STRATEGIC MANAGEMENT OF RECEIPT INSPECTION

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The process of determining acceptability of a lot of material by inspecting a sample is known as acceptance sampling. Acceptance sampling can be performed at any stage in a process from the initial receipt of materials to the inspection of finished product [1]. Viewed as an isolated activity, inspection identifies unacceptable material but does not improve the quality system. Since quality cannot be inspected into a material or product, the inspection and sampling process is often viewed as a cost-added, necessary evil of a comprehensive quality system. However, a strategically managed and directed inspection program can be a major catalyst for system improvement.

Consider the inspection which occurs at the receipt of purchased materials as described in Figure 1. Positioned between external suppliers and internal customers or end users, the receipt inspection process (sometimes called incoming materials or receiving inspection) is uniquely located to be a key catalyst for communication and problem solving in a comprehensive and system-oriented quality program.

Receipt inspection should be recognized as a strategic link in the material supply chain. The information from the inspection process can be used by both internal groups (such as end users and purchasing) and external suppliers to improve organizational quality by promoting the communication needed to identify and solve problems. Assuring the quality of purchased materials is the immediate short-term goal of receipt inspection, but promoting the long-term, continued improvement of the quality and value of purchased materials must not be ignored.

This article is a description of the program of a federal research center to improve receipt inspection performance and integrate these activities into the total quality, mission assurance, and reliability efforts of the site. Inspection is often viewed as old news in state-of-the-art quality programs. However, when inspection of purchased materials is necessary (such as in many ISO-9000 systems), the authors hope this article will be a catalyst for production and inventory control professionals to strategically examine the receipt inspection activities to determine if they meet organizational goals for long-term quality improvement.

IMPROVEMENT ISSUES AND GOALS

A federal research center was in the initial stages of a sitewide quality improvement effort. With 3,000 employees and contractors on site and a mission that covered aeronautic and aerospace research and testing activities, this was a challenging task. Due to the impact that failure of a single piece of hardware could have on the unique, one-of-a-kind products and facilities of the center, the receipt inspection area was identified as a critical activity in the quality effort. A review of data indicated that an average of over 10% of the received line items were defective.

Management's primary objective in developing an improvement plan for receipt inspection was to change the process from reactive to proactive in nature. In the past, the receipt inspection function had simply presented results from the sampling process. Management made a determination to turn this effort into one which proactively made a difference in the quality of a product which arrived for inspection. This was a critical step and a realization that since all inspection processes have a possibility of accepting defective material (even in 100% inspection, the possibility of error exists), the process which improves product supply from the vendor will yield superior long-term results.

Based upon a strategy which would begin the process of continuous long-term improvement and at the same time yield immediate short-term results, the plan focused on three key elements:

- It had to involve suppliers in a demanding yet supportive manner. Suppliers had to understand that business as usual was not acceptable. However, the research center was willing to support a supplier's conscientious efforts to improve.

- It had to involve the total research center organization and present the opportunity for involved parties (from purchasing to end users) to participate and reap the benefits while buying into the risks of change.
- It had to rationalize the inspection activity in a value-added context. This could occur only if the level of defects decreased over the long term.

To accomplish these goals, it was clear that the sampling plan used in receipt inspection was a key element.

SAMPLING PLAN ISSUES

In the context of a centerwide total quality effort focused on promoting new methods and attitudes, center management was uncomfortable with several aspects of the existing sampling plan based on Military Standard 105E (Mil Std 105) [3]. This plan permits acceptance of a lot if less than a specified number of defects is found in the sample; the acceptable number of defects is often greater than zero. Statistical issues aside, management saw that the acceptance of a lot with *any identified defects* was philosophically unacceptable and incongruous with the new approaches desired by the center quality program. Management realized that although a sampling plan cannot guarantee quality, it can convey goals and ideals beyond numbers and probabilities. An improved method was desired based on accepting lots only if the sample contained zero defects. Such a plan would send the desired message to both internal and external groups: any level of defects in materials received at the center was unacceptable.

The present sampling plan had a significant hidden cost. Instead of placing responsibility on the supplier for identifying and correcting defective lots, it burdened the center receipt inspection group with considerable effort to rectify a defective lot. For rejected lots, the existing plan typically required some form of increased inspection such as accelerated sampling, 100% inspection, or both. Since none of this effort is value added, management adopted the position that defective lots should not result in the expenditure of additional effort by the receipt inspection group. Once a lot is identified as defective, it should be returned to the supplier who assumes responsibility for assuring only material which meets all specifications is returned to the research center. The receipt inspection group would add more value if its effort was directed at identifying and resolving the reason the lot was rejected.

