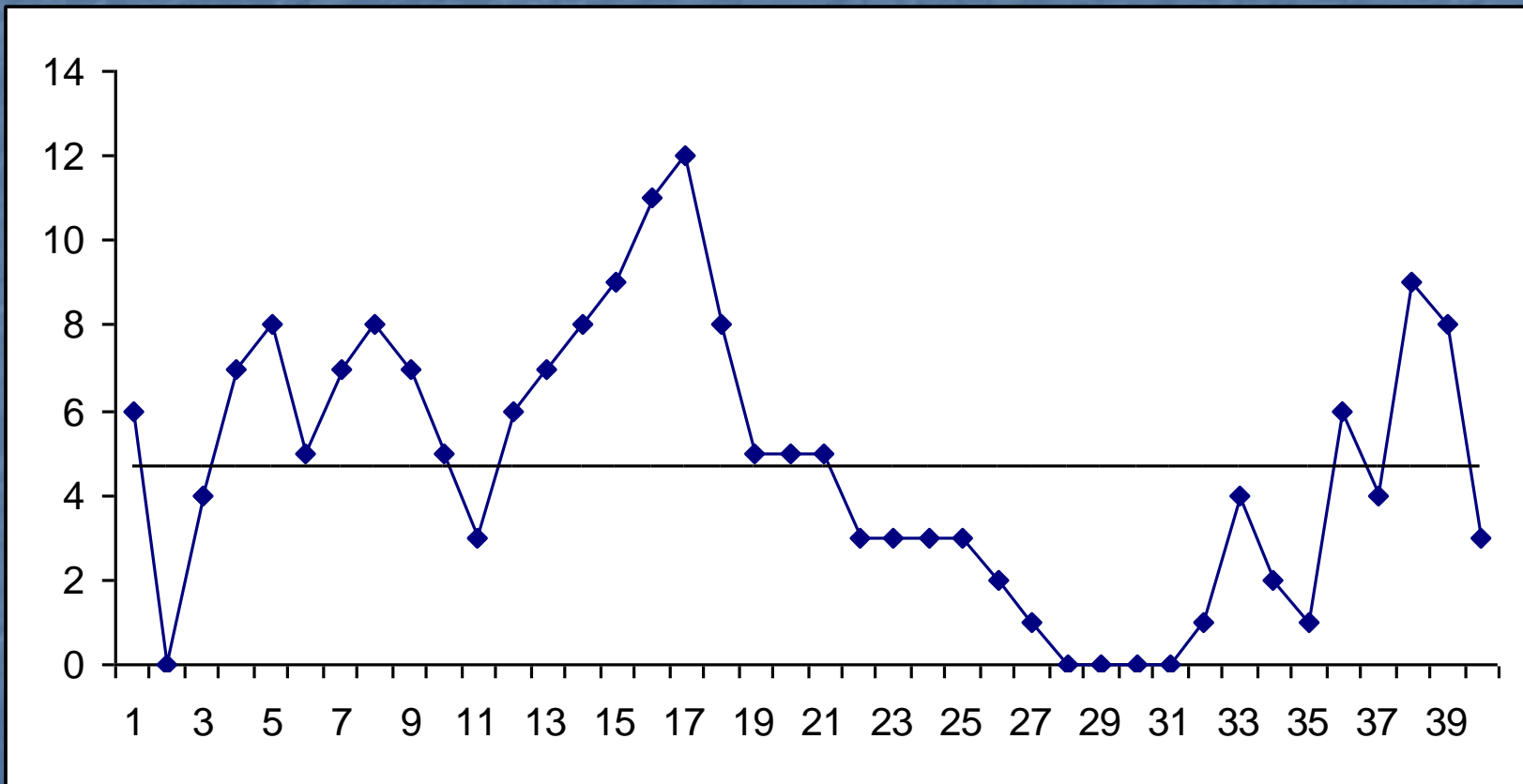
# How Do We Know Real Improvement?

- All processes vary!

- Some variation is normal "common" variability called common cause variability.

- Other variation has a root cause called "special cause" variation.

