BLG 475E: Software Quality and Testing
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Introduction to Software Quality

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What is quality?

- Philip Crosby (Quality is free, 1979)
  - *"Quality means conformance to requirements"*

- Joseph Juran (Quality Control Handbook, 1988)
  - *"(1) …consists of those product features which meet the needs of customers and thereby provide product satisfaction.*

    (2) …consists of freedom from deficiencies"

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Different definitions of quality

- Hoyer & Hoyer (What is quality, 2001)
  - 8 well known definitions
- Conformance to requirements
  - Crosby, Juran, Shewhart, Taguchi
- Meeting customer needs
  - Deming, Feigenbaum, Ishikawa, Juran, Shewhart
- Different levels of quality
  - Deming
- Dynamic quality due to changing needs of customer
  - Feigenbaum, Ishikawa
- Price of a product or service as part of quality
  - Ishikawa, Shewhart
- Loss to society by Taguchi

What is software quality?

- *IEEE Definition 1991*
  - *The degree to which a system, component, or process meets specific requirements*
  - *The degree to which a system, component, or process meets customer or user needs or expectations*

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What is the challenge about software quality assurance?

Software quality challenge

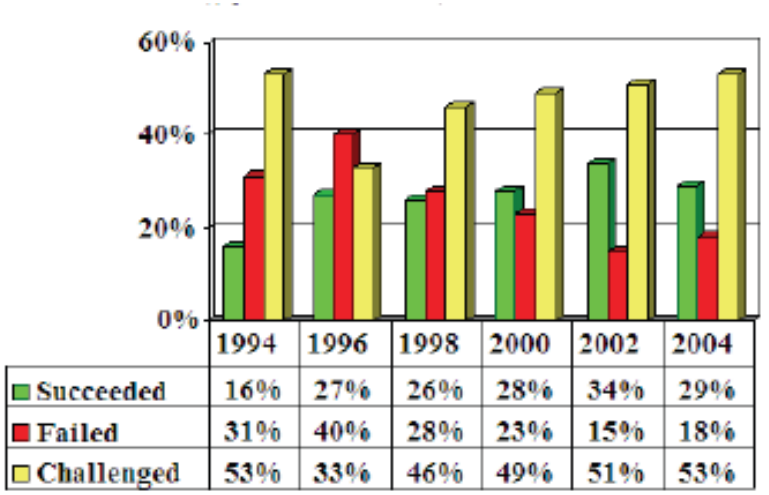
- Differences between software and other industrial products
  - Product **complexity**
    - Multitude of operational possibilities
  - Product visibility
    - Software is **invisible** as well as defects
  - Product development and production process
    - **Defects detected** only during development phase
    - Production process is not required.

Software Failures

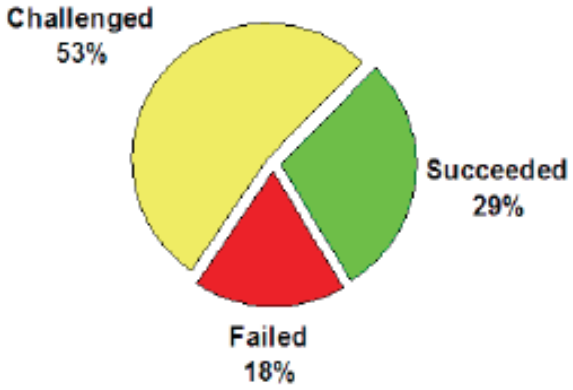
- Software failures everyday and in every country
  - Business and societal costs are over billions of dollars a year.
  - Universally unprejudiced

Costs of software development

- IT is one of the largest corporate expenses outside employee costs. (5-10%)
- DataMonitor estimate of 2013: Costs of software industry, $450 billion.
- 5-15% projects will be abandoned before or shortly after delivery as hopelessly inadequate. [1]
- Standish Group Chaos Report: 50% are challenged (late or over budget delivery)



