Quality Engineering at Colgate- Palmolive

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Agenda

- Introduction
- Background
- Related Work
- Procedure
- Results
- Defects and Recommendations
- Future Work
- Conclusions
Introduction
What is Quality Engineering?

- Improving manufacturing processes
- Saving time and money
- Meeting and exceeding customer expectations
History of Quality Control

- Relatively new
  - Deming
  - Juran
- Western vs. Japanese philosophies

W. Edwards Deming

Joseph M. Juran
Examined Softsoap® hand soap manufacturing process at Colgate-Palmolive
- Oral care, home care, personal care, and pet nutrition products
- Focused primarily on Softsoap® Aquarium Series

Focused on improving the defects present in the process that were causing the majority of problems
Background
**Six Sigma**

- Based on the statistical standard in which units conform to specified ranges even six sigmas from the mean
  - Over 99% of the units will fall within that specified range
Quality Tools - 1

Flowcharts
- Symbolic representation; unbiased
- Tool reveals unpredicted complexity, problem areas, redundancy, unnecessary loops, and possible areas for simplification

Check Sheet
- No additional processing
- Patterns in the data become evident quickly

EXAMPLE: CHECK SHEET FOR DATA COLLECTION

<table>
<thead>
<tr>
<th>Product name</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Chapter 9
Quality Tools - 2

Histograms

- Information about the parent population from which the samples are taken
- Large amount of information can be observed
- Distribution of the data and patterns in the data become obvious

Pareto Diagrams

- Similar to a histogram, but data arranged from largest frequency to smallest frequency
Quality Tools - 3

Cause and Effect Diagrams

- Think about possible causes of a problem
- How are causes/problems interrelated?

Poka-Yoke

- Mistake-proofing
- Avoid simple human error through automation
Package Manufacturing

- **Blow molding**
  - Machine blows high temperature, high pressure air into a pre-form in a mold

- **Injection molding**
  - Resin hopper feeds into a heated compartment
  - Resin heated and injected into a channel and then into a mold

- **Lamination**
  - Plastic film created and processed
  - Multiple layers of film are pasted together (laminated)
  - Composite film product.
Related Work
“It is no longer sufficient that the product be of good quality and represent good value. Today packaging and the design play a major role in its success or failure.” – E. H. Balkeman in the article “Soap Packaging”
Goals of Packaging

- Provide protection to the product
- Attract the customer
- Be as cost effective as possible
PROCEDURES

and the

Experimental/ Engineering Design
Procedure and the Experimental/Engineering Design
First Stop: Colgate-Palmolive Manufacturing Plant in Morristown, New Jersey

Goals

- To gain an understanding of Colgate’s manufacturing of liquid hand soap, particularly Softsoap Aquarium Antibacterial Soap
- To observe the setup of the factory

We observed many aspects of Colgate’s manufacturing line...
From the Preforms…

to…

The Finished Product!
At Colgate-Palmolive...

We observed how:
- the preforms were blown up
- how the inserts were placed into the bottles
- how the soap was created from its ingredients
- how the soap was placed into the bottles
- how the bottles were packaged for shipment

Team Quality also:
- carefully scrutinized the process
- asked the operator numerous questions
- took some tallies of some defects we noticed in the plant
Applying What We Know

– Flowcharts
– Check sheets
– Cause-and-Effect Diagrams
The Flowchart

- The Colgate manufacturing plant was split into two floors: the premake floor and the finishing line.
- Main goal of the...
  - The premake floor: To prepare all the mixtures for the final assembly downstairs (vanilla and fragrances).
  - The finishing line: To create the products as we see it.
    - Soap was mixed together and put into bottles.
    - Bottles were assembled and packaged.
Receive Raw Materials

Are the materials safe to use?

If yes, receive pink slip and continue

If no, materials rejected
PRE-MAKE FLOOR

Review Pre-make (vanilla and fragrance)

Are the materials safe to use?