# Common Versus Special Cause

- Common Cause Variation is variation caused by the process. It is produced by the interaction of aspects of the process that affect every occurrence

- Common Cause Variation that affects all the individual values of a process Common causes inherent causes of variation in a process. They are typical of the process, not unexpected.

- Once special causes of variation are removed, a focus on removing common causes of variation can pay big dividends.

# Who Owns It?

- Special cause variation can usually be removed by the "operator".

- Common cause variation is the responsibility of management.

  - Usually requires resources
  - Changes in staff levels
  - Redesign of processes

- Typically control charts are used to separate the sources.

# Control Charts

- What are they?

- Why use them?

- What is the principle behind control charts?

- How are they constructed?

- When do they indicate the process is in statistical control?

- When do they indicate the process is out of statistical control?

# What Are They?

- Control charts are like line charts with upper and lower statistical limits.

- Can be developed for individual measurements, means, standard deviations and ranges

- Can be developed for attribute data

# Why Use Them?

- To monitor the average output of the process

- To monitor the variability of the process

- To aid in identifying process problems in a timely manner.

- Separate Common from Special Cause Variability.

# What is the Principle?

- Control charts are a graphical method used to <u>compare local (within-subgroup) variability</u> with <u>global (between subgroup) variability.</u>

- Typically based on the assumption that the process data are normally distributed around an overall process mean.
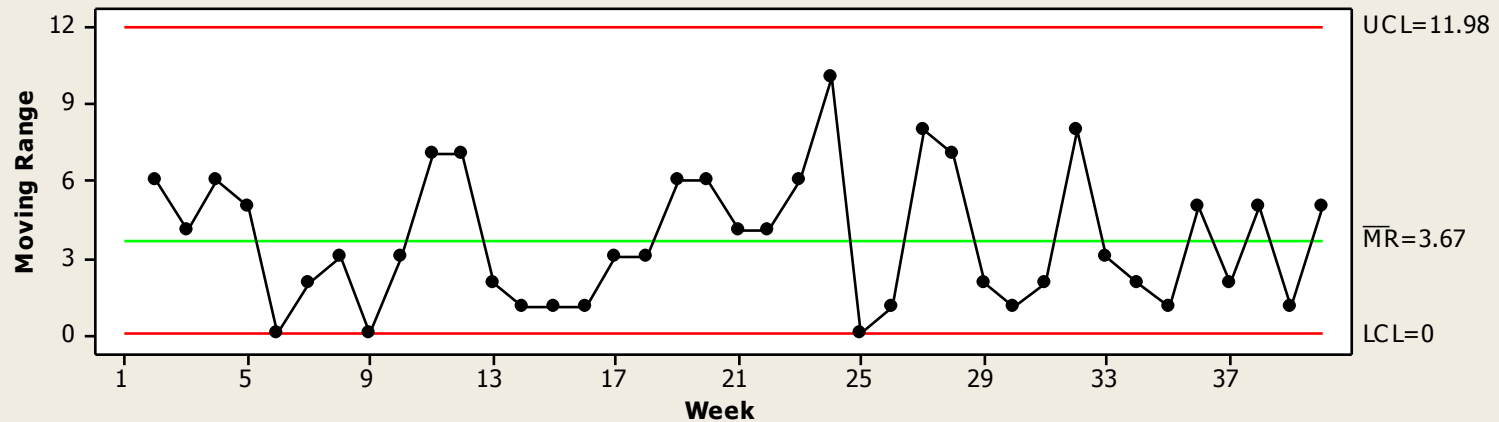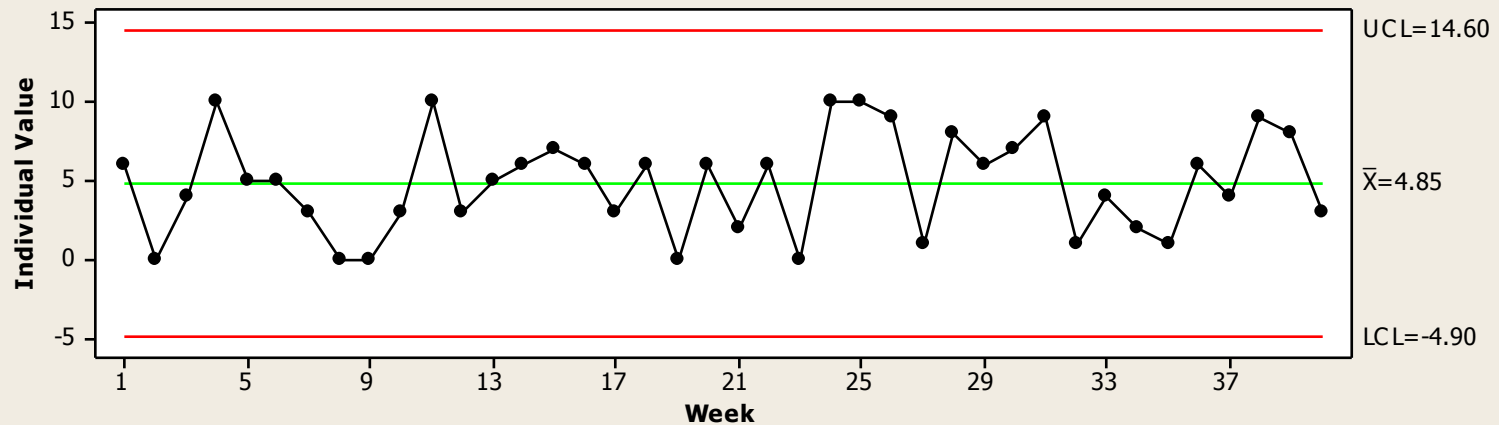
# Control Chart Example

