Playing the Deming Bead Game

Dennis Karney, University of Kansas

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Introduction

One of the most enjoyable aspects of teaching in the quality improvement area for me is getting to “be the boss” in the Deming Bead Game. As most of you are probably already aware, in one sense, the Deming Bead Game is nothing more than the classical “urn of beads” from which you randomly sample with replacement. The bead population is fixed in size as well as proportion of white and nonwhite beads. The sample size is fixed and the objective is to consistently attain samples which are virtually all white (assuming white is the predominate color). Indeed, the desired sample mix is chosen in a way that this objective is statistically impossible to achieve. When I saw Dr. Deming play this game in the Spring of 1986, he used 2,000 beads of which 80% were white and 20% red. The sampling paddle held 50 beads and the object was to get 1 or fewer red beads per sample paddle. Our set of beads at KU originally consisted of 3000 beads of which 81.5% were white and 18.5% were nonwhite of various colors. Our sample paddle holds 50 beads and our objective is always to get one or fewer color beads per paddle.

For our set of beads at KU, assuming that colored beads and white beads are the same size and weight, that they are well mixed, that there is no paddle bias and so on, then using traditional probability computations, one can achieve the objective of 1 or fewer color beads in a sample only 4 times out of 10,000. Thus, if you asked someone to generate the sample for you and you required that they deliver 1 or fewer colored beads in the sample, you can bet the family farm that they won’t be able to do it. However, Deming would be quick to point out that the assumptions made above do not accurately reflect reality. (For instance, paddle bias exists. As Dr. Deming pointed out at the seminar I attended, this is my 9.8 paddle and this is my 10.2 paddle. In honesty, he may have said 9.7 and 10.1 but you get the point.) Indeed, the information you need to see the impracticality of the task is to note that the data from repeated sampling shows that the sampling process is a stable system with a lower control limit (or $\mu-3\sigma$ for the purist) greater than 1. Indeed, in our case, data from our two dozen bead games yields a sample mean of 9.40, an upper control limit of 17.68, and a lower control limit of 1.11. In fact, the only time one of our
participants has achieved 1 or fewer colored beads in a sample occurred when one CEO spilled hundreds of beads on the floor and her direct reports picked up the beads in such a way that only white ones went into the paddle and all others into the “urn”. Of course, when the control chart was generated later on, the zero was identified as a special cause and a great teaching point was made.

Armed with the above knowledge, a set of Deming beads can be transformed into a powerful teaching tool in the quality improvement area. Specifically, the sampling of the beads can become a powerful experiential exercise for managers and students which helps them better understand random variation and its implications. These implications can be statistical in nature, e.g., the notion of a stable system, or managerial in nature, e.g., people do not cause all / most variation, or both, e.g., managerial action must be focused on the causes of the problem to be effective. Decide first which points you want to make during the game and then designing activities around the sampling to illustrate the points. For me, the key point to make is that in a stable process a manager must focus efforts on identifying and removing common causes (colored beads) of variation in order to improve. Best efforts or working harder won't do it. With this in mind, I design a whole exercise around the beads (outlined below) which builds to this one point. My style is to show participants in a non-threatening way how pointless much of what we teach in the name of good management is if it is not addressing the real cause of the problem.

In our quality improvement seminars, we use this exercise about midway through the seminar, usually after we have discussed a number of management issues and some data driven improvement/problem-solving issues. The exercise is always after lunch and is used as a connector between their world and ours. In this connector role, feel free to add whatever makes sense to the participants or you as long as it doesn't involve removing colored beads. In this way, the results wouldn't be affected and your point will be made. I would suggest if you want to use the game in your teaching, develop supporting materials to the sampling which fits your personality, which makes your points and most of all, in which the participants have fun. Don’t rush to show the statistical sampling piece in 20 minutes. The fun is important in learning and building intuition. Usually a typical game takes me between 80 and 90 minutes to play. This includes only a short discussion of the major point (for me, management's job is to identify and remove colored beads). A more extensive discussion follows a break. I hope these notes help you in your quality teaching. Enjoy.

Outline of the Deming Bead Game Demonstration

I. Introduce the exercise and recruit ten volunteers. An announcement like the one shown at the end of this document may be useful.

II. Train the management.

A. It is the recorder’s job (last job advertised) to record the number of defectives on the chart that is provided when the count is announced. At the end of the day, the recorder is to total the number of defectives and compute the daily average. Also, the recorder is to fill in all participants’ names.
B. The job of the chief inspector (next-to-last job advertised) is to compare the two numbers from the two inspectors. If the numbers agree, announce the result and dismiss the worker. If the two numbers do not agree, decide how to make them agree, then announce the result and dismiss the worker.

C. The job of the two inspectors is to count the number of defectives in each worker’s production, write down the count and pass the count to the chief inspectors. The two inspectors are to work independently. Usually, I have the chief inspector sit between the two inspectors.