Finally, the existing sampling plan was not clearly understood by suppliers or users and it did not facilitate the communication necessary to improve the supply chain.

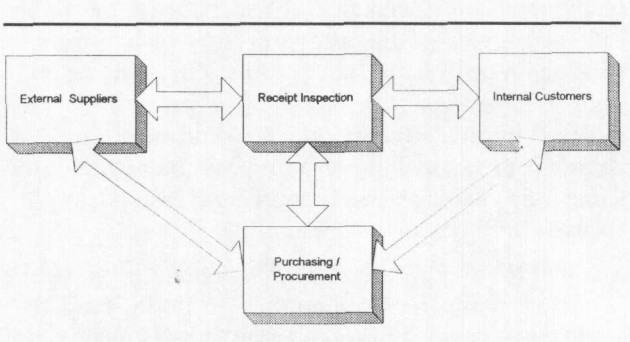

FIGURE 1: Functional relationships

NEW SAMPLING PLAN

To meet program objectives, "zero defect" (also called C = 0 and zero acceptance) sampling plans, which specify rejection of a lot if more than zero defects are found in a sample, were particularly attractive. This type of plan is clear to both internal and external groups in its adherence to a consistent performance target—no defects in the lot. A local manufacturing plant had been using a zero-defect plan for receipt inspection for five years with positive results. This plan was specifically developed to replace Mil Std 105 and had been "designed to provide superior defect protection with less inspection effort [2]." The next paragraphs will examine the two parts of this claim by comparing the zero-defect plan and original Mil Std 105-based plan.

Superior Defect Protection

To verify the claim of equal or greater protection against defects, operating characteristic (OC) curves must be examined. Sampling plans are characterized by OC curves which plot the probability of accepting a lot at a range of defect levels. (The reader is referred to [1] for a complete review of operating characteristic curves and sampling theory.) Two lot defect levels draw particular focus in OC curves. The acceptable quality level (AQL) is that defect level which will be accepted with a high probability and is supposed to represent acceptable process quality. On the other end of the spectrum, the lot tolerance percent defective (LTPD) is the defect level which should be rejected with a high probability. This level of defects represents unacceptable quality. The improved defect protection

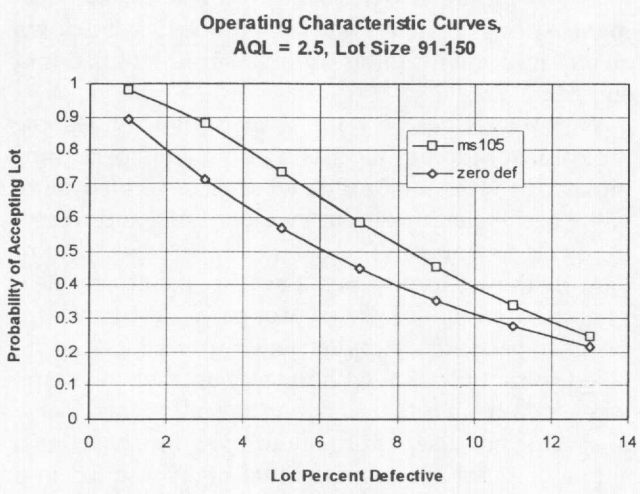

FIGURE 2: Operating characteristic curve comparison, AQL = 2.5

TABLE 1: Sample Size Comparison, AQL = 2.5

	Mil STd 105 Plan		*Zero-Defect Plan*	
Lot Size	*Sample Size*	*Accept/ Reject*	*Sample Size*	*Accept/ Reject*
2–8	5	0/1	5	0/1
9–15	5	0/1	5	0/1
16–25	5	0/1	5	0/1
26–50	5	0/1	5	0/1
51–90	20	1/2	7	0/1
91–150	20	1/2	11	0/1
151–280	32	1/2	13	0/1
281–500	50	2/3	16	0/1
501–1200	80	5/6	19	0/1
1,201–3,200	125	7/8	23	0/1
3,201–10,000	200	10/11	29	0/1

claim of the zero-defect plan focuses on the LTPD and should result in a higher probability of rejecting (and conversely a lower probability of accepting) a lot with a defect rate at the specified LTPD. The selected zero-defect plan targets improved defect protection at the 10% defect level.

Figure 2 shows a typical comparison of operating characteristic curves for a lot size of 91–150 and AQL = 2.5. The zero-defect plan gives a 31% probability of accepting a 10% defective lot compared to nearly 40% probability for the Mil Std 105-based plan. The zero-defect plan does offer superior consumer protection as claimed. In this case the zero-defect plan is superior at all defect levels.