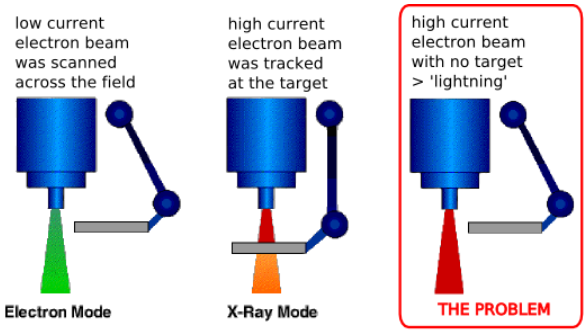
	1994	1996	1998	2000	2002	2004
Succeeded	16%	27%	26%	28%	34%	29%
Failed	31%	40%	28%	23%	15%	18%
Challenged	53%	33%	46%	49%	51%	53%



1 Charette 2005, Why software fails,IEEE Spectrum.

Software Hall of Shame

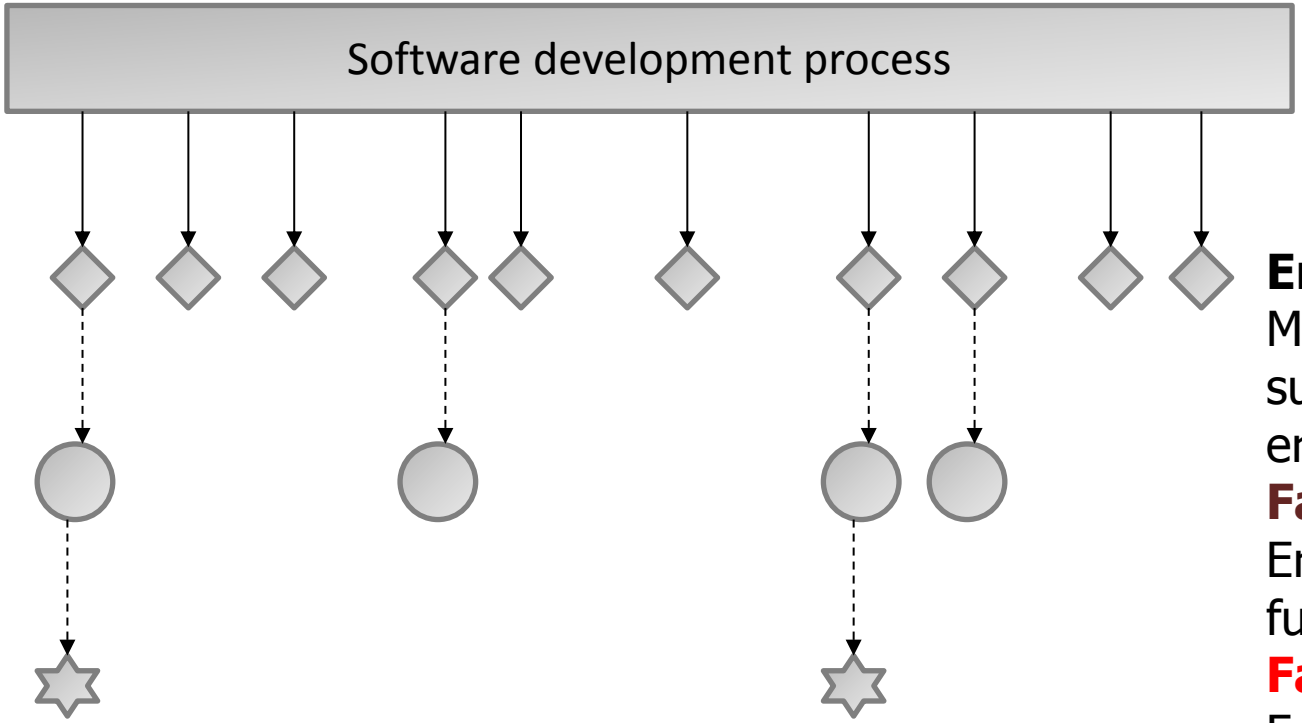
- Ariane 5 Rocket Explosion (1996)
  - Development cost $7 billion, rocket $500 million
- Mars climate orbiter (1999)
  - Orbiter $125 million
- Therac-25 Radiation Therapy (1985-1987)
  - The worst accident in 35-year history of medical accelerators
- Resource planning in FoxMeyer Drug Co. (1996)
  - Bankruptcy
- See more from ”Why Software Fails”, IEEE Spectrum, Volume 42 Issue 9, September 2005.



tray including the target, a flattening filter, the collimator jaws and an ion chamber was moved OUT for "electron" mode, and IN for "photon" mode.

