EIN 5226

Basic Tools I

Chapter 5 Sections 5.1-5.12

Karen E. Schmahl Ph.D., P.E.

Introduction

- This chapter continues the discussion of basic techniques and offers a collection of data analysis, data presentation, and improvement alternatives.
- A wide variety of tools are briefly described for the purpose of aiding with the efficient building of strategies for collecting and compiling information that leads to knowledge. With this knowledge we can make better decisions.

Give a small boy a hammer, and he will find that everything he encounters needs pounding. (Abraham Kaplan, 1964)

If all you have is a hammer, everything looks like a nail. (Abraham Maslow, 1966)

Introduction

Tools working with ideas:

- Activity network diagram*
- Affinity diagram*
- Benchmarking
- Brainstorming
- Cause-and-effect diagram
- Flowchart
- Force field
- Interrelationship digraph (ID)*
- Matrix diagram nominal group technique (NGT)
- Matrix Diagram*
- Prioritization matrices*
- Process decision program chart (PDPC)*
- Tree diagram*
- Why-why diagram

** Often referred to as the 7 management tools*

Introduction

Tools working with numbers:

- Check sheets *
- Control chart *
- Histogram *
- Pareto chart *
- Probability plot
- Run chart
- Scatter diagram *

** Along with the flow chart and cause and effect diagram, these are often referred to as the 7 Quality Tools*

5.1 Descriptive Statistics

Minitab output

Descriptive Statistics: C3

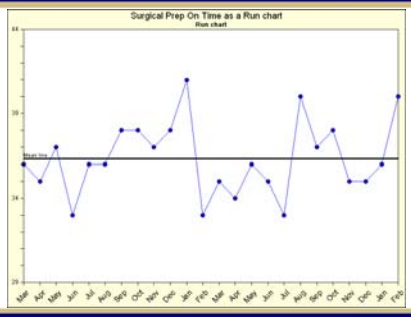
Variable	Total Count	Mean	StDev
C3	50	23.01	21.22

Minimum	Q1	Median	Q3	Maximum	IQR
0.06	6.51	16.84	36.90	85.97	30.39

5.2 Run Chart (Time Series Plot)

- A run chart permits the study of observed data for trends or patterns over time.
- 20~25 points are needed to establish pattern and baselines.
- Can be used to compare a performance measurement before and after a solution implementation to measure its impact.
- Problem exists with the interpretation of run chart: all variation as important (over-reacting) → control charts

5.2 Run Chart (Time Series Plot)

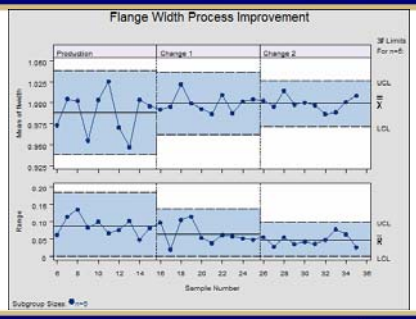


www.pqsystems.com/.../chart_BasicRunChart.png

5.3 Control Chart

- Method to monitor data variability over time
- Monitoring can be on process inputs or outputs
- It can separate special cause from common causes
  - Early identification of special causes
  - 94% of the troubles belong to system (common cause); only 6% are special cause (Deming 1986)
- It gives not only process monitoring and control, but also direction for improvements.

5.3 Control Chart



http://support.sas.com/rnd/app/qc/qc/shwclms.gif

5.5 Check Sheets

- Check sheets contain the systematic recording and compiling of data from historical or current observations.
- After agreement is reached on the definition of events or conditions, data are collected over a period of time.

Problem	Week			Total
	1	2	3	
A	///	###	//	10
B	/	//	//	5
C	////	/	/	6

What type of data is it?

The days of the week are

A. Nominal B. Categorical C. Ordinal

D. A & B E. B & C F. Quantitative

The problem types are

A. Nominal

B. Categorical

C. Ordinal

D. A & B

E. B & C

F. Quantitative

Talley of Form review problems

Week of

Problem	Mon.	Tues.	Wed.	Thur	Fri.	Total
incorrect form						
Missing data						
incorrect data entry						
Illegible writing						
incorrect calculation						
Missing signatures						
Other						
Totals						

12

What type of data is it?