Most of the research center management was not familiar with OC curve theory and was very surprised with these probabilities of accepting high defect rates. This fact alone served to emphasize the critical importance of system improvement as a more potent tool for quality improvement than reliance on inspection.

Level of Inspection Effort

The question of inspection effort can be answered by a comparison of sample sizes stipulated by each plan. Table 1 shows a typical comparison of the sample quantity for an equivalent quality target. The claim of less inspection can be verified from this table since the zero-defect plan stipulates equal or smaller lot size in each case.

The zero-defect plan contains a less obvious source of inspection time savings. By definition, the zero-defect inspection effort stops as soon as the first defect is found, but Mil Std 105 plans continue inspection until the reject number is exceeded. For example, in Table 1 for a lot of 281 to 500 items, Mil Std 105 continues inspecting when two or less defects are found but rejects the lot at the third defect.

Since the claims of less inspection effort and higher defect protection were verified, the zero-defect plan [2] was adopted to replace the Mil Std 105-based plan.

PROGRAM IMPLEMENTATION

The revised inspection program was implemented in three steps. The first step developed the combined involvement of center internal functions including the purchasing group, the using groups, and the inspection group. Risks and objectives were reviewed and unanimous commitment to the program goals was ob-

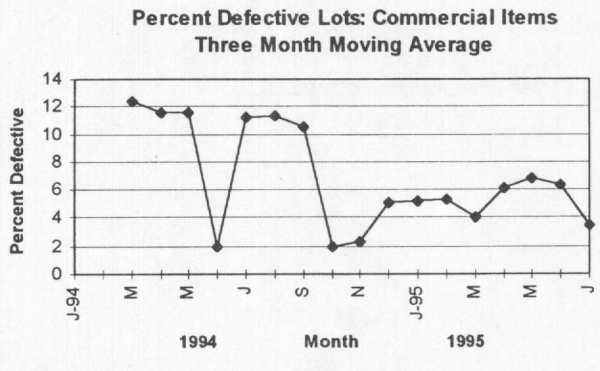

FIGURE 3: Percent defective trends

tained. A critical element of this step was the establishment of communication procedures between these groups and the vendors, to allow discussion of issues such as materials, specifications, and substitutions.

The second step involved notification from the purchasing group to all suppliers describing the new inspection program at the center. The letter notified vendors that any lot which failed to meet the zero-defect standard would be returned and that any vendor with three returned lots would be removed from the vendor list. The letter also offered to assist suppliers in meeting this new standard by consultation and visits to help suppliers improve their quality systems.

Special attention was given to the federal defense supply centers since such a large amount of material was received from these organizations. Meetings were conducted with the supply center directors to explain the program. These managers immediately perceived the possible benefits of information from the program and committed to take these new data and work with their suppliers to improve the supply chain at an additional level. This step achieved a huge expansion of the program benefit since improvement would be achieved for all customers of the federal supply centers and not only the research center.

Step three involved the implementation of the zero-defect sampling plan. This was started across the board with the exception of any product that had been purchased under a preexisting contract which stipulated a different inspection plan. The long-term goal is to use the zero-defect plan as a basis for any future contractual inspection.

RESULTS

As an immediate and clear measure of program performance, the level of defects from commercial suppliers was tracked. The program has been fully implemented since the last half of 1994, and quantitative results are promising. Figure 3 shows a significant reduction in the three-month moving average of the percent defective lots beginning in the last quarter of 1994. Since many of the center suppliers provide specialized items which are not frequently purchased, management expects the defect rate to continue to trend down as any issues with these suppliers are identified and solved.

With the reduced level of inspection activities, the receipt inspection group has been able to spend time on vendor visits and audits which have added more value to the quality system by identifying and resolving problem causes. This value-added aspect is evident in the uniformly positive response to the new program from both internal groups and external suppliers. In particular, suppliers have appreciated the detailed communication with the end user which occurs when a problem is identified. As a result of this review of specific end-user requirements, vendors have been able to suggest substitutions that often resulted in a higher quality item at an equal or lesser price. Vendors have improved internal processes with a resulting enhancement in their position to compete for new customers.

CONCLUSIONS

The incoming materials inspection process can serve as a catalyst for organizational quality improvement. Due to its strategic position at the interface of vendors and users it can facilitate communications and continuous improvement. It is critical that the inspection standards are clearly understood by suppliers and fit the strategic and business needs of the organization. A zero-defect sampling plan, which is easily documented, understood by all involved parties, and clearly defines the standard of performance, can be a tool for improving the quality performance of the supply chain.

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