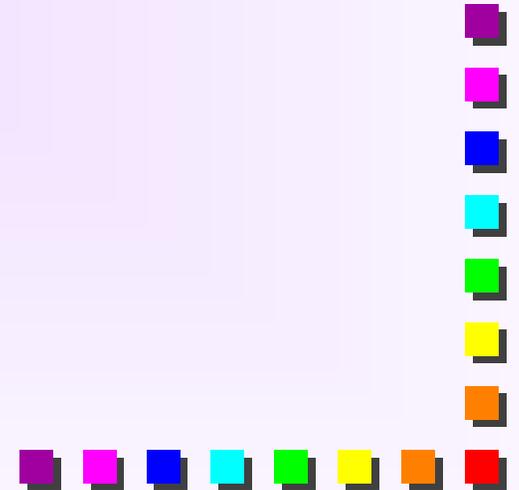


Fundamentals of **T**otal **Q**uality **L**eadership

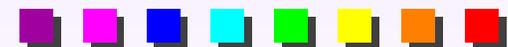
Module 5 Basic Process Improvement Tools



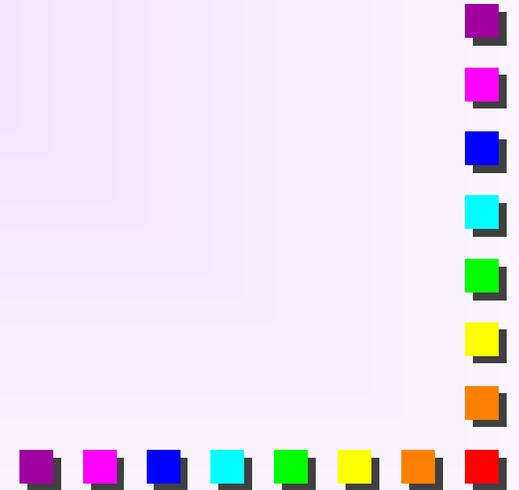
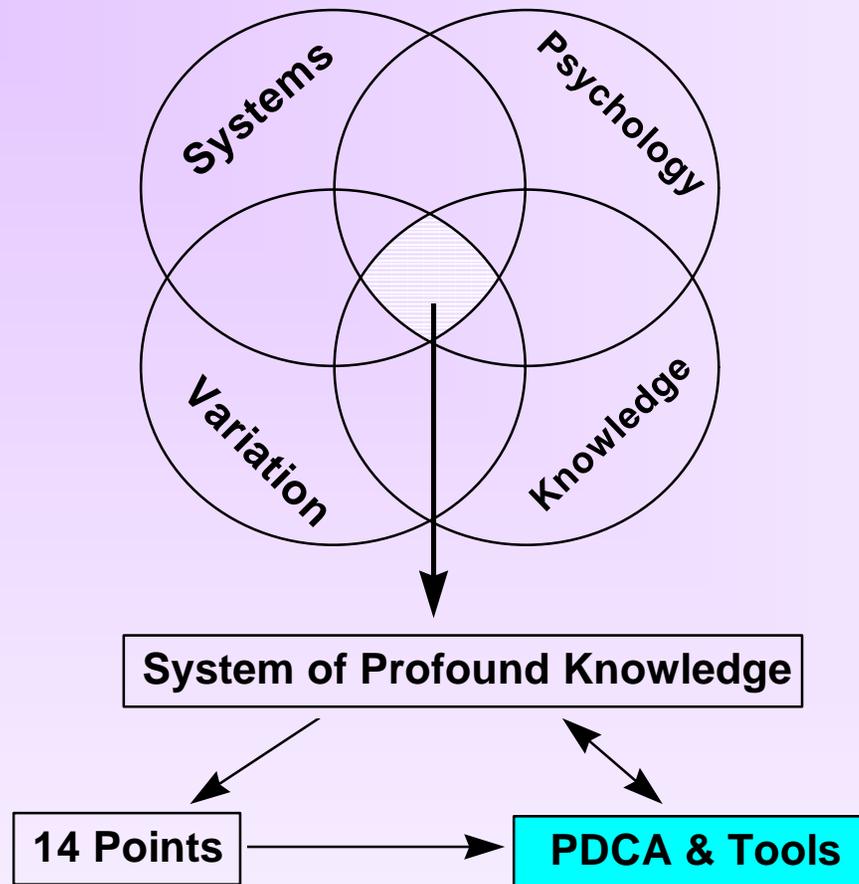
Learning Objectives

