

DECISION SCIENCES INSTITUTE

Adding Spice to the Teaching of Quality:
Variation, Poka Yoke, and a Defect Collection

Brad C. Meyer
Drake University

ABSTRACT

This paper presents several ideas for teaching quality in an introduction to operations management class. Contained is a teaching outline for the subject of poka yoke along with both a short and a longer assignment for students. Then the paper describes a defect collection and discusses its usefulness in adding interest to the subject of quality.

KEYWORDS: innovative education, quality, poka yoke, defects

INTRODUCTION

Although we are past the heyday of the quality management movement, the subject of quality is still a critical one for students in an introduction to operations course. Product and service quality are subjects all students are painfully aware of through personal experience, but insuring that goods and services meet customer requirements and are free of defects requires skills that are not natural to most people and a background in quality principles can go along way even for students who are not officially management majors. Coverage of quality commonly includes a history of managing quality, variation, statistical process control, acceptance sampling, control charts, Deming method, DMAIC, quality function deployment, Six Sigma, quality mindset as a strategic and cultural phenomenon, PDCA cycles, cost of quality, quality certifications and awards, and other related concepts.

The purpose of this paper is to present a few ideas useful to the teaching of quality. I will first present a context for teaching a major portion of the unit on quality and then will provide more detail on the area of poka yoke, including a short and a longer assignment. Then I will discuss the power of a defect collection to stir student interest in the material.

THE THREE KINDS OF DEFECTS

My presentation on quality generally begins with definitions of quality (manufacturing and service), cost of quality, and the impact of defects on production rate and capacity. After that I organize tools for improving quality around three kinds of defects. The three kinds stemming from three causes. These are degradation errors, careless errors, and lack of training errors. See table 1. Each type of defect can be addressed with a different type of management action.

This organizational structure allows me to first discuss variation and control charts. My coverage of those subjects is not particularly novel. If you are not familiar with Deming's Red Bead Experiment or the Funnel Experiment, I recommend that you explore those as options for adding interest and engagement to this subject. (Deming, 1982, Turner, 1998, Wright & Smith, 2003)

Table 1: Three types of defects/errors

degradation defects/errors	random/careless defects/errors	lack of training defects/errors
caused by a slow decline in system performance or materials	caused by human inconsistency or interruptions	caused by workers who do not know the proper methods.
prevented by use of control charts and variance reduction	prevented by poka yoke devices	prevented by better training
example: you go to cut some paper on a paper cutter at the office, but the blade is so dull it frays the edges and you have to do it over.	example: you assemble the report containing your budget request and you forget the appendix that details your cost assumptions.	example: new person doesn't know what to do when insured had a pre-existing condition.

POKA YOKE

The concept of poka yoke is not given much coverage in typical operations management textbooks. This is unfortunate because the concept is very powerful, even if simple (Shingo, 1986). Appendix 1 shows the outline I use to introduce poka yoke. My main points are the psychological difference between “fool-proofing” and “mistake-proofing”, the 3 levels of poka yoke, the difference between poka yoke and automation or better training, and examples of poka yoke devices. I have two exercises I have used when teaching poka yoke. The first is a simple exercise appropriate for undergraduates (works best with students who have internships or part time jobs.) or graduate students with work experience. This activity takes 10 to 20 minutes and is done in class.

Poka Yoke Activity: in groups, pick an example of a service failure that occurred recently to one of the members of your group. Answer the following questions.

- how likely was this failure to cause lost business for the service provider?
- was any service recovery action taken? Explain.
- how could this failure have been prevented?
 - make the error impossible?
 - make the error immediately visible
 - create a self-check so the error won't reach the next process step

Prepare to share briefly with rest of class

The second exercise I have used with poka yoke is best for MBA students, especially those in a part time program who are also in the workplace 8 hours a day, 5 days a week. This assignment asks them to find a commonly occurring error at their place of work, estimate the impact, and design a poka yoke. There is also a substantive write up to go along with exercise, which can be done individually or in small groups. The entire assignment write-up and a grading rubric can be found in Appendix 2. I have had some very useful applications among MBA students who can often save their company significant amounts of money by putting poka yoke into place.

THE DEFECT COLLECTION

To introduce the subject of defects, I bring to my class my defect collection. This is a set of items and stories of defects. I have collected these over several years and after showing them to my class, I often find students are willing to expand my collection by bringing in defects that they have encountered. I have used the collection in two different ways. At times, I simply show the items and pose questions as to how they occurred, how much expense they caused to the organization, and how they could have been prevented. The other approach I have is to divide the class into groups and hand one example to each group and ask them to determine the error, make a best guess as to how it was caused, and then think of ways that such an error could be prevented using the principles of poka yoke.

