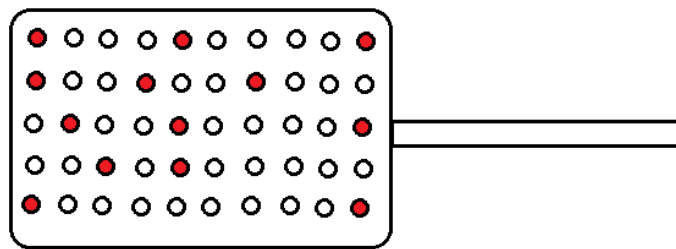


SPC

LESSON: Deming's Red Bead Experiment

Introduction: This is a clever demonstration of management's attempts to improve quality. Dr. Deming often refers to it as a "stupid experiment that you'll never forget."

- The experiment starts with a process machine that has 80% white and 20% red beads, hence the name "red bead experiment."



Deming's Red Bead Paddle

- The **objective** of the bead factory is to **make white beads**. The customer will not accept anything but white beads, all **red beads are defective**.
 - ◊ The red beads could represent faulty machines or tools, a bad engineering design, a defective part, a procedural flaw, an unreasonable change request, ... all the things that can and do go wrong with a process.
- **It is a worker's job to produce only white beads**, though the supervisors and management control the number of red beads in the processes that are given to the workers (e.g., faulty tools, bad designs, ...)

The Experiment Set Up:

1 Factory Foreman

3-5 Assembly Line Workers

1-2 Inspectors

1. Each worker takes a turn drawing a **sample of beads from the machine**. [The machine is only supposed to produce white beads.]
2. Once a sample is drawn, then it will be checked by the first inspector who will **count the number of white and red beads** produced by the worker. The second inspector will check the count of the first inspector.

3. The number of red and white beads will be shared with the foreman and **recorded** in the chart on the following page.
4. After a worker is done with his shift, he will **prepare the machine for the next worker**. Each worker must be certain to collect all extracted beads and place them back into the machine that produces white beads.
5. After the machine is prepared, the **next worker begins** the same process of collecting white beads.
6. The manager must make sure that the production of beads by the worker, the inspection, the inspection of the inspection, the recording of data, and the maintenance of the machine takes **no longer than 2 minutes** on any given trial.
7. The foreman may secretly **keep time** of the process and only alert the team at the last second if they are not working fast enough.
8. **Punishments may be handed down** by the foreman to the workers for poor white bead production, time delays, not respecting the foreman, not meeting uniform dress code,
9. **Praise, merit pay, gifts may be given by the foreman** to the workers for excellent white bead production, no time delays, brown-nosing foreman,

Chart: Red Bead Experiment Data: Number of red (defective) beads per worker

	Hour 1: Number of red beads	Hour 2: Number of red beads	Hour 3: Number of red beads	Hour 4: Number of red beads	\bar{X} = avg per worker	R = range per worker
Worker 1:						
Worker 2:						
Worker 3:						
Worker 4:						
Worker 5:						
\bar{X} = average # of red beads per hour						
R = "max – min" red beads per hour						

Let $\bar{\bar{X}}$ be the average number of red beads for all 4 workers for all 4 hours; i.e., $\bar{\bar{X}}$ is the average of the averages. Let \bar{R} be the average of the R's for all 4 hours. Make a control chart below with the following control limits:

Center line: $\bar{\bar{X}}$

Upper control limit: $\bar{\bar{X}} + 3 \cdot \frac{\hat{\sigma}}{\sqrt{n}}$, where $\hat{\sigma} = \frac{\bar{R}}{2.326}$

Lower control limit: $\bar{\bar{X}} - 3 \cdot \frac{\hat{\sigma}}{\sqrt{n}}$, where $\hat{\sigma} = \frac{\bar{R}}{2.326}$

Sketch the \bar{X} control chart with Center Line and Upper and Lower Control Limits below. Then, plot the individual hourly average \bar{X}_i on the control chart for each hour i .



Are any of the sample means beyond the upper control limit (UCL) or lower control limit (LCL) on the \bar{X} chart?

Is there variation in the process? Why? Is it common cause variation (random) or special cause variation?

Lessons from the Red Bead Experiment

- The variation comes from the process. There was no evidence that any worker was better than another.
- The workers could, under no circumstances, do any better.
- Inspection after the process doesn't improve quality; it just catches defects before they leave the plant.
- Clear instructions to workers will only increase the probability that the process will behave as intended.
- Banners and slogans raise the awareness of quality as an issue to be concerned with, but also tells the workers that management believes that a reminder is required to produce a quality product. This creates an environment of mistrust.
- Intimidation creates fear, which does nothing to improve a process.
- Pay for performance cannot make a process with only common cause variation any better. The performance of the workers was controlled by the process.
- Praise will encourage a person to perform the process as they have learned to perform it. It will not improve a process with only common cause variation.
- Incentives will not improve a process and have a short effect on employee morale.

Some of Dr. Deming's Fourteen Points Applied to the Red Bead Experiment

- 1. Create constancy of purpose for improvement of product and service.** The red bead experiment is a process. The only way to actually improve the process was to change the number of red beads in the machine. While the process data varied, the foreman was deceived into thinking workers' actions were impacting the process, when only random variation was taking place.
- 2. Adopt the new philosophy.** Management controls the number of red beads in a process initially since they design the products, purchase the machines, supplies or facilities, and establish the operating procedures. Once a system is installed, management has to find a way to reduce the number of red beads if they want to improve the process. The problem is that in most cases management does not know where the red beads are, but the workers do. It is only through a joint effort between management and workers that processes can be improved.
- 3. Cease dependence on inspection to achieve quality.** While two people counted the number of red beads (two inspectors), they never differed. The inspector adds no value in actually changing the process.
- 4. Improve constantly and forever every process for planning, production, and service.** In real life processes, there usually are some things that the workers can do to create improvement. But according to Dr. Deming, common or chance causes are controlled by management (usually 85% of the problem), and local faults or special causes (15%) are controlled by workers. Hence the major responsibility for process improvement (85%) lies with management changing the systems.
- 5. Institute training on the job.** A simple understanding of control charts would have helped the foreman recognize that the process was really a stable process and that the variation was normal and expected. While the foreman gave clear instructions of what was expected to the workers, this alone did not create quality.
- 6. Drive out fear.** If management really wants to learn where the red beads are in a process so they can remove them, they must be willing to listen and stop blaming workers for poor results. The intimidation or comparisons of the workers had no effect on the outcome of the red bead experiment.
- 7. Eliminate slogan, exhortations, and targets for the workforce.** In the same way that intimidation and comparisons between workers did not impact the outcome of the red bead experiment, neither did the slogans, buttons, or incentive schemes.
- 8. Remove barriers that rob people of pride of workmanship.** Eliminate the annual rating or merit system. How do you think the workers felt about their performance appraisals? Do you think that it motivated them to do better? Has anyone ever had a performance appraisal where the comments were similar to the same junk and clichés that were fed to the workers in this experiment?
- 9. Put everyone in the company to work to accomplish the transformation.** If management does not actually solicit employee input on solving business processes they are passing up a golden opportunity for improvement. Everyone at all levels of the organization has to be focused on quality improvement.