By the end of this module the student will be able to:

- ◆ Explain the purpose and uses of basic process improvement tools
- ◆ Construct and apply Flowcharting, Brainstorming, Affinity Diagrams, Cause and Effect Diagrams, Nominal Group Technique (NGT), Multivoting, Check Sheets, Pareto Charts, and Run Charts
- ◆ Describe Histograms and Control Charts
- ◆ Describe the importance of a Data Collection Plan
- ◆ Complete an exercise using the basic process improvement tools



DON Approach to Quality Management



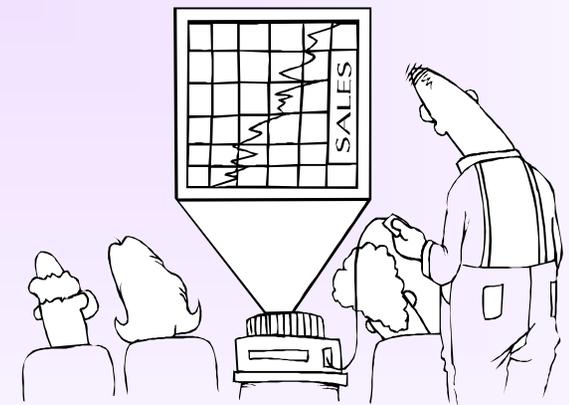
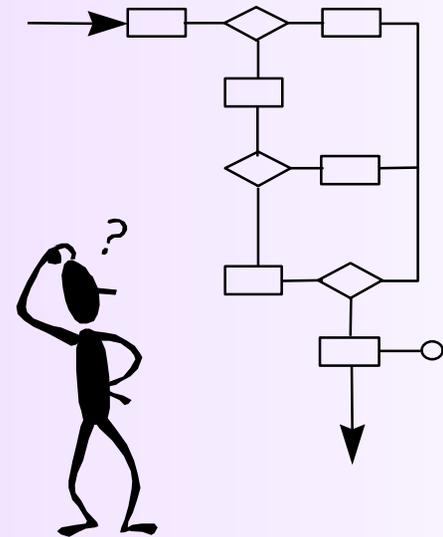
Basic Tools for Process Improvement

- ∪ Flowcharting
- ∪ Brainstorming
- ∪ Affinity Diagram
- ∪ Cause and Effect Diagram
- ∪ Nominal Group Technique (NGT)
- ∪ Multivoting
- ∪ Check Sheet
- ∪ Pareto Chart
- ∪ Histogram
- ∪ Run Chart
- ∪ Control Chart
- ∪ Data Collection Plan



Purpose of Tools

- ◆ Describe and improve processes
- ◆ Evaluate process or output variation
- ◆ Assist with decision-making
- ◆ Analyze data in a variety of ways
- ◆ Display information

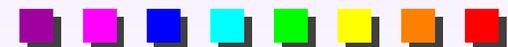


Flowchart

A diagram that uses graphic symbols to depict the nature and flow of the steps in a process

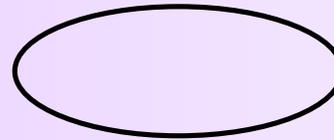
Benefits of Using Flowcharts

- ◆ Promotes understanding of a process
- ◆ Identifies problem areas and opportunities for process improvement
- ◆ Provides a way of training employees
- ◆ Depicts customer-supplier relationships