My inspiration for a defect collection began when I purchased a quart of Havoline motor oil at a Walmart. I selected the item off the shelf as SAE 30 weight oil. See Figure 1. When the item was rung up at the cashier, the register displayed an “item not found” message, meaning it was an item that the store did not carry. I checked the shelf label and it seemed clear that the store did carry Havoline SAE 30 oil. After some time of examining the container, I finally discovered that the label on the back of the container was for SAE 5W-20, an uncommon oil weight not sold at this Walmart. See Figure 2. The back label was the one that contained the scanable UPC code, and thus the item not found message. I was able to talk the cashier into letting me purchase the item, which I thought would be a good classroom prop and my defect collection was born.

Figure 1 – Front of Havoline SAE 30 oil container



Figure 2. Back side of Havoline oil container



Figure 3 shows the correct look of Brach's mint filled straws, a classic holiday candy. Figure 4 shows a bag also labeled as mint filled straws, but it is clearly not the same candy.

Figure 3. Brach's mint filled straws



Figure 4. Bag of holiday candy that is not mint filled straws



Mislabeling of products is not be a significant problem in many cases. Figure 5 shows one example, however, where a lawsuit claimed a serious result from purported mislabeling.

Figure 5. Lawsuit resulting from mislabeled product

Judge Tosses Hair Dye Lawsuit for Blonde Who Had Less Fun as Brunette

Wednesday, October 08, 2008

Associated Press

BRIDGEPORT, Conn. —

A judge has brushed off a Connecticut woman's claim that L'Oreal Inc. ruined her social life when she accidentally dyed her hair brunette with one of its products.

Charlotte Feeney of Stratford said she can never return to her natural hue, a shock that left her so traumatized she needed anti-depressants.

She says she suffered headaches and anxiety, missed the attention that blondes received and had to stay home and wear hats most of the time.

A Superior Court judge dismissed Feeney's 2005 lawsuit Monday, saying she never proved her allegation that L'Oreal put brown hair dye in a box labeled as blonde. The company also had disputed the claim.

Feeney's attorney, David Laudano, declined to comment and she could not be reached after the judge's decision.

It is not uncommon to find errors in print, such as the pizza coupon in Figure 6.

Figure 6. Pizza coupon



Websites also have their analog of the misprint. Figure 7 shows how mistyped information might interact with algorithms that create the text for webpages.

Figure 7. Amazon listing of the Arab Studies Quarterly Journal.



Arab Studies Quarterly

Manufacturer: Assn Arab Amer Univ
Graduates

List price: ~~\$75.00~~

Our price: **\$90.95** that is -21% off!

[Buy From Amazon](#)

Arab Studies Quarterly

Average Rating ★★★★★

More serious are cases where prices are mistakenly listed far below the actual price. Occasionally this happens with airline prices and show in Figure 8.

Figure 8. News article about an error in airline prices

When Airline Fares Are Too Good To Be True

By Scott McCartney

It's a sport among many hardcore travelers: trying to spot ridiculously low fares that airlines post by mistake—a \$5,000 ticket offered for say, \$500.

Airlines, once they realize their mistake, often try to wriggle out of honoring the deal—even though they typically charge heavy fees to customers who want to make changes after a ticket is purchased. Now, armed with a government opinion in their favor, carriers have gotten even stingier. British Airways, PLC canceled 1,200 reservations for 2,200 passengers from the U.S. to India last fall when it mistakenly offered tickets for \$40 on Oct. 2. The airline had been trying to raise prices by \$40, but that increase mistakenly

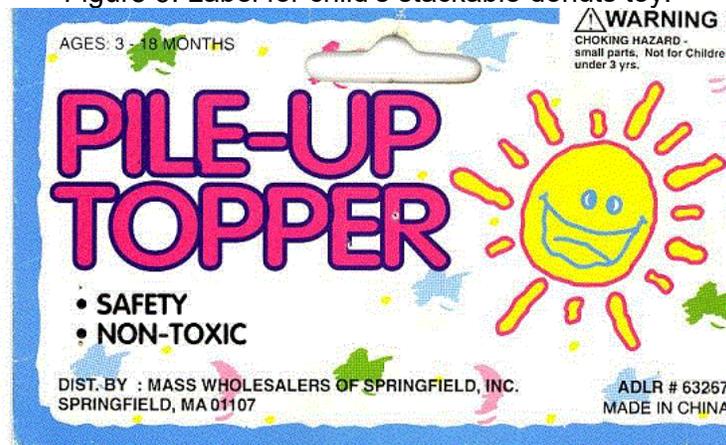
became the full coach fare when sent to reservation systems by a British Airways office in India, according to a company spokesman.