If yes, receive green slip and continue

If no, materials rejected
Look up recipe in the Computer

Prepare the various ingredients by heating and measuring

FINISHING LINE

Pre-forms are expanded by using hot air. They are then cooled by cold water.
Are the bottles in good condition?

If yes, the bottles continue on the assembly line

If no (the bottles are bent or has major scratches) put bottles in a discharge bin

10% of these bottles are reheated and reused to make new preforms
Labels are put on bottle surface

Are the labels orientated correctly?

If yes, continue

If no, bottles are rejected
Machine puts insets into the bottles

Are the inserts put in correctly?

If yes, continue

If no, inserts are put in manually
Machine puts insets into the bottles

Vanilla and fragrances come from separate tubes and are mixed in a tank to create soap. Soap is put into bottles by skids.

Pumps are screwed onto the bottles

Soap bottles are packaged and stored in storage room
We created a list of defects we noticed with the assembly line. We looked at the flow chart and created a list of possible defects that could occur.

- **Check sheet:**
  1. Labels have incorrect orientation
  2. Inserts do not stay in the bottle
  3. Soap bottles are overfilled
  4. Twist tops over spun
  5. Overflow after insertion of tops
  6. Too much pressure creates an unstable box
  7. Not enough bottles packaged in each box
  8. Empty slots in the machine that places inserts in bottles
These are some defects Colgate employees check for in a day to day basis:
1. Color Variation
2. Incorrect Contents
3. Scratches
4. Damaged pump
5. Off center label
6. Air bubbles in labels
7. Viscosity of Soap
8. Weight of Soap
9. Fragrance of Soap
Cause-and-Effect Diagrams

We created 4 cause-and-effect diagrams based on the four major defects we observed on the tour:

- Large bottles with a crushed appearance
- Inserts not present or not orientated correctly
- Unfilled boxes
- Tops of soap popping off
After we went through the process of gathering data, we finally had enough information to prepare for our experiment!

The Preparation

- Numbering and measuring the dimensions of the bottles.
  - Height of the bottle
  - Width of the bottle
  - Width of the neck of the bottle
  - Height of the pumps
- This allowed us to see if the results of our experiment had any correlation to the bottle’s dimensions.
Observing Black Spots
Preparation (continued)

Black spots: occur due to the “recycling” and re-melting of some defective bottles

Why we looked at it:

More black spots

Bottle Consists of more recycled Material

Polymer of the bottle is weaker

Easier for the bottle to be crushed
Often, many inserts do not enter the bottle correctly, causing the process to be slowed or possibly stopped, so that the inserts could be put in manually.

Therefore, we examined:

- The material of the inserts (its shape, texture, and flimsiness)
- How difficult it was to manually insert some of the inserts
The Experiment

Goal: To test the strength and weight distribution of each bottle

Design: The machine had two metal plates that were positioned with one over the other. In the middle, there was a gap, where the object that was being compressed was placed.

What we did: We placed each bottle on the machine individually, and the Universal Tester Machine applied weight to the top of the bottle, until the bottle yielded. To replicate Colgate products we added water to the bottles to act as “soap”.
How Data was Collected

- The machine was attached to a computer, which had a program to keep track of how much pressure was being applied to the bottle and the rate at which the bottle bended.

- We also took note of where we saw the bottle buckle first, and which part of the bottle had the most dents after the compression.
Results
## Production Efficiency

<table>
<thead>
<tr>
<th></th>
<th>Goal Day</th>
<th>Average Day</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>75000 cases</strong></td>
<td><strong>Plant running for 63% of the day</strong></td>
<td><strong>76071 cases</strong></td>
</tr>
<tr>
<td><strong>produced</strong></td>
<td><strong>83 cases per minute</strong></td>
<td><strong>Plant running for 57.92% of the day</strong></td>
</tr>
<tr>
<td></td>
<td><strong>91 cases per minute</strong></td>
<td><strong>91 cases per minute</strong></td>
</tr>
</tbody>
</table>
Inserts

- An estimated 2% of inserts are not correctly placed into the bottle.