Symbols Used in Flowcharts

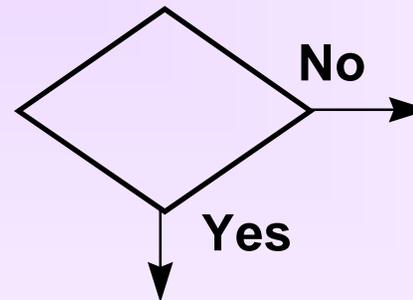
Start / End



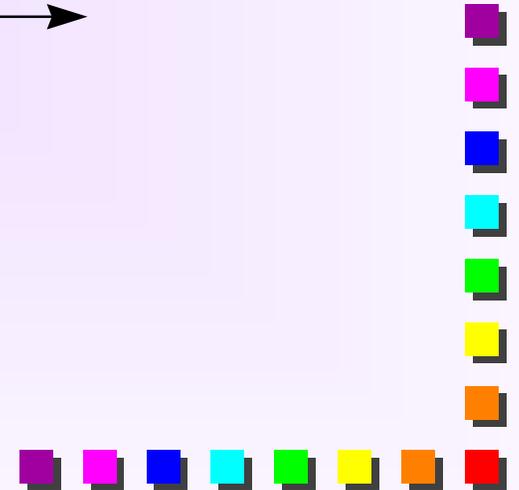