←HOMEWORK #2

Error → Fault → Failure



Error
Made by programmer such as grammatical error or logical error

Fault
Error can cause improper functioning of a software

Failure
Fault becomes failure only when it is ”activated”.

Figure from (Galin, 2004)

Software Quality Assurance

- IEEE definition 1991
  (1) A planned and systematic pattern of all actions necessary to provide adequate confidence that an item or product conforms to established technical requirements
  (2) A set of activities designed to evaluate the process by which the products are developed or manufactured. – Contrast with quality control

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According to Galin (2004), SQA should not be limited to a) development process, b) technical aspects of the functional requirements.

Software Quality Assurance (SQA)

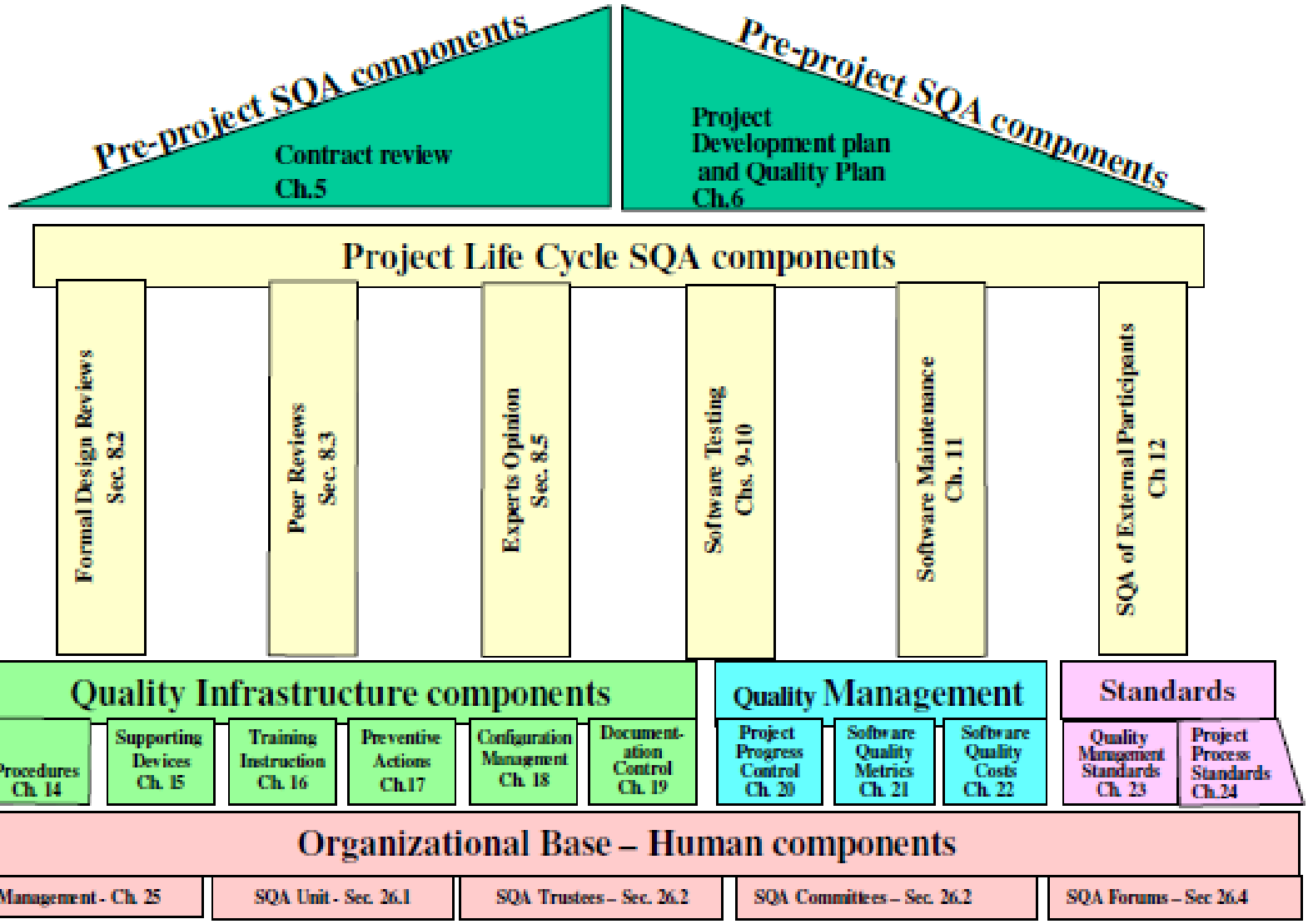
- Expanded definition by Galin (2004)
  - A systematic, planned set of actions necessary to provide adequate confidence that the software development process or the maintenance process of a software system product conforms to established functional technical requirements
    - as well as with the managerial requirements of keeping the schedule and
    - operating within the budgetary confines.

