Assessing the Health of Your SPC System

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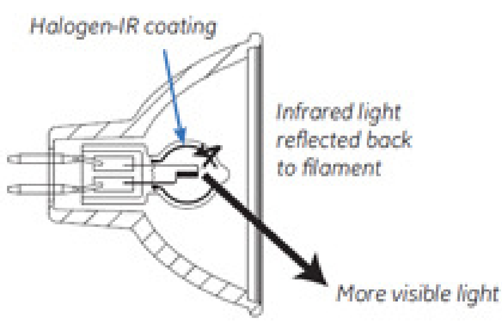
The Questions

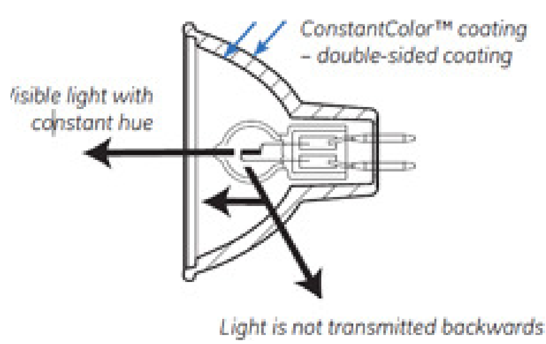
- How do you know if your SPC processes are healthy?
- What would an ideal SPC system look like?
- Where could your SPC system fail?
- How do you track the health of your SPC system on an ongoing basis?

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.

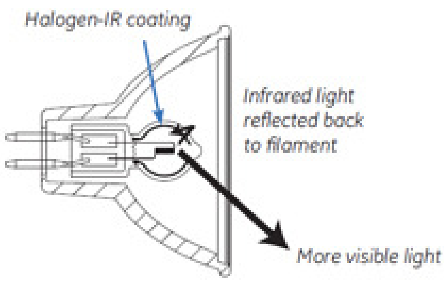
Case Study: The Blue Flashing Light

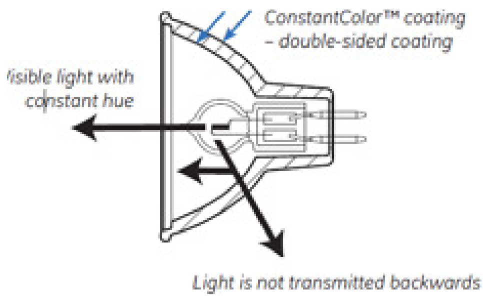




Case Study: The Blue Flashing Light

- 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 consquences





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:

$$\begin{aligned} \alpha_{family} &= \sum_{i=chart} \sum_{j=rule} \alpha_{ij} \\ &\simeq 4 \times 4 \times 0.005 \\ &\simeq 0.08 \end{aligned}$$

That is, we can expect one false alarm / type 1 error to appear at, on average, in about every $1/0.08 = 12$ 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.

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

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

Phases in the Life Cycle of a Control Chart

- Concept
- Design
- Implementation
- **Production** (**chart is static in this period**, **focus is on improving the production process**)
  - **Operate the chart** (**see the following slide**)
  - **Improve the production process**
- 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. Interprete 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*
- *www.mmbstatistical.com/Notes/SPCAuditChecklist.xls*