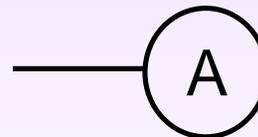
Process Step



Decision

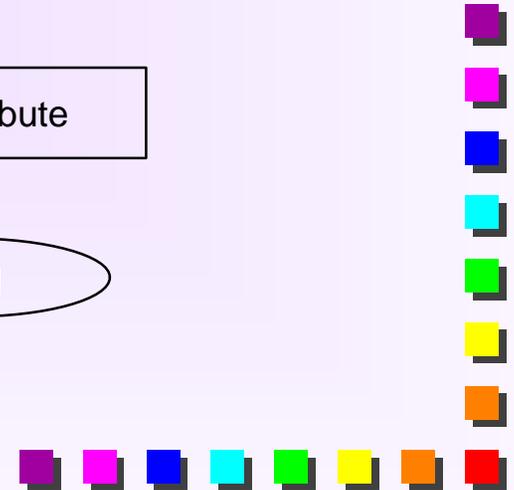
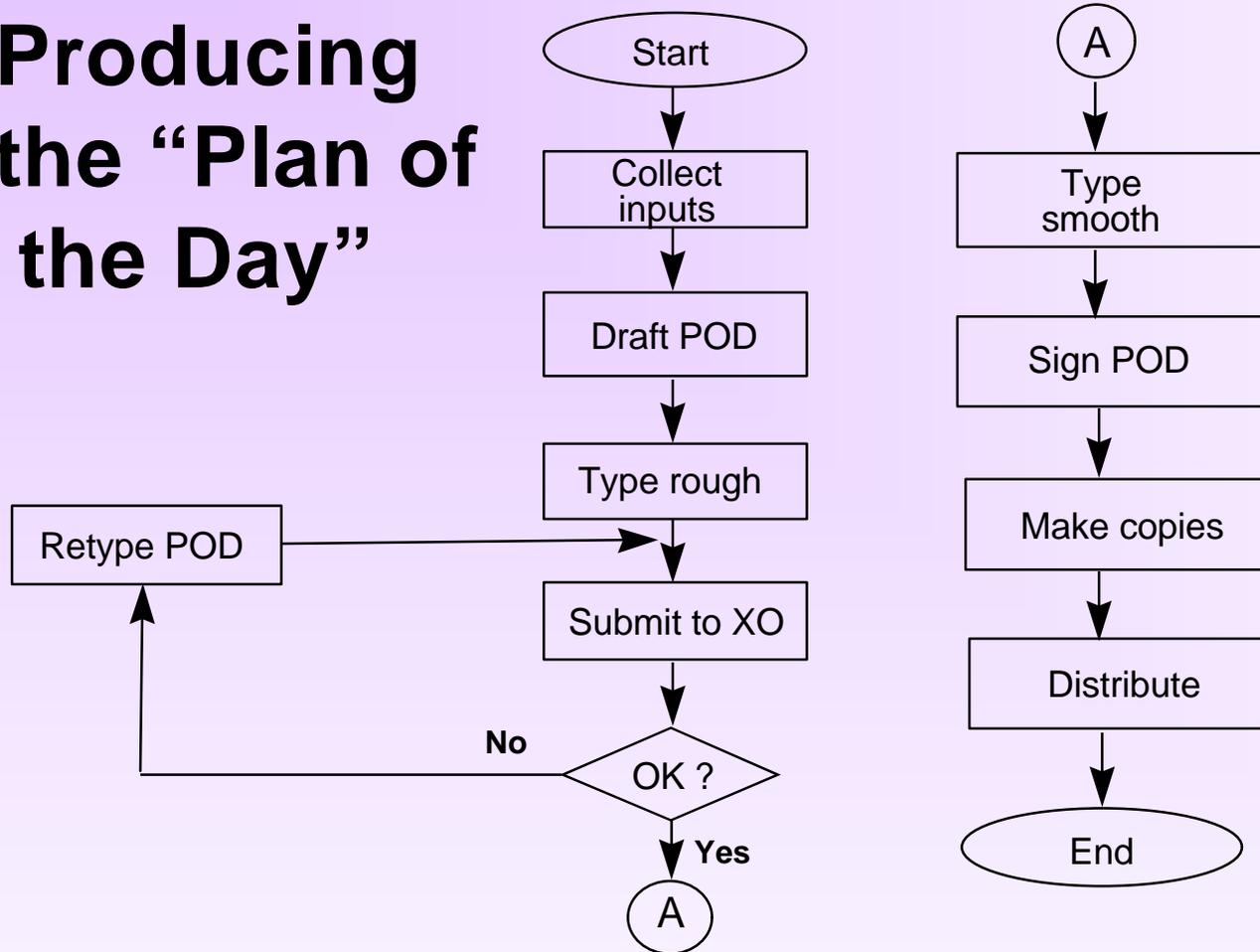