Tally of Form review problems

Week of 2/12

Problem	Mon.	Tues.	Wed.	Thur	Fri.	Total
Incorrect form	1		1	1	2	5
Missing data	4	3	4	5	4	20
Incorrect data entry	2	4	3	4	4	17
Illegible writing	1		2	1	1	5
Incorrect calculation		1	3	2	1	7
Missing signatures		1	2	1	1	5
Other	1			1	1	3
Totals	9	10	15	14	13	61

The tallys/ totals are

A. Quantitative /Continuous

B. Quantitative /Discrete

If I calculated the % of each type, that would be

A. Quantitative/Continuous

B. Quantitative/Discrete

13

Checklist Hints -

- Establish objectives for in data collection
- Get agreement on what is to be observed.
- Record facts, not opinions.
- Make sure people understand why they are being asked to collect the data.
- Make the form easy to use and integrate it into normal routines.

14

DATE: 1/13/89 -1/19/89
FLOOR: 4 EAST
SHIFT: 7-3

	Tray Delivery Process							
CHECKSHEET	MON	TUE	WED	THU	FRI	SAT	SUN	TOTAL
Tray Disabled				1	1	1		*3*
Production Sheet Inaccurate	1		1			1		*3*
Menu Incorrect	1		1		11		1	*5*
Diet Order Changed	1				1		1	*3*
Wrong Order Delivered	1		1		1	1		*4*
Patient Asleep	111	1	11111	1	11	111	1	*16*
Patient Out of Room	11111	111	11	1	1	11	11	*16*
Doctor Making Rounds		11	1111	1	1	1	1	*11*
Patient Not Hungry	1	1	11	1	111	1	11111	*14*
Cart Faulty					1	1	1	*3*
Plate Warmer Broken	11	11	111	11	1111	1	11	*16*
Heating Unit Broken	1	1			1		1	*4*
Thermometer Miscalibrated	1					1		*2*
Nursing Unavailable	111	11	111	1111	11	111	111	*20*
Cart Unavailable	11	111	11		11		11	*11*
Elevator Malfunction			11	111		1		*6*
TOTAL	**22**	**16**	**25**	**13**	**21**	**17**	**20**	**134**

Source: http://mot.vuse.vanderbilt.edu/mt322/Check.HTM (7/17/05)

15

Checklist Hints (cont.)-

- Make sure that observations are as representative as possible of the true state of affairs.
- Give feedback to those who have collected the data where appropriate.

16

Location Diagram

- Checklist showing where data is occurring

  Examples: The 1854 London Cholera Epidemic
  The visual display of quantitative information
  Edward Tufte, ImprintCheshire, CT. : Graphics Press, c1983

- On product – defect concentration diagram-
  - Picture of the unit, showing all relevant views.
  - Types of defects noted on picture

  Example: Painting operation
  http://www-ist.massey.ac.nz/61325/sg/chap3-1.htm

Location Diagram

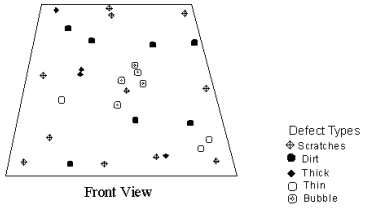
A location diagram is a form of a checklist showing where data is occurring

The 1854 London Cholera Epidemic

from Tufte, 1983, p. 24

The visual display of quantitative information / Edward R. Tufte
ImprintCheshire, Conn. : Graphics Press, c1983

Defect Concentration Diagram
for a Painting Operation.



Front View

Source: http://www-ist.massey.ac.nz/61325/sg/chap3-1.htm 19

5.6 Pareto Chart

The Pareto Principle

- 80% of effects come from 20% of causes
- Examples (note exact numbers will not be 20%/80%)
  - 20% of population pays 80% of the taxes
  - 20% of customers provide 80% of revenue
  - 20% of software bugs cause 80% of crashes
  - 20% of manufacturing process characteristics cause 80% of the quality problems.
- Vital few – Trivial many

- A Pareto chart is a tool to help identify the vital few.

Juan Institute video – Juran's Pareto Principle
(2 minutes)

http://www.youtube.com/watch?v=HwTSnkBWaHM

(Link also provided in Blackboard.)

Pareto Charts

A frequency distribution bar chart arranged by category from most frequent to least.