SQA vs. Software Quality Control

- Quality control
  - A set of activities designed to evaluate the **quality of** a developed or manufactured **product** (IEEE, 1991)
- Quality assurance
  - A set of activities performed during development processes
  - Minimizing the cost of guaranting quality
  - Preventing causes of errors

”Quality control are only a part of the total range of quality assurance activities.”

The Software Quality Shrine



From Galin 2004

History of Quality Control Models

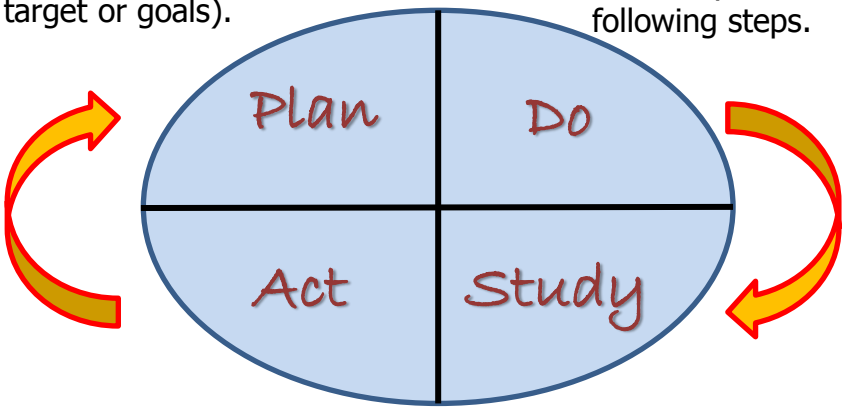
Plan – Do – Study – Act (PDSA)

- Originated in 1920s (Japan)
- Shewhart, Deming, Juran worked all in AT&T Bell Labs.

- Iterative 4-step management method for the control and continuous improvement of processes and products.

Establish the objectives and processes necessary to deliver results in accordance with the expected output (the target or goals).

- Implement the plan, execute the process, make the product.
- Collect data for charting and analysis in the following steps.



- Request corrective actions on significant differences between actual and planned results.
- Analyze the differences to determine their root causes.
- Determine where to apply changes that will include improvement of the process or product.

- Study the actual results and compare against the expected results to ascertain any differences.
- Look for deviation in implementation from the plan.
- Look for the appropriateness/ completeness of the plan to enable the execution.

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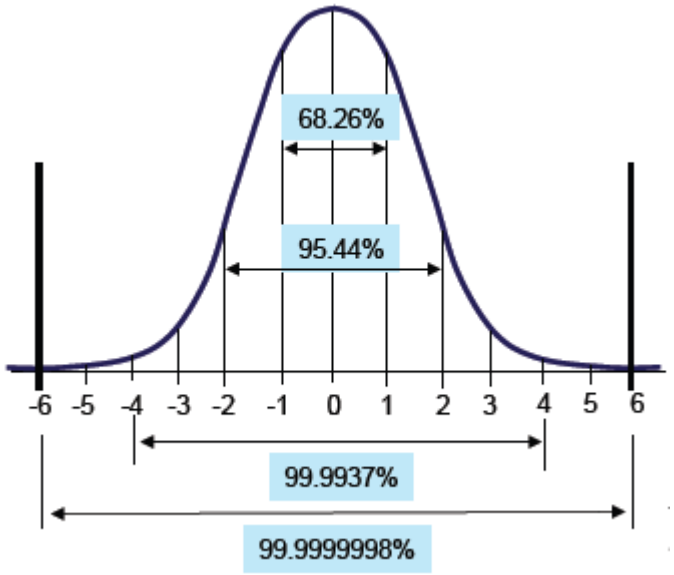
Six Sigma

- First initiative in Motorola 1987.
- Process/ Product/ Service Quality Improvement and Cost Reduction
- Extension of PDSA: Define, Measure, Analyze, Improve, Control
- Involves extensive usage of statistics to minimize process variations and product/ service defects.