Connector



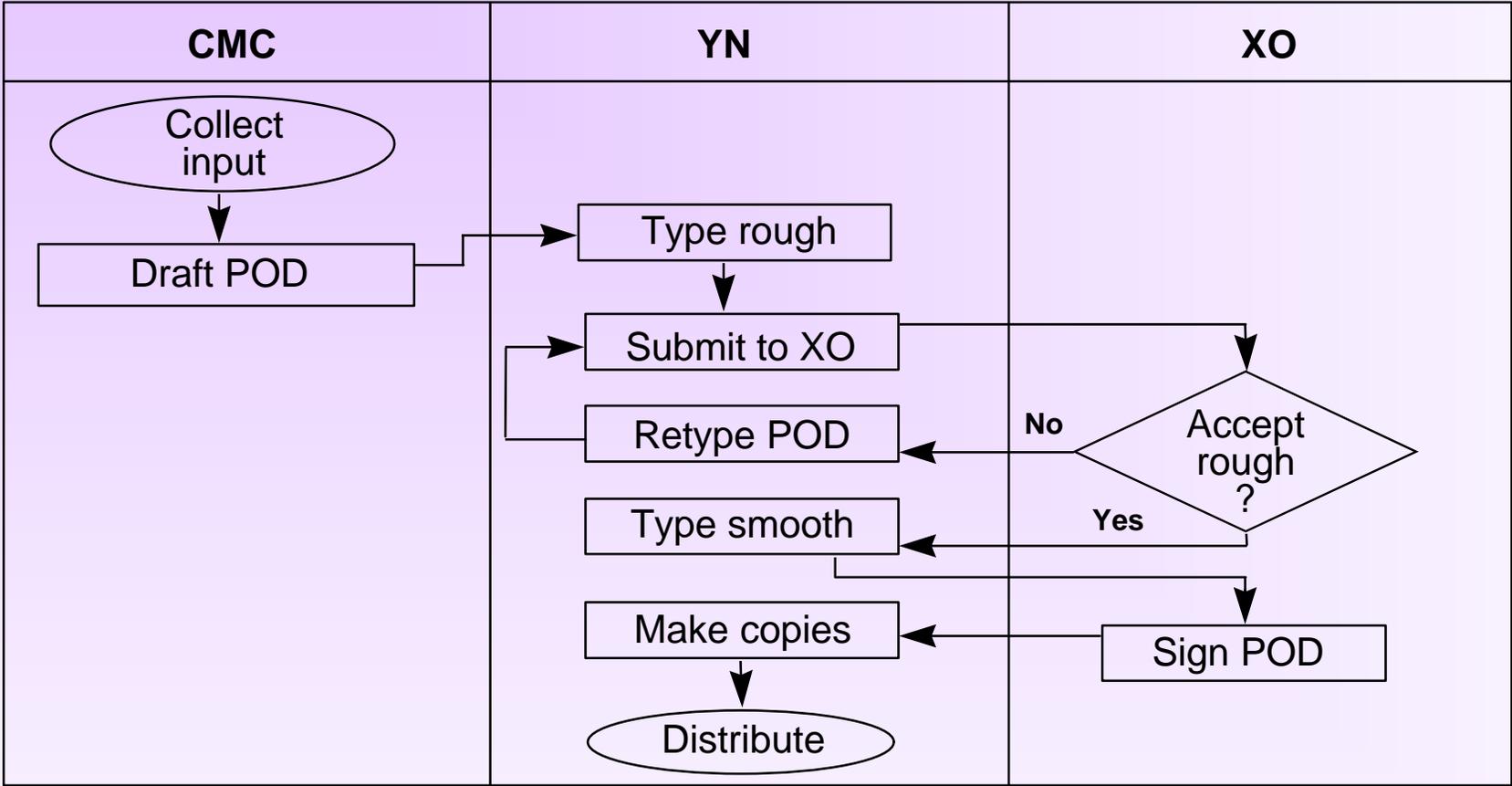
Linear Flowchart Example

Producing
the “Plan of
the Day”