- Around 10-21 bottles per minute will have incorrectly placed inserts:
  - Each of the 2 workers at this station will have to correct a bottle on average every 6-12 second.

- At this rate, around 8 thousand bottles each day will have incorrectly placed inserts:
  - About half of these inserts fall out of the bottle,
  - This cost adds up to around 116$ each day in wasted inserts.
Recycling

- Assuming 97.5% of preforms are blow molded successfully
- Colgate recycles 10% of nonconforming bottles from the blow mold stage
- If a preform is processed three or more times, it leads to weakening of the PETE
- Each preform costs $0.04724
Recycling

Plant spends nearly $1000 on wasted preforms each day

Sucessful preforms (915132 Preforms)
Wasted Preforms (21132 Preforms)
Other (6 Preforms)
Defects and Recommendations
Major Defects

- Misshapen bottles
- Inserts
- Time Utilization and Efficiency
- Foreign Particles
**Misshapen Bottles**

- Deformities and Indentations
  - 10% - Melted Down into Preforms
  - 90% - Thrown Away
- Reheated bottles can obtain black spots
- Cost to Colgate: $998.28 per day
Recommendation

- Keep track of the preforms
  - Maximize number of times each preform is reblown
  - Minimize number of bottles thrown away
  - Save money
Wasted Inserts

- Insert is oriented incorrectly
- Insert does not make it into the bottle
- No insert is picked up by machine
- Cost:
Recommendations

- Change the shape of the insert
  - Make the bottom corner sharper
- Less plastic saves money
- Fewer errors saves money
Change in Insert Shape

Original

Revised
Empty Slots

- Machines were in operation but no bottles were in queue
  - Wasted machine run time

- Cost:
  - Wasting electricity and time
Recommendations

- Start up the machines in the order that they are used in the finishing process.
- Allow for a large queue to build up before starting the next machine in the sequence.
- Result: More productive and less electricity wasted.
Foreign Matter

- Common customer complaint
  - Hair, bugs, metal, etc.
- Machines are kept in an enclosed environment
- Lines are not covered
- Cost:
Recommendation

- Place signs on underside of bin cover
  - Remind employees to close bin lids

- Require hair nets be worn, in addition to the gloves, to increase sanitation

- Result: More satisfied customers
Bottles

- Very strong
- Very resilient
- Compressor Statistics
Help the Community

- Many bottles, containing soap, were discarded due to minor defects in the labels or bottle
- Donate the bottles to local homeless shelter or similar organization (Community Food Bank of New Jersey in Hillside)
  - Decrease waste
  - Obtain tax cuts
Future Work
Bottles - 1

- Colgate could study the pressure distributions of this Aquarium Antibacterial Soap more closely with more specialized technology.

- Get an accurate approximation of the thickness of all parts of the bottle.

- Study the design of all the bottles to spread the pressure distribution more evenly.
Bottle Work (continued)

- Studying the different polymers that are available to create the bottle and see which polymer would fit the function of liquid hand soap the best (strongest physically and which plastic can be used as a good fragrance barrier)
- Create an eco-friendly soap bottle that uses less plastic, but is just as efficient.

Inserts

- Study the vacuum and see if they can find which material the vacuum has the best suction on and use that material to print their inserts on. (less slippery and less flimsy)
Studying the different polymers that are available to create the bottle and see which polymer would fit the function of liquid hand soap the best
  - Strongest physically
  - Good fragrance barrier

Create a more eco-friendly soap bottle that uses less plastic, but is just as effective
**Inserts**

- Study the vacuum and look for a vacuum piece and plastic that have a high coefficient of friction to increase the grip
  - Less slippery
  - Less flimsy
Conclusions
Learned

Quality Engineering's Goal
- Make products or services better in a cost-effective way

Quality Tools
- Flowchart
- Cause and Effect Diagram
- Histogram
- Pareto Chart
- Check Sheet
- Poke-Yoke
Learned (Continued)

- Quality Control Equipment
  - Calipers
  - Compressor

- Manufacturing Processes

- Teamwork and Group Dynamics

- Questions are Important to Gaining Information