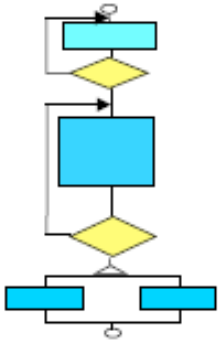
Six Sigma

- Why is it 6 sigma?
- Metrics
  - Defects per million opportunities (# critical defects that the process is estimated to generate per million opportunities (operations or steps))
  - Sigma quality level (Process at 6 Sigma level is expected to generate 3.4 defective parts per million.)
  - Yield (the estimated percentage of defect-free items (probability of zero defects) churned out by a process)

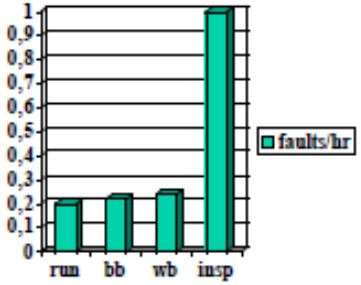


Statistical Process Control (SPC)

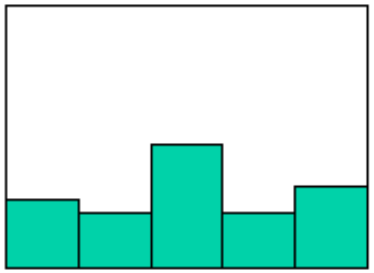
- Monitor the inputs and outputs of processes
- Control variations of measurements
- Use of a suite of techniques
  - Process flow charts
  - Tally charts
  - Histograms
  - Pareto analysis
  - Cause-effect diagrams
  - Scatter diagrams
  - Control charts