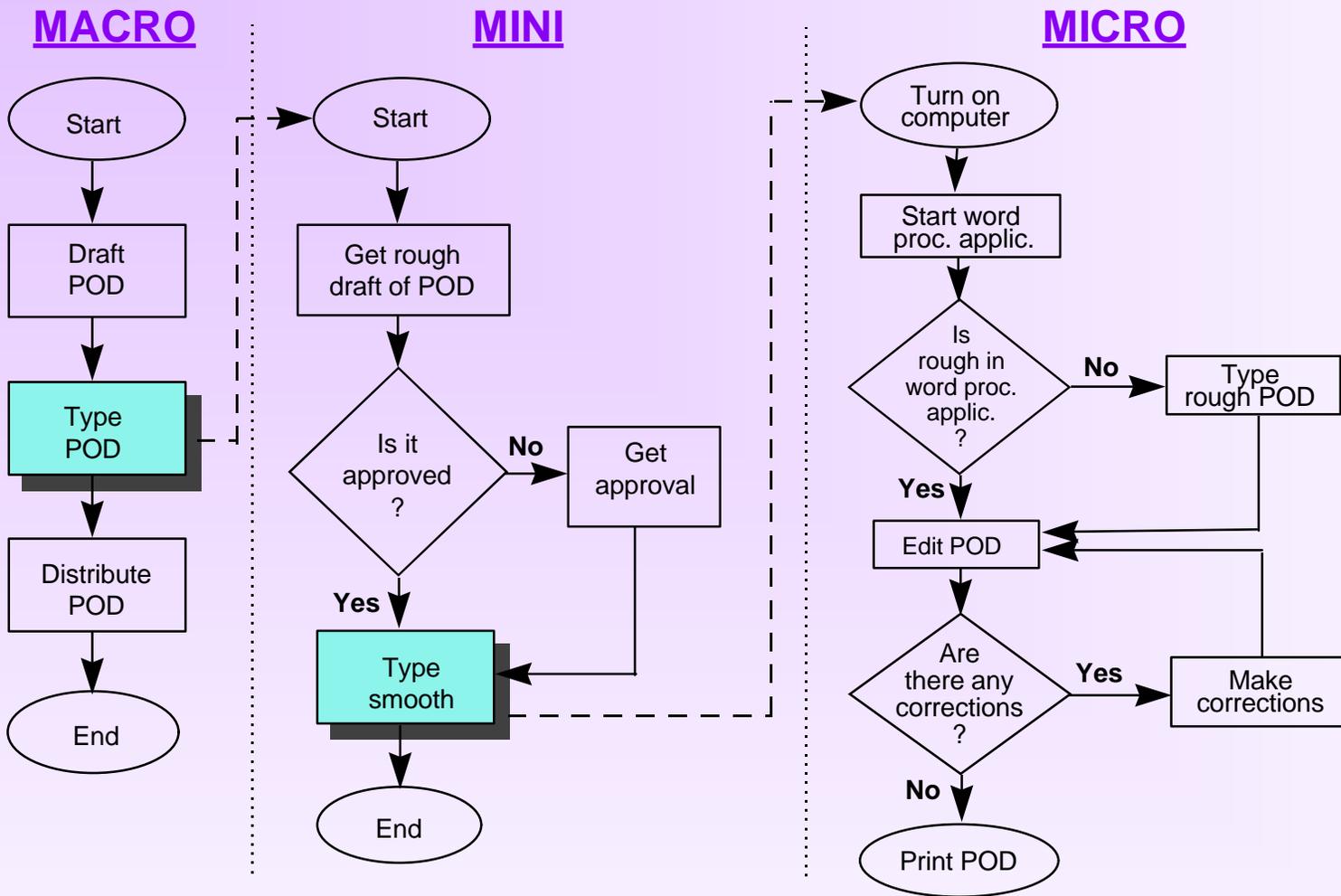


Deployment Flowchart Example

Producing the “Plan of the Day”



Levels of Flowcharts



Guidelines for Flowcharting

- ◆ Assemble the right people
- ◆ Start with the big picture
- ◆ Observe the current process
- ◆ Decide on “as-is”, “regulation”, or “ideal” flowchart
- ◆ Define the level of detail



Constructing a Flowchart

- ◆ Define the process to be flowcharted
- ◆ Record the steps, activities, and decisions
- ◆ Arrange the sequence of steps
- ◆ Draw the flowchart using symbology
- ◆ Validate the finished flowchart



Constructing a Deployment Flowchart

- ◆ List major steps of the process vertically on the left
- ◆ List the responsible process workers across the top
- ◆ Place each step in the appropriate column
- ◆ Connect the steps



Interpreting a Flowchart

Step 1 - Examine each process step

*Bottlenecks? Poorly defined steps?
Ineffective sequence? Delays? Weak links?*

Step 2 - Examine each decision symbol

Can this step be eliminated?

