THE RED BEAD EXPERIMENT

People: Six workers consistently referred to as "Willing Workers."; two inspectors and one chief inspector; one recorder.

Materials: Red and white spherical beads; commercially available demonstration kits generally provide 4,000 beads: 3,200 white, 800 red; a container to hold the beads; A paddle with 50 indentations that will hold one bead each.

Processes: Willing workers dip the paddle into the bead container until it is completely covered, then carefully withdraw it. Gently shaking the paddle and allowing excess beads to roll off results in a paddle with a bead in each of the 50 indentations.

During the experiment, each willing worker, in turn, dips the paddle into the container and produces a sample of 50 beads. This is repeated for several rounds, usually four or five, to simulate a number of workdays—willing workers produce one sample per day. After the willing workers produce their sample, they report to an inspector who counts defects. A defect is a red bead or a vacant indentation. The willing workers then report to a second inspector who makes a second count of defects. After making their counts, the inspectors report to the chief inspector who checks the results of the inspectors. If the results are the same, the chief inspector reports the number to the recorder. If the results are not the same, the chief inspector counts the defects, reports that number to the recorder, and directs the willing worker to dump the beads back in the container and return to the work line. The recorder writes all results on a matrix that shows willing worker performance by day.

In practice, the facilitator of the experiment adds other, potentially confounding elements to the experiment. Willing workers are provided brief training and told they will have an apprenticeship period. They are then put directly to work without any period of apprenticeship. New workers who are added to the line as a result of dismissals are given no training. The facilitator announces a quota of no more than one red bead per day. The facilitator praises good performance—a very low number of defects—and condemns or punishes with dismissal poor performance—a very high number of defects. The facilitator may throw in quality slogans and generally exhort the willing workers to perform better. After several days work, the facilitator threatens workers with dismissal because of their inconsistent and generally poor performance. After all, no one is meeting the quota of no more than one defect per paddle. The facilitator ensures that senior managers among the participant group are included in the willing worker group and, as the experiment progresses, points out their poor performance to the great glee of the other participants. Finally, when all workdays are complete, the facilitator closes the operation and tells all willing workers to collect their severance pay on the way out.

The matrix prepared by the recorder might look something like this:

Name	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Total**	**Average**
Worker 1	17	6	7	6	5	41	
Worker 2	8	7	10	8	11	44	
Worker 3	9	9	14	16	12	60	
Worker 4	10	16	8	11	9	54	
Worker 5	10	10	10	7	8	45	
Worker 6	7	20	11	11	13	62	
Total	61	68	60	59	58	306	
Average							10.2

The red bead experiment reveals much about system performance. While many system elements interact, in this case materials determine results. The bead mixture is 80% white beads and 20% red beads. The paddle holds 50 beads. Given a fair production effort by the worker—that is, the worker does not try to change results by quickly dipping the paddle again if it looks like a large number of red bead are on the paddle from the initial dip, or the worker does not bump the paddle against the container and knock some beads off—the number of red beads in each sample of 50 will be about 20%, or about 10. As expected, results show an average of 10.2 red beads. As the number of samples increase, the average will get closer and closer to 10.0.

Other factors may seem to influence results, but they are not relevant:

- **Inspections** (excessive) have no effect on system performance
- **Quotas** have no effect on system performance
- **Slogans** have no effect on system performance
- **Exhortations** to do well have no effect on system performance
- **Rewards and punishments** have no effect on system performance
- **Management** (by the facilitator) has no effect on system performance

In this case, the only thing that matters—the only factor that affects and determines system performance—is the percentage of red beads in the bead mix. The lesson is: fix the system, don't blame the workers. It calls back to the 85/15 rule that says about 85% of a worker's performances is determined by the system and 15% is determined by individual effort. The bead mixture principally determines results. A worker can still influence results to a degree through careless performance (knocking beads from the paddle during production) or by cheating (dipping the paddle twice), but performance results are mostly a matter of materials, an aspect of the system that is beyond the worker's control.

The red bead experiment also reveals something about variation. The data above show an average number of defects of 10.2 per production. But individual production numbers vary from 5 to 20 defects. Each production of 50 beads will not be exactly the same; results will vary. How much results may be expected to vary can be determined by using a control chart and calculating upper and lower control limits. For these data, the upper and lower control limits are 19 and 2, respectively. Normal system performance will yield 2 to 19 defects in any individual production. Workers should not be criticized or specially rewarded for performance within this range. Quotas should not be established outside this range. Slogans and exhortations should not address any performance outside this range.

What about Worker 6 who produced 20 defects on Tuesday? How should management respond? Punish the worker? Recall that control limits do not encompass 100% of the data. Control limits are sometimes established at 3σ above and below the mean, which encompasses 99.73 % of the data. The performance of 20 defects could be normal system performance that falls within the other 0.23%, or, if these data relate to performance that occurred after the control limits were established, the 20 defects could be a result of special cause variation acting on the system. Perhaps Worker 6 was a new hire that joined the work line after the initial workers completed training and, therefore, received no training. An untrained worker is a source of special cause variation.

Using a control chart to analyze the data obtained during the red bead experiment shows that the system is stable and is producing predictable results. The red bead experiment is often an eye-opening experience for participants. It shows more clearly than any text can describe how systems influence results.