III. Train the six workers, the willing workforce.

   A. Introduce yourself as the “Boss” or “Boss-Sir”.
   B. Select the average person from the six workers. Inform the other workers that their job is to do better than the average person.
   C. Have the recorder write down the names of the workers with the average persons' names first.
   D. Perform on-the-job training on how to do the job.
      1. Mix the beads. Explain how important it is to hold buckets certain ways, etc. (procedures).
      2. Use the mistake proof paddle to make the daily quota of fifty beads.
      3. Show the results to the inspectors.
      4. When dismissed, return the materials and wait until the next day's work.
   E. Explain that you are there to help so if they have any questions to please ask. (I then ask do they understand and wait for a "Yes Boss Sir") ..

IV. Inform the other observers that they are consultants. Their job is to watch the process in order to suggest improvements and when asked, to give the boss the answer he is looking for.

V. Day One Operations

   A. At the end of the day review the results.
   B. Introduce the goal as an incentive to the workers. Get consultants to tell you to do this.
   C. Reward the workers with the fewest defectives by recognizing them as “employees of the day”.
   D. Holler at worst employee. Employee to do better. ..

VI. Day Two Operations

   A. At the end of the day review the results.
   B. Select the employee of the day.
   C. Introduce the Quality Poster Program.
   D. Note how hollering helped and reward didn't. (This may have to wait until Day 3, Randomness is like that!)

VII. Day Three Operations
A. At the end of the day review the results.
B. Select the employee of the day.
C. Have a visit from the corporation president to give a short pep talk to the co-workers.

VIII. Day Four Operations

A. At the end of the day review the results.
B. Select the employee of the day.
C. Since the performance is very poor, shut down operations.

IX. During each day, chatter, note trends, motivate workers, plead to do better, etc.

X. Immediately after the game but before a break, I always ask a set of questions like the following:

1. Why were the boss's actions ineffective?
   (A: Not addressing cause of problem)
2. What was the cause of the problem?
   (Too many colored beads)
3. What do the colored beads represent?
   (Causes of inherent process variation, the things that inhibit and keep the worker from doing a good job)
4. Who can identify colored beads?
   (Anyone)
5. Who can remove?
   (Management and empowered workers through actions of management)
6. Who are you in your organization?
   Or what job are you aiming for when you get out of school? (Management)
7. So what's your job?
   (To identify and remove colored beads)

XI. Discuss what was learned from the exercise. This may include the following:

A. The experience in the game may help build a common language. The role of manager is to remove colored beads from the system.
B. Systems are impacted by at least six major things: people, materials, methods, machines, measurements and the environment. The game illustrates a system in which the workers have absolutely no control but the management takes actions assuming the problems are caused solely by the workers.
C. The exercise illustrates the actions that many managers try because they do not understand the nature of variation and thus they do not understand the futility of their actions in the midst of systems impacted by variations.
D. Improvement in the system results from removing the colored beads a few at a time. If only a few colored beads are removed the results will not be apparent. However, over time as more and more beads are removed you will be able to see the difference. Thus, it is
important to start removing the colored beads one by one rather than waiting for an action that will remove 100 beads all at once. It is management's role to create an atmosphere where more and more people are empowered to remove colored beads from the system.

E. Don't be afraid to ask them to give examples of colored beads they know of in their jobs.

**Material Required for the Exercise**

I. A paddle with 50 holes and a set of beads with a mixture of about 80% white and 20% colored. Places to obtain these include:

   The Red Bead Experiment, PO Box 1296, Cupertino, CA 95015
   [www.redbead.com](http://www.redbead.com)

   Lightning Calculator, P.O. Box 611. Troy, Michigan 48099-0611
   Phone: (248) 641-7030 Fax: (248) 641-7031

   or try a search for red beads or Deming red beads on your favorite search engine.

II. Two baskets to mix the beads with. It works best if one of the baskets is about six inches high. This bucket should be the one the beads are sampled from.

III. A chart to record the daily results like this one:

<table>
<thead>
<tr>
<th>Name</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Total</th>
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</tbody>
</table>

IV. A poster with the goal of “one colored bead per lot” on it.

V. A quality poster for use in days 3 and 4.

VI. Small prize for the employees of the day. You need to anticipate ties, so you may need six or seven prizes to be safe.

**Sample Announcement**
HELP WANTED

HILKARN Bead Inc., located in Kwality, Kansas has openings for 10 people. Applicants must be WILLING TO WORK AND WILLING TO DO THEIR BEST! Advancement is rapid and depends solely on an individual’s performance, not someone else’s. HILKARN rewards quality workers.

SIX POSITIONS: Minimal education, ability to follow instructions, possess two hands. No experience necessary. WOMEN AND MINORITIES ARE ENCOURAGED TO APPLY.

TWO POSITIONS: Ability to count to 18 (maybe even 20) without help. Access to pencil/pen and paper. Experience helpful, but not necessary.

ONE POSITION: Ability to count to 20, compare two numbers, sufficient verbal skills to report results of comparison. MBA desired but not necessary.

ONE POSITION: Ability to do basic addition of rows and columns with numbers as high as 20, multiplication and division too. Would help if had calculator experience. Accountant desired, but will consider mathematician or engineer.