Step 3 - Examine each rework loop

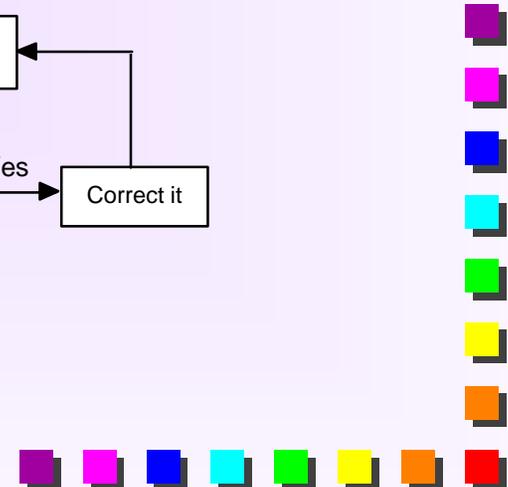
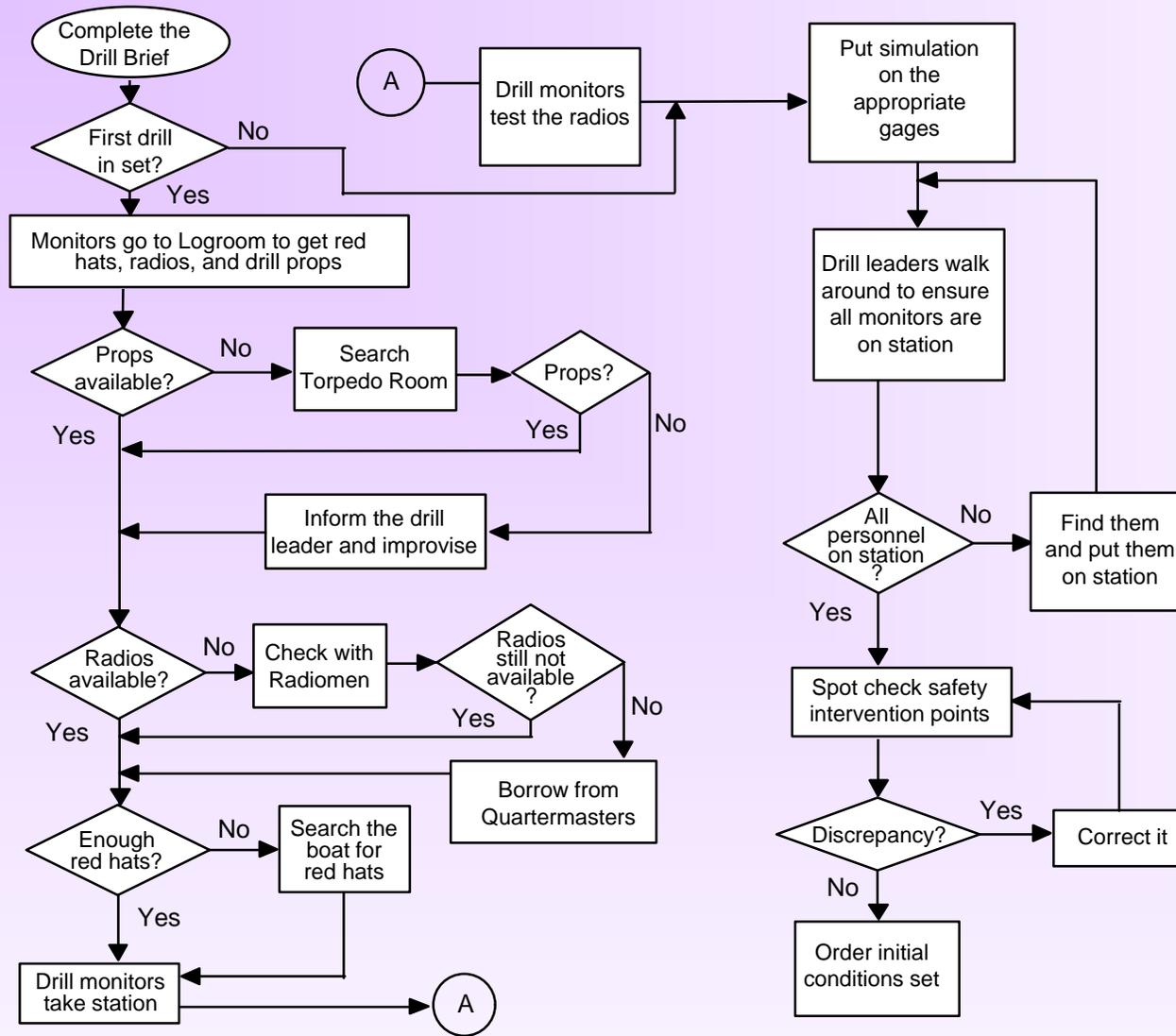
Can it be shortened or eliminated?

Step 4 - Examine each activity symbol

Does the step add value for the end-user?