- Let's revisit our two run charts from earlier.

- Use the an individuals chart with a moving range.
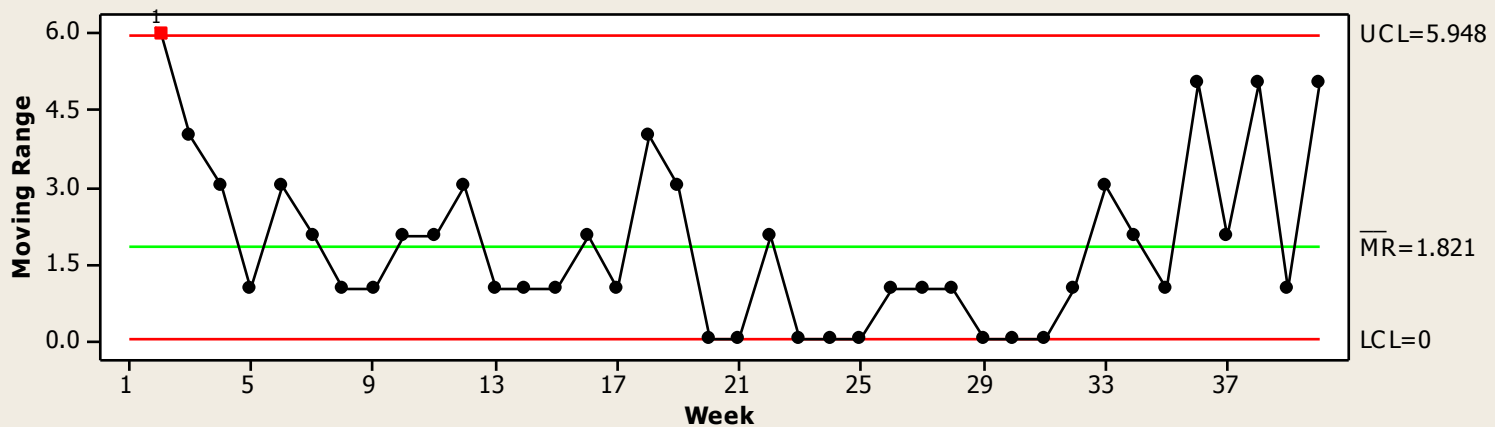
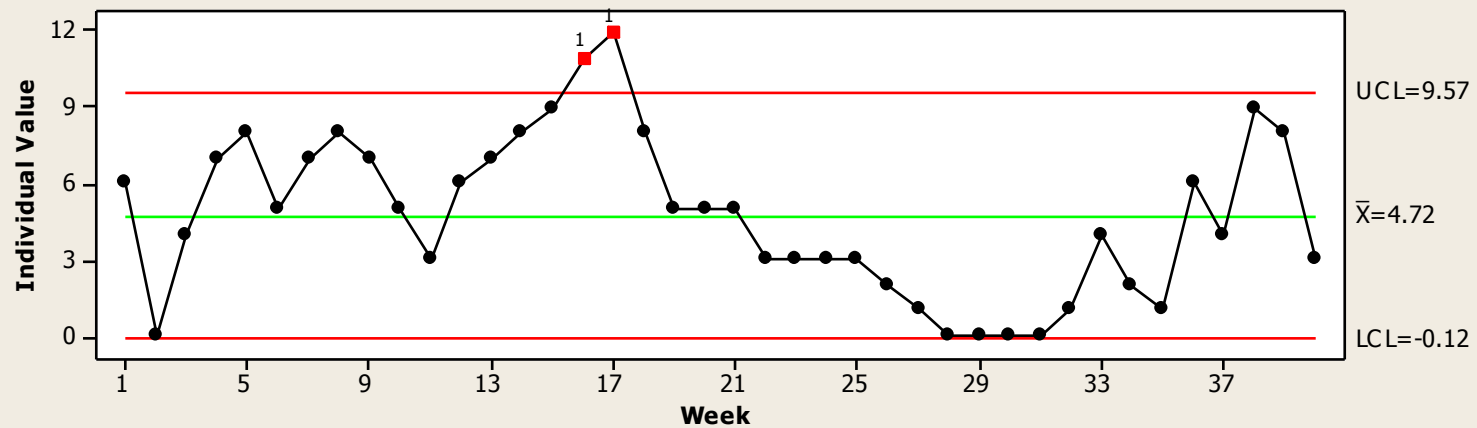- Assume no trends in the data (for now!)