Steps:

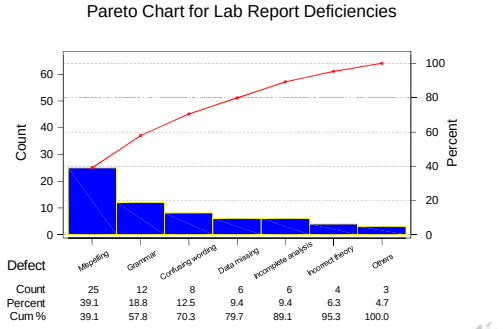
1.Decide what measurement to use and collect data – frequency, cost, time, percent

2.Determine appropriate scale and label chart accordingly

3.Construct bar for each category of data- starting with highest measurement value.

Useful to visually highlight most important problems

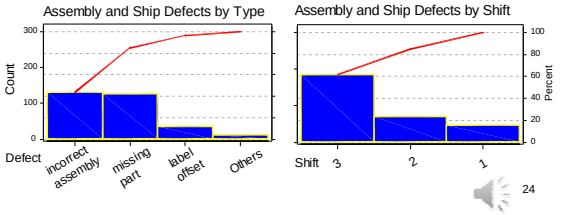
22



23

Pareto Chart Considerations:

- The most frequent problem is not always the most costly.
- Often further subdividing a category and creating another Pareto will provide more information for identifying a problem.
- Regrouping of data into different categories may highlight different problems



24

5.8 Brainstorming

- Valuable means of generating ideas and involving a group.
- Use brainstorming for
  - Accumulating a broad range of inputs
  - Generating creative, original ideas
  - Obtaining participation of the entire group
- Many ways
  - to conduct a brainstorming session
  - to compile the information from the session

5.8 Brainstorming

Formal process of brainstorming

- Setup:
  - Table arranged in a manner to encourage discussion
  - Problem or question is written down for everyone to see
- Basic rules:
  1. Ask each member in rotation for one idea
  2. Rule out all evaluations or critical judgments
  3. Encourage wild ideas (Welcome unusual ideas)
  4. Encourage good-natured laughter and informality
  5. Target for quantity, not quality
  6. Look for improvements and combinations of ideas

5.8 Brainstorming

Guideline for the leader:

1. The problem needs to be simply stated.
2. Two or more people should document the ideas in plain sight so that the participants can see the proposed ideas and build on the concepts.
3. The name of the participant who suggested the idea should be placed next to it.
4. Ideas typically start slowly and build speed. Change in speed often occurs after someone proposes an offbeat idea. This change typically encourages others to try to surpass it.
5. A single session can produce over 100 ideas, but many will not be practical.
6. Many innovative ideas can occur after a day or two has passed.

5.8 Brainstorming

- A follow-up session can be used to sort the ideas into categories and evaluate them.
- Techniques commonly used in follow-up are
  - Nominal Group Technique (NGT) 5.9
  - Multivoting
  - Affinity Diagrams 5.12

Nominal Group Technique

The Nominal Group Technique* is a method that allows a group to

- Generate a large number of ideas
- And prioritize the ideas

within a structure that gives everyone an equal voice.

* Technique developed in 1968 by Andre Delbecq and Andrew Van deVen at the University of Wisconson.

Nominal Group Technique

Structured Brainstorming

1. **Introduce and clarify issue to be addressed.**
2. **Have each person silently write at least three ideas on the subject.**
3. **In turn, have each person read *one* idea.**
4. **When most of the ideas are recorded, open the floor for additional ones.**

(Basic Brainstorming rules apply)

5.9 Nominal Group Technique (NGT)

Nominal group technique expedites team consensus on relative importance of problems, issues, or solutions.

- An NGT is conducted by displaying a generated list of items, perhaps from a brainstorming session, on a flipchart or board.
- Eliminating duplications and making clarifications, then creates a final list.
- The new final list of statements is then prominently displayed, each item is assigned a letter, A, B ,...
- On a sheet of paper, each person ranks the statements, assigning the most important a number equal to the number of statements and the least important the value of one.
- Results from the individual sheets are combined to create a total overall prioritization number for each statement.