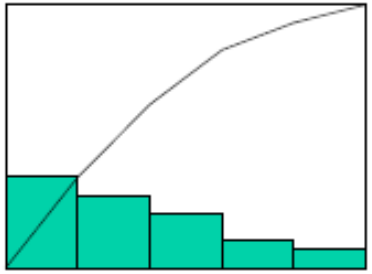
Process flowchart



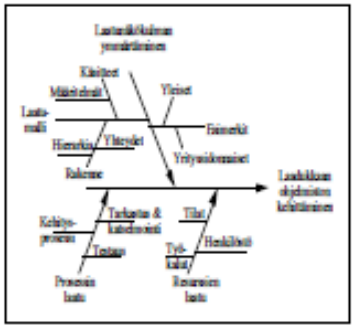
Tally chart



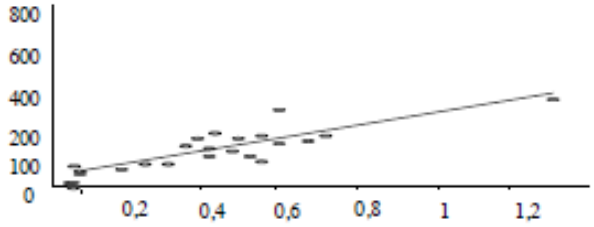
Histogram



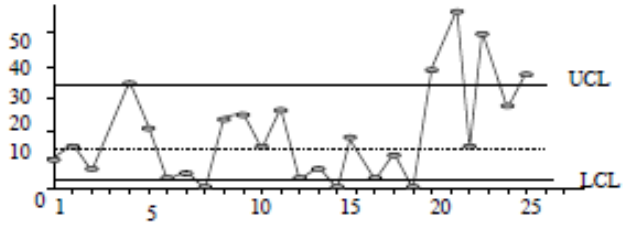
Pareto diagram



Ishikawa diagram

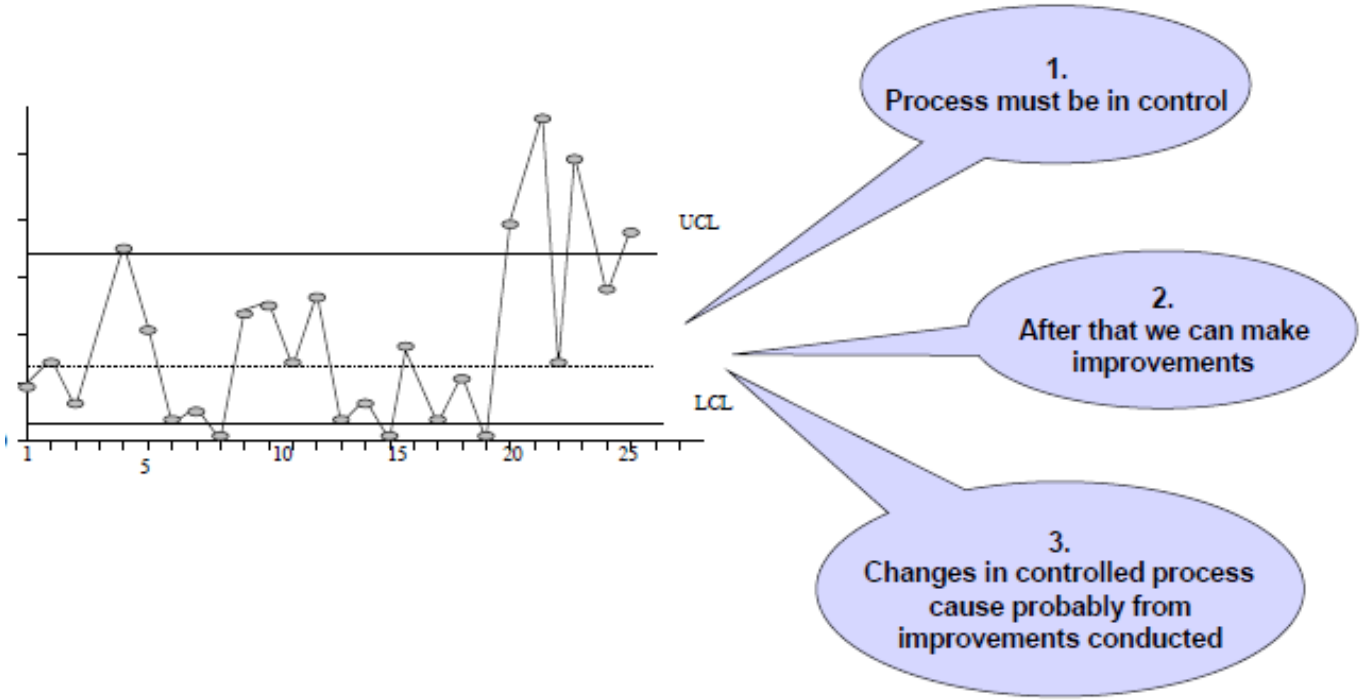


Scatter diagram



Control chart

SPC – Control Charts



- Uses 3 sigma limits
- CMMI (Capability Maturity Models) suggest using SPC during implementation of Level 4 and 5.

Total Quality Management (TQM)

- 4 principles
  1. Focus on work processes (assess, analyze and improve)
  2. Analysis of variability (control the variance in process)
  3. Management by fact (collect data, use statistics, experiment)
  4. Learning and continuous improvement

Customers
- quality for the customer

Culture in company
- shared values and beliefs

Counting
- tools, techniques and training in their use

SPC as part of TQM

TQM: A set of core values

- Explicit identification and measurement of customer requirements
- Creation of supplier partnerships
- Use of scientific methods to monitor performance and to identify points of high leverage for performance improvement
- Use of process-management heuristics to enhance team effectiveness (flow charts, brainstorming, cause-effect diagrams)

References

- Hoyer, R. W. and Hoyer, B.Y., *What is Quality*, Quality Progress, 2001, vol. 34, issue 7.
- Charette, R., *Why software fails*, IEEE Spectrum, 2010.
- Galin D., *Software Quality Assurance: From theory to implementation*, Addison Wesley, 2004.
- Garvin, D.A., *What does "Product quality" really mean?*, Sloan Management Review, 1984.
- Hackman, J.R., Wageman, R., *Total Quality Management: Empirical, Conceptual, and Practical Issues,* Administrative Sciences Quarterly, 40, 309-342, 1995.
- For more info. on software failures, see:
  - http://www.ima.umn.edu/~arnold/disasters/ariane.html
  - http://courses.cs.vt.edu/cs3604/lib/Therac_25/Therac_1.html
  - http://www.devtopics.com/20-famous-software-disasters-part-3