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TenStep Supplemental Paper

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Understanding Statistical Process Control

Quality practitioners use Statistical Process Control (SPC) to monitor, manage, analyze, and improve process performance by eliminating special causes of variation. While traditional inspection-based quality control systems can be expensive and inefficient, SPC gives companies the benefits of a scientific, data-based management style where decisions are based on facts. The philosophy behind SPC is that process output can be statistically controlled through engineering and management action. This approach helps companies to:

- Identify critical problem areas in a process
- Reduce variation
- Check for abnormal variations
- Determine the capability of a process
- Understand and optimise processes
- Determine the reliability of the product

Although SPC appears to be an easy and straightforward technique, its implementation is rather complicated. The successful application of SPC requires a combination of skills such as engineering, management, teamwork, and planning. The use of control charts is a critical aspect of SPC, but it is not the only way SPC can be implemented. There are ten key ingredients for the successful implementation of SPC. These include:

1. **Management commitment**

   Commitment from senior management is crucial for the successful application of SPC. Managers should first understand the importance of SPC as a variation reduction technique. Therefore, senior managers must also be trained on the concept of SPC and its underlying principles. Management should also provide adequate budget and resources for improving existing processes/systems.

2. **Training**

   For the best results, SPC training should begin at the higher levels of the company and then cascade down through the hierarchy. In general, staff does not respond to SPC initiatives unless managers are familiar with them. In-house training courses followed by projects and workshops ensure faster learning. Training should include appreciation of SPC, exposure to relevant statistics, use of quality tools in SPC, and the creation and implementation of control charts. Some companies even appoint an SPC facilitator who establishes, monitors, and develops the SPC program. Responsibilities of an SPC facilitator include:

   - Offering practical advice to senior managers and employees
   - Providing information on all aspects of SPC

- Monitoring progress and ensuring prompt, effective action
- Assisting in the development of a training strategy

3. Teamwork

Today's fast-paced business needs demand close interaction and teamwork between various departments. Senior management members, a steering committee, and a process action team all have a hand in the successful implementation of SPC. The steering committee may include an SPC facilitator, a quality manager, a production manager, a purchasing manager, a process manager, and a maintenance manager. This committee should be responsible for initiating, managing, and controlling the SPC implementation. Top management should not only support and give total commitment to SPC implementation, but also delegate the responsibility of the implementation to the steering committee. Progress can be monitored based on reports from this committee.

The steering committee and top management support the process action team. The process action team must identify the assignable (or special) causes of variation within a process and make the appropriate changes. A typical process action team can consist of operators, their supervisors, a process engineer, quality engineers, a maintenance engineer, and an SPC expert.

4. Process definition

This is one of the key issues to be dealt with in the early stages of any SPC implementation. Processes should be tackled one at a time and worked on until significant results are achieved. Companies should also prioritize processes based on statistical and technical importance. Here, statistical importance refers to the stability and capability of processes, while technical importance focuses on how critical a process is to the quality of the finished product. After identifying a process, it must be defined in terms of its affiliation with other operations.

5. Process parameters

It is important to choose the performance characteristics or process parameters that are the most critical to the process performance and product quality, and that can be measured accurately. It is also important to choose continuous performance characteristics rather than simple attribute characteristics.

6. System evaluation

Measurement helps in the understanding of a particular aspect of the product or process. Like processes, measurements can also vary. Uncertainty in measurement is attributed to a number of inputs, such as gauges used, operator errors, and measuring methods. All of these cause variation within the measurement process. It is important to identify, isolate, and eliminate these variations in measurement. SPC studies should not be implemented until measurement systems are found to be stable and capable.

7. Control charts

Control charts are used to detect whether a major change or shift in a process is imminent or has already occurred. Selecting the appropriate control charts is absolutely critical for the success of any SPC program. For variable data like weight, length, thickness, strength, force, and pressure, variable control charts (e.g. X-bar and R chart) are ideal. In contrast, when data is of an attribute nature (like good/bad or pass/fail), attribute charts (e.g. p-chart) must be used.

8. **Cultural change**

   Successful implementation of SPC involves a cultural change in the work environment. Employees who are closest to a process should be empowered to take ownership of their everyday processes. When people closest to the process cannot handle problems, the process action team can resolve them with the support of the steering committee and management.

9. **Pilot project**

   It is not advisable to apply SPC to all areas/departments simultaneously. The SPC steering committee could draw up a pilot project to encourage the use of SPC as a powerful problem-solving tool. It is important to first gain the support of top management and the interest of employees involved. Once SPC is successfully applied to one process, it is easy to extend its use to other areas within the department and across other departments.

10. **Computers and SPC software packages**

    Companies now use computers in most every area. Use of SPC software packages has enabled users to plot control charts, eliminating the manual calculations involved in determining control limits and charting procedures. However, be sure that operators and other personnel involved in SPC projects fully understand the principles of SPC before using the software package.

It is often argued that SPC techniques are objective, but their use in decision-making is more subjective. It is up to individual engineers or managers to interpret the results and take further actions. Simply plotting a control chart or calculating a process capability index cannot improve quality or prevent process deterioration. The benefits of SPC depend on how the results are interpreted and used.

From control charts to Pareto analysis, SPC offers many tools to improve performance. However, even the most stringent statistical techniques will not help unless they lead to process changes. Variation may be an integral part of processes, but if you find unusual variations and deal with them, you will be closer to reaching quality and productivity goals.

Unfortunately, organizations are often torn between short term business needs and the need to get to the root cause of a problem. They often make a choice in favor of the former. This is especially true if operators are given the impression that by bringing variations to the attention of management, they are being seen as bearers of bad news. They can feel pressured to keep measurements within limits if management is not

supportive. There are three types of adjustments that are often made without actually addressing the root cause of the problem. They are:

- **Choosing the sample.** Process operators are expected to randomly pick samples, collect process data, and enter it into the control chart. However, they may pick and choose a sample that will fall within the desired limits to comply with management requirements.
- **Entering wrong readings.** Operators adjust their SPC readings by entering inaccurate data into the control chart.
- **Tinkering with the process.** Operators may tinker with the process to get better readings. Such adjustments give the operator a psychological feeling that the problem has been resolved.

These adjustments prevent SPC from being effective. Ultimately, the organization will pay for poor quality. Organizations need to re-evaluate the way they view and implement SPC. They should first decide to what extent they are willing to accept variability in the process. Based on this, they can provide reasonable process control limits.

Operators manning the process should be assigned the task of collecting data and entering it into the SPC control charts. Studying the control charts, identifying root causes, and prescribing corrective action should be assigned to the quality control or engineering personnel. This way, the operators will no longer experience stress when the process strays from the specified SPC limits. Therefore, they will not feel pressure to misrepresent process information. Of course, the success of the SPC initiative will ultimately depend on management commitment and the engineering personnel's motivation to meet the highest quality standards.