5.9 Nominal Group Technique (NGT)

Tally of Initial Round of Ranking

(Each participant ranked the top 7 items, highest being 7 and lowest being 1)

Item Code	Five Participants					Total	First Round Ranking
	1	2	3	4	5		
A	4	7	0	7	4	22	2
B	0	0	6	6	0	12	6
C	3	5	5	0	0	13	5
D	7	6	7	5	3	28	1
E	2	4	3	0	7	16	3
F	0	3	2	0	5	10	7
G	6	2	4	1	2	15	4
H	5	0	1	3	0	9	
I	1	1	0	4	0	6	
J	0	0	0	2	1	3	
K	0	0	0	0	6	6	
L	0	0	0	0	0	0	

http://www.wsa-intl.com/Portals/70018/images/202.jpg

Why is our ship dragging anchor in heavy weather?
The CO of a guided missile cruiser has tasked the XO to meet with the department heads and the leading Boatswain's Mate in charge of the Sea and Anchor Detail. The group is to determine why the ship has dragged anchor the last three times it was anchored in heavy weather.

Ranking and Prioritization

RANKING:	
A. Haven't set the anchor properly	6, 7, 6, 4, 4, 7, 4 = (38)
B. Not enough chain out	5, 5, 7, 5, 5, 6, 7 = (40)
C. Bottom not assessed properly	7, 6, 5, 6, 7, 5, 6 = (42)
D. Ship isn't steaming at anchor properly	1, 1, 1, 2, 1, 2, 1 = (9)
E. Piling too much anchor chain on the flukes	2, 2, 4, 3, 3, 3, 3 = (20)
F. Inadequate navigational fixes	3, 4, 3, 7, 6, 4, 2 = (29)
G. QMs not notifying CDO of weather changes	4, 3, 2, 1, 2, 1, 5 = (18)
PRIORITIZATION:	C, B, A, F, E, G, D

http://www.doh.state.fl.us/hpi/pdf/NominalGroupTechnique.pdf

33

Multivoting

Multivoting is a method to narrow down a previously generated list by utilizing group input.

1. Generate a list of items
2. Allow members to vote on as many items as they like
3. Talley the votes
4. To reduce list, eliminate choices with fewest votes.
5. Vote again on reduced list, continuing to eliminate alternatives.

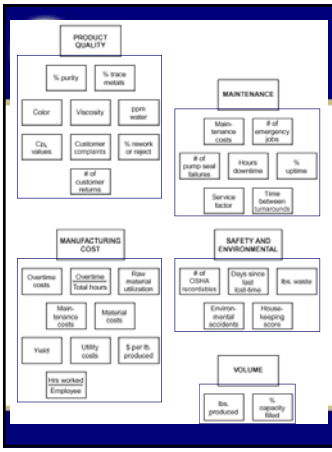
34

5.12 Affinity Diagram

Affinity diagram can organize and summarize the natural grouping from a large number of ideas and issues.

- Boldly record each brainstorming idea individually on a post note, using at a minimum a noun and verb.
- Next, place the post note on a wall and ask everyone, without talking, to move the notes to the place where they think the issue best fits.
- Upon completion of this sorting, create a summary or header sentence for each grouping. (Create subgroups for large groupings as needed with a subhead description.)
- Connect all finalized headers with their groupings by drawing lines around the groupings.

Affinity Diagram



http://www.asq.org/learn-about-quality/idea-creation-tools/overview/affinity.html

5.11 Cause-and-Effect Diagram

- Used to explore and graphically display causes of a problem
- Focuses on causes not symptoms

  Means for teams to focus process input variables that could affect process output variables.
- Also called a Fishbone or Ishikawa diagram.

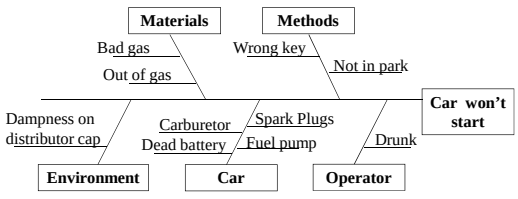
Cause and Effect Diagram

Steps

1. Brainstorm potential causes of problem
   (Creating affinity diagram often helpful)
2. Construct the diagram
   - Place problem in box at head of "fish"
   - Organize brainstorm causes in bones identifying further sub-clauses as necessary. Ask why. Duplication OK.
3. Identify causes for further investigation or action.