In a letter to customers who complaint, the DOT said it believed airlines should accept “some responsibility: for erroneous fares and should make customers “whole” when tickets are rescinded.

Siddharth Dutta wanted more than just a refund from British Airways and sued the airline in small claims court in Santa Clara County Calif. Last month, a judge ordered British Airways to cover the higher cost of a replacement ticket because the airline entered into a contract when it charged Mr. Dutta's credit card and gave...

An important class of defects are those that occur when changes are made in systems and there is no process to insure that everything affected by the change is updated. This can lead to inconsistency in the process, or even contradictions in a product, document or label. Figure 9 shows the label from a child's stackable donuts toy. The customer is told that the toy is for children 3 to 18 months. At the same time, the toy is a choking hazard and is not for children under 3 years of age.

Figure 9. Label for child's stackable donuts toy.



As a manufacturing example, I show the class a pen cap. Figure 10 shows a non-defective classic Bic pen cap.

Figure 10. Classic Bic pen cap.



Then I ask the students to compare that to a defective pen cap I acquired as a young boy. The cap is shown in Figure 11. While I am not 100% sure of the cause of the error, it does provide an opportunity to discuss the danger of tools or fixtures that can be aligned either correctly or with a turn of 180%. This pen cap could have been produced with an injection mold where the top was turned 180% from the correct orientation.

Figure 11. Defective Bic pen cap.



Other examples in the collection are sealed retail packages with no product or with fewer items than the package is supposed to have, misprinted books, and products with missing parts. I also discuss more serious cases such as Toyota accelerators, peanut products with salmonella, and exploding batteries in cell phones.

These examples of errors have left such an impression on my students that I think I have won at least one teaching award based primarily on my defect collection. I believe this is a transferable classroom prop, meaning that it is something most professors could create by keeping a watchful eye out for examples.

CONCLUSION

This paper provides some tangible examples for adding color to the teaching of quality. Poka yoke is a topic that is easy to understand and apply and students can leverage it immediately if they are working at the time of their schooling. A defect collection can add interest to the teaching of quality as well by providing students with interesting, if not entertaining, examples of defects and helping them to ponder how such defects can be prevented.

APPENDIX 1 – Poka Yoke teaching outline

Poka Yoke (*mistake* proofing – not *fool* proofing)

1. Shigeo Shingo – working with Toyota and other Japanese companies
2. Add process elements to prevent a defect from passing to the next step in the process. Such process elements are called “poka yokes” or “poka yoke devices”
3. Three levels of mistake proofing
 - i). make the error impossible
 - ii). make the error visible so it can be corrected right away
 - iii). require the operation to perform a self-check so errors will not pass to next step
4. Try to effect level i, if that is not possible, then level ii, if that is not possible, level iii.
5. Examples
 - a. Shigeo Shingo’s fix for keeping manuals in alphabetical order
 - b. insert for car gas tank that will not allow a leaded fuel pump to be used to fill a car requiring unleaded fuel
 - c. small wires connecting the gas cap to the car that will not allow the mistake of leaving the gas cap at the pump
 - d. waste receptacles at McDonalds with an oval hole for waste that will not allow a tray to be thrown away
 - e. MS Word underlining of misspelled words
 - f. a check list for a mortgage document, detailing all signatures and addendums that must be present.
6. What poka yoke is not:
 - simply making something more efficient is not poka yoke. Poka Yoke reduces mistakes or defects.
 - poka yoke is not training or some behavioral modification technique to change the worker behavior. The idea is to find ways to prevent mistakes without depending on the attentiveness or skill of the person.
 - poka yoke is not the same as automation.
 - a. poka yoke seeks for small expenditures and simple fixes. They are generally add-ons to the process or product design.
 - b. however, automation does take out the human element that causes mistakes

7. Some approaches of poka yoke

- redesign the product (good or service) to eliminate the process mistake
- add a device that forces the correct execution of the step
- add limiters that allow only correct actions (menu instead of command line)
- add a sensing device that detects the mistake and alerts the operator
- add a software check that detects an error and alerts the user
- require workers to perform a self-check
- use visuals to direct worker actions and reveal errors

