Assessing the Health of Your SPC System

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The Questions

● How do you know if your SPC processes are healthy?
● What would an ideal SPC system look like?
● Where could your SPC system fail?
● How do you track the health of your SPC system on an ongoing basis?
Assessing the Health of Your SPC System
The following analysis is presented for SPC control charts; however, the same approach is applicable to all control-phase methods.

Case Study: The Blue Flashing Light
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- Too many run rules
- Too many charts
- There is always at least one chart that is out of control
- Operators become desensitized to the blue flashing light
- A missed, real out-of-control event can have devastating consequences

Multiple Testing Errors in SPC

- SPC is a prime example of an opportunity to suffer from excessive type 1 / false alarm errors caused by multiple testing from keeping too many run rules on too many charts.
- Each run rule has its own false alarm / type 1 error rate.
- The run rules are not strictly independent of each other but their errors are roughly additive.
- The error rates from several charts are roughly additive.
Multiple Testing Errors in SPC

**Example:** Suppose that four control chart run rules, each with false alarm / type 1 error rate of about 0.5%, are applied to four control charts. What is the overall false alarm / type 1 error rate for the family of rules and charts?

**Solution:**

\[
\alpha_{\text{family}} = \sum_{i=\text{chart}} \sum_{j=\text{rule}} \alpha_{ij}
\]

\[
\approx 4 \times 4 \times 0.005
\]

\[
\approx 0.08
\]

That is, we can expect one false alarm / type 1 error to appear at, on average, in about every \(\frac{1}{0.08} = 12\) sampling intervals. This rate might be acceptable if we’re sampling hourly; however, we must be very careful if we intend to sample more frequently or plan to use more run rules and/or keep more charts.

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**SPC Chart Lifetime**

- Shewhart designed SPC long before control charts could be maintained by computers.
- He expected that an operator could keep no more than 3-4 charts at a time with a few run rules.
- Which charts were kept is determined in reaction to recent and current problems.
- As the problems are resolved the charts kept for them are demoted - sampling frequency and sample sizes are reduced until the charts go away, i.e. chart life is finite so the set of charts kept is dynamic.
- SPC chart Pareto principle: Some control charts are more productive and valuable than others. Keep those few charts.
- You’re keeping the correct set of charts if you can’t operate the process (to deliver the desired level of quality and productivity) without the current set of charts.
- Keeping too many charts dilutes the benefits of SPC - a muddle of charts versus a finely-tuned set of charts.
- Will cause the operators to lose faith in the value of SPC
Quality Cost of SPC

- Actual SPC practice often diverges from its intent
- If performed correctly then SPC is a prevention cost
- If the control feedback loop is not practiced, then SPC is an appraisal cost at best, i.e. Statistical Process Documentation
- If no one looks at or uses the data, then SPC is a failure cost
- If SPC is only performed to meet contractual requirements, e.g. the purchase order requires it, then SPC costs are a cost of doing business

Phases in the Life Cycle of a Control Chart

- Before we can assess the health of an SPC process we must understand the life cycle of a control chart.
- There are six phases in the life cycle of a control chart:
  - Concept
  - Design
  - Implementation
  - Production
  - Reassessment
  - End of Life
- As we review the six phases, ask:
  - What would best practice look like?
  - How could this step go wrong?
Phases in the Life Cycle of a Control Chart

- Concept
  - Recognize a problem/opportunity
  - Identify an appropriate measurement
  - Choose a measurement instrument
  - Choose a statistic
  - Choose an appropriate control chart

- Design
- Implementation
- Production
- Reassessment
- End of Life

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Phases in the Life Cycle of a Control Chart

- Concept
- Design
- Validate the measurement system
- Chart design parameters
  - Subgroup design
  - Sample size
  - Sampling interval
  - Control limits
  - Run rules
  - Role in the family of charts
- Process log
- Finalize the chart design

- Implementation
- Production
- Reassessment
- End of Life
Phases in the Life Cycle of a Control Chart

- Concept
- Design
- **Implementation** (chart is evolving in this period, some early improvements to the process are possible/likely)
  - Train the operators
  - Give the operators authority to manage the process
  - Run with the preliminary control chart
  - Refine the chart
  - Debug the SPC process
  - When the SPC process is stable, put the chart into production

- Production
- Reassessment
- End of Life
SPC Process
The SPC process per Shewhart:
1. Identify appropriate processes to track
2. Collect timely data
3. Keep a process log to correlate out-of-control events to potential special causes
4. Interpret the data in a timely manner
5. Take appropriate action:
   a. Only common causes present: Keep your hands off!
   b. One or more special causes present:
      i. When the out-of-control event is bad, change the process to prevent it from occurring again.
      ii. When the out-of-control process is good, change the process to make it permanent.

Phases in the Life Cycle of a Control Chart
- Concept
- Design
- Implementation
- Production
- Reassessment
  - Review/revise chart design parameters
  - Revalidate the operators
  - Revalidate the measurement system
    - Is the choice of instrument still appropriate?
    - Is the instrument still capable?
- End of Life
Phases in the Life Cycle of a Control Chart

- Concept
- Design
- Implementation
- Production
- Reassessment
- End of Life

  - If the chart required to meet the contractual requirements of the customer, then keep it
  - Perform cost/benefit analysis - confirm that the chart is still useful/productive
  - Test for chart end-of-life
    - Process problem is still present - continue using the chart
    - Why hasn’t the problem been eliminated? Review the corrective actions
    - Problem has been eliminated - kill the chart

SPC Audit Checklist - Design

- What would the ideal SPC system look like, in terms of design, practice, value?
- Brainstorm a list of benefits
- How could the SPC system fail?
- Brainstorm a list of risks
- Refine the answers into categories with subpoints
- Write pointed questions or observation points that address the issues
- Assign weights to the items
- Choose a scoring system such as:
  - \(-1\) = deficient
  - \(0\) = nominal
  - \(+1\) = superior
- Multiply weights by scores, calculate category sums, calculate grand total score
- Track the category sums and grand total on their own control charts
SPC Audit Checklist - Execution

- Identify the scope of the SPC audit
- Map out the hierarchy of charts kept: departments, production processes, specific SPC charts
- Choose a sample of the SPC processes to audit
- Use the audit checklist to collect baseline data before making any changes/improvements to SPC processes
- Use the audit findings to identify opportunities for improvement
- Implement SPC process improvements
- Use the periodic SPC process audits to track performance changes
- Use the audit checklist on a maintenance basis to preserve the gains

Presentation Notes

- [www.mmbstatistical.com/Notes/AssessingYourSPCSystem.pdf](http://www.mmbstatistical.com/Notes/AssessingYourSPCSystem.pdf)
- [www.mmbstatistical.com/Notes/SPCAuditChecklist.xls](http://www.mmbstatistical.com/Notes/SPCAuditChecklist.xls)