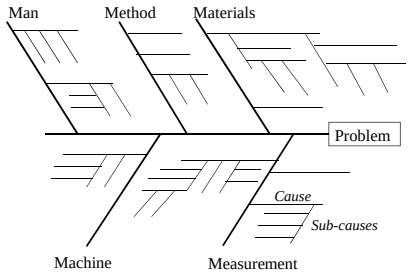
38

Cause and Effect Diagram



39

Cause and Effect Diagram



5.11 Cause-and-Effect Diagram

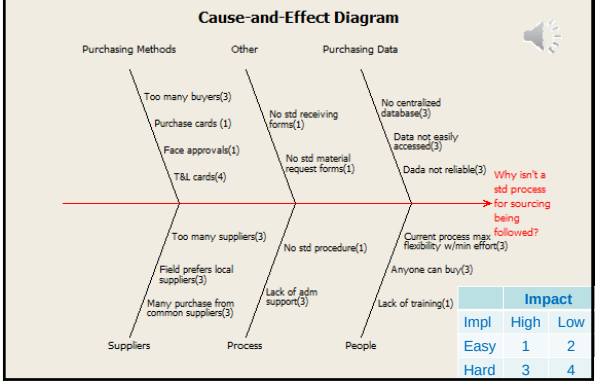
- When constructing a cause-and-effect diagram, it is often appropriate to consider six areas of causes that can contribute to an effect: materials, machine, method, personnel, measurement, and environment.
- Each one of these characteristics is then investigated for sub-causes. Sub-causes are specific items or difficulties that are identified as a factual or potential cause to the problem (effect).

5.11 Cause-and-Effect Diagram

Variations in creating a cause-and-effect diagram:

- A team may choose to emphasize the most likely causes by circling them.
- it can also be beneficial to identify noise factors (n) (e.g., ambient room temperature and a raw material characteristic that cannot be controlled), and factors that can be controlled (c) (e.g., process temperature or speed) by placing the letter n or c next to the named effect.
- Include score with an importance and ease-of-resolution matrix.

5.11 Cause-and-Effect Diagram



Example – Problem Solving

- Skilled machinist is running large, expensive part on a machining center.
- Machinist "hears" that tool has dulled, stops the machine cycle and changes the tool, and re-engages the program.
- Tool crashes into part. (When program was interrupted, it had been machining on the back side of the part.)

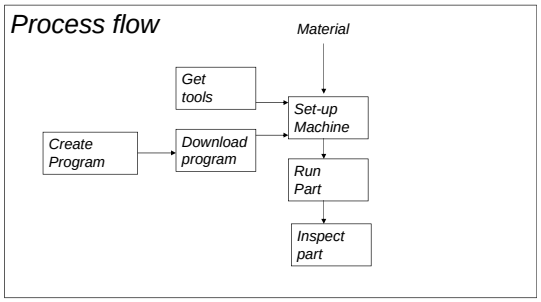
44

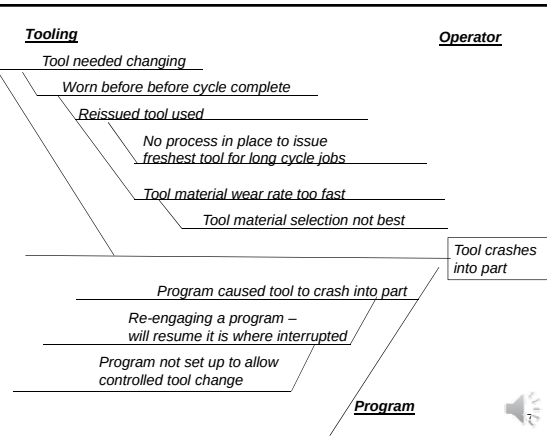
Typical 5 Why

- Tool crashed into part
  - Why?: Program reengaged without raising tool to clear part
  - Why?: operator inattention
- Action: Retrain operator

How effective can this action be?

45





Tool crash problem

- Actions to prevent reoccurrence
  - Revise program to incorporate tool check in mid program
  - Implement tool kitting program to include long cycle time considerations

48

Problem Solving Approach and Basic Tools

1. Understand your process
   Flow diagrams
2. Look for root and contributing causes
   Brainstorm, Affinity, Cause & Effect Diagram
3. Validate causes
   Run chart, Histogram, Scatter Diagram
4. Implement actions
5. Verify effectiveness of actions

49

Related Assignments

Please see Blackboard for related Assignments