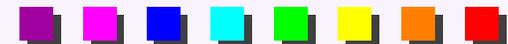


Fire Drill Preparation Flowchart



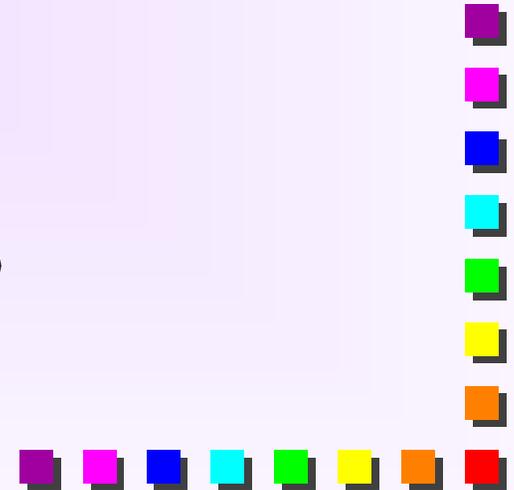
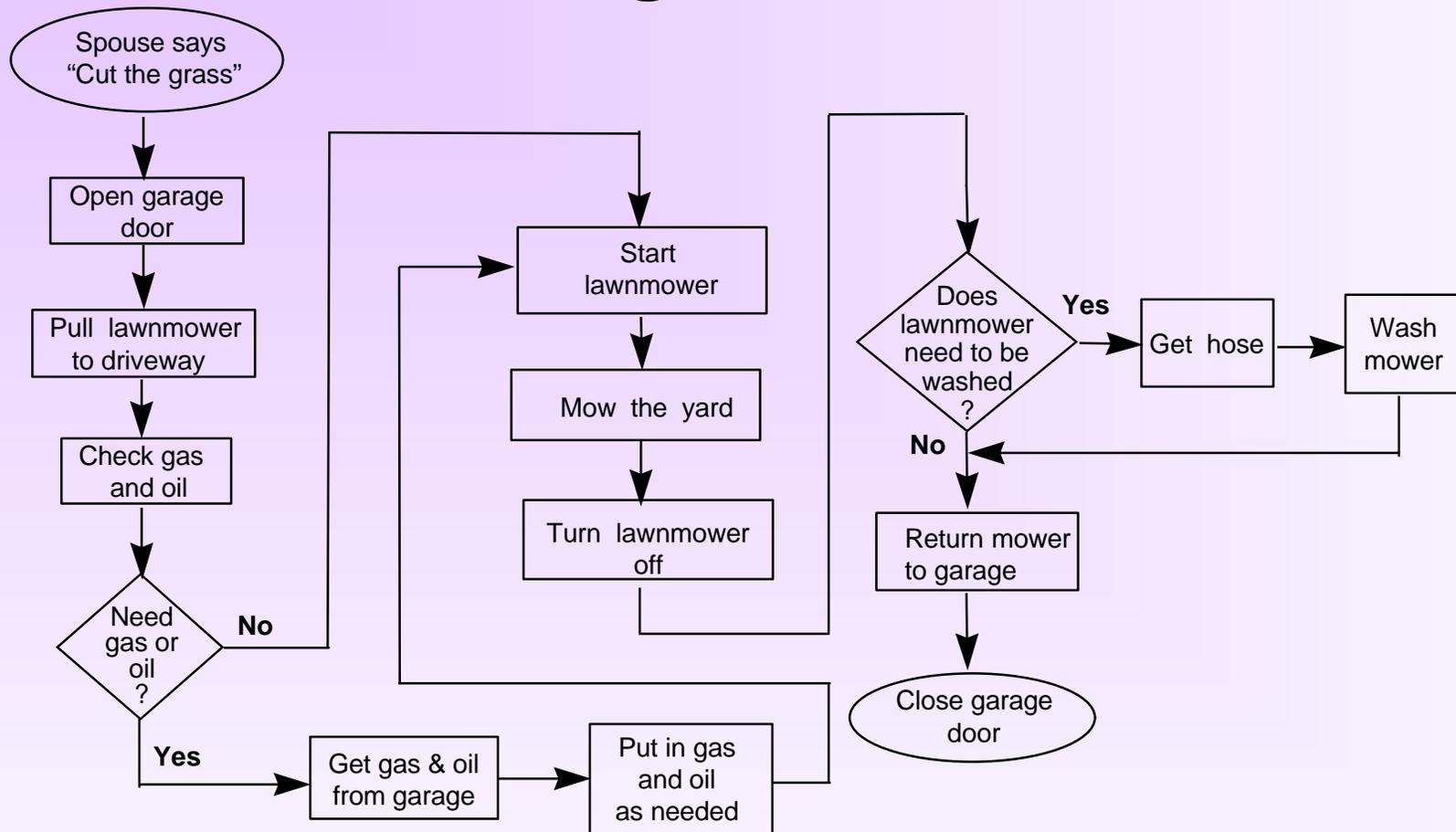
Flowchart Exercise

***Construct a mini-level
flowchart of “cutting
the grass”***



Flowchart Exercise Example

“Cutting the Grass”



Brainstorming

An idea-generating technique used by teams to generate many ideas in a short period of time

Benefits of Brainstorming

- ◆ Rapidly produces a large number of ideas
- ◆ Encourages creativity and innovation
- ◆ Encourages involvement by all members
- ◆ Fosters a sense of ownership
- ◆ Provides input to other tools



Guidelines for Brainstorming

- ◆ **Set the format**
(structured/unstructured)
- ◆ **Display ideas