For more examples see: <http://www.mistakeproofing.com>

8. Do poka yokes always accomplish their goal? Here is a portion of a student's paper submitted for the poka yoke assignment in this class. (Marsha Weber, Fall 05)

A huge benefit to a pharmacist is the software that the company utilizes in the filling of prescriptions. These pharmaceutical systems have been designed to detect drug/drug interactions, drug/disease state interactions, overusage/underusage of medications, and various insurance problems. These problems are presented to the user as a Drug Utilization Review (DUR). When the computer system detects an interaction or a problem of some sort with the prescription being entered, it presents the user with a "hard-halt error". It forces the user to read and acknowledge the error that has been detected, and to enter in a password or otherwise physically override the problem before moving on to the next screen. This is an area where a pharmacist is able to utilize their expertise for the benefit of the patients.

While the DUR process is a great mechanism for detecting problems with medications, it is often overlooked and ignored. Pharmacy Technicians are often the ones responsible for inputting prescriptions into the computer and for filling them once they are completed. The pharmacist spends little time in front of the computer, and is mainly responsible for just performing the final check on the prescription. This allows them a great deal of time to spend with patients who need prescription counseling or have questions on their medications. While it is beneficial for the pharmacists to be interacting directly with the patients, it leaves the technicians with a lot of responsibility for filling prescriptions correctly and for attending to these DURs.

Because technicians are used to entering prescriptions into the computer, they often operate on "autopilot", and this is where many mistakes are made. When they learn of a pharmacist's override password (which is generally common knowledge amongst the pharmacy employees), they tend to enter it in automatically when prompted, often without even reading the problem that the computer system has detected. This leaves the pharmacist unaware of the problem and can lead to complications for the patient ranging anywhere from minor to severe to fatal.

APPENDIX 2 - Error Elimination Assignment

This assignment should be emailed to bradley.meyer@drake.edu as a Word document.

Select a commonly occurring and economically significant error that occurs in a process of your company or of some other company with which you do business. Use the principles/ideas discussed in class to invent a process change that will eliminate this error, or greatly reduce its occurrence. Do not simply report on an idea that has already been implemented or is already under consideration. You must come up with an original idea.

Note, on John Grout's mistakeproofing site (<http://www.mistakeproofing.com>), most of the everyday examples are presented in the context of a consumer product, like an automobile, or a filing cabinet. I am asking you to think in terms of error proofing a process, not a product. So, don't give me a paper that describes some consumer **product** and an error that can occur in using the **product** and how the company can redesign the **product** to prevent the customer from making this error. I want a recommendation for an error prevention process change that will prevent an **employee** from making an error when carrying out a **process** of the company.

Your report must contain the following:

1. Describe the process and the error that occurs.
2. Estimate how much this error costs the company who owns the process.
3. Describe a process change that would eliminate or greatly reduce the occurrence of this error.
4. Categorize this process change as
 - poka yoke – prevent
 - poka yoke – make visible
 - poka yoke – self inspection
5. Estimate how much it would cost to implement your ideas.
6. Compare the cost of changes with the cost of the error and recommend a course of action for the organization.

You will be graded both on the presentation of your report (grammar, spelling, clarity, format) and on how useful the content of your report would be to the organization. Strive for brevity in this assignment. Make your information clear and concise and avoid extra fluff. For example, don't include an explanation of the concept of poka yoke, assume the reader knows that. A typical paper will be 1 to 3 pages in length.

Error Elimination Grading Form

Name _____

Content (12)

___ product error (should be process)

___ not a costly error

Device is

___ prevention

___ make visible

___ stop before passed on

___ left out cost of poka yoke

___ no course of action recommended

___ report not useful to organization

Quality of Idea (4)

___ still allows errors

___ depends on the person

___ probably an irritation to the worker

Mechanics (3)

___ grammar problems

___ spelling problems

___ expression problems

Organization (1)

___ grouping problems

___ sequencing problems

___ transitions problems

Total Score _____

REFERENCES

Deming, W. E. (1982). *Out of the crisis*. Cambridge , MA : Massachusetts Institute of Technology, Center for Advanced Engineering Study.

Shingo, S. (1986). *Zero quality control: Source inspection and the poka-yoke system*. Productivity Press.

Turner, R. (1998). The red bead experiment for educators. *Quality progress*, 31(6), 69.

Wright, C. M., & Smith, M. E. (2003). Serving Up the Red Beads Experience. *Decision Sciences Journal of Innovative Education*, 1(1), 127-131.