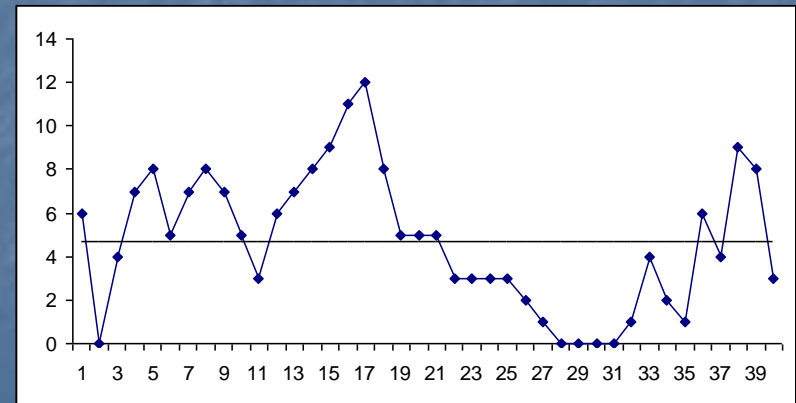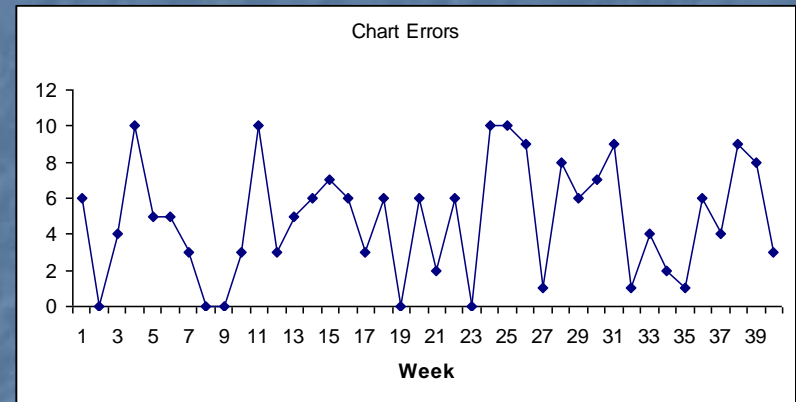
# Example 1



I-MR Chart of Chart Errors

# Example 2

# Control Chart Rules

- When is a process out of statistical control?

  - Look for trends
    - 5 or more decreasing or increasing
    - 7 or more "drifting" in the same direction (i.e. looks like a line through these would have a significant slope)
  - Look for points outside the control limits
  - Look for consecutive points on one side of the mean (7 or more points on one side – should happen less than 1% of the time)
  - Look for points within the control limits but close to the limits
    - 2 or more out of 20 consecutive points close to the same limit
  - Look for too much variability
    - Subgroup means oscillate across the center line and are close to the limits
  - Look for cycles in the chart

# Benefits of Control Charts

- Control limits are not specifications –
  - A process can be in statistical control and out-of-specification

- Control charts are a method to assess whether the process is not shifting or trending and whether the variability is consistent across time.

# Additional Benefits

- Use of controls charts in conjunction with other quality control tools can help in finding the cause of the problem:

  - Indicate where process change took place on the control chart: was there an effect?

  - Plot shift changes on the control chart: are all your shifts performing similarly?

  - Use Pareto charts to innumerate problems and show which problem(s) are occurring with the highest frequency

  - Use a flowchart to show the flow of the process: is it too complex in parts? are there redundancies? Can the process be simplified?

# Sustaining Improvement

- While the benefits of continuous quality improvement (CQI) done right are extraordinary, organizations implement CQI with a huge variation in skill and commitment.

- More than half of about 1,200 corporate employees who answered a Gallup survey for the American Society for Quality Control say their companies claim that quality is a top priority. But only about one third say their companies follow through with effective programs.

- In health care, where CQI is relatively new and where there is often a tendency to implement short-term fads, the quality of CQI implementation is very uneven. Physician executives are in an excellent position to become the champions of CQI and to play a lead role in ensuring that it is done right in their organizations.

# How to Make it Work

- 1. Become educated on what CQI is and how it works.

- 2. Help lead the CQI process.

# How to Lead

- Focus on at least these three areas:

    - Concept

    - Process

    - Tools

# The Concept

- It is helpful to learn how other organizations define CQI and to develop a definition that is most meaningful to you.

# How Do You Define CQI?

- Meeting (or exceeding or anticipating) customer expectations.

- Internal and external customers.

- CQI as a continuous way of doing business.

- Improving processes.

# Process

- Once you understand the theory of CQI, it is critical to learn why CQI is successful at some organizations and at others never seems to get off the ground.

- What are the Key Success Factors?

# Key Success Factors

- Visionary Leadership

- Commitment to Customers

- Trained Teams

- Physician Participation

- TQM Process

- Alignment of Management Systems

# Tools

- DMAIC

- Graphical Tools

- Process Planning

-

# 4 Step Approach

- Plan the Strategy
  - Benchmark successful organizations

- Support CQI
  - Make CQI updates part of all meetings

- Improve
  - Select the most beneficial quality improvement projects

- Advance CQI
  - Assess performance and recommend additional training to get others involved

# References

- "Adopting Deming's Quality Improvement Ideas: A Case Study." Hospitals 64(13):58-60,62,64, July 5, 1990.

- Berwick, D. "Continuous Improvement as an Ideal in Health Care." New England Journal of Medicine, 320(1):53-6. Jan. 5, 1989.

- "Data Spin Debate on Hospital Quality." Wall Street Journal, May 24, 1990.

- Francis, A., and Gerwels, J. "Building a Better Budget." Quality Progress 22(10):70-5, Oct. 1989.

- Laffel, G., and Blumenthal, D. "The Case for Using Industrial Quality Management Science in Health Care Organizations." JAMA 262(20):2869-73, Nov. 24, 1989.

- Melum, M. "Total Quality Management: Steps to Success." Hospitals 64(23):42, 44, Dec. 5, 1990.

- Melum, M., and Sinioris, M. "The Next Generation of Health Care Quality." Hospitals 63(3):80, Feb. 5, 1989.

- Merry, M. "Total Quality Management for Physicians Translating the New Paradigm." QRB 16(3):101-5, March 1990.

- Nolan, T., and Provost, L. "Understanding Variation." Quality Progress 23(5):70-8, May 1990.

- Scholtes, P., and Hacquebord, H. "Six Strategies for Beginning the Quality Transformation, Part II." Quality Progress 21(8):44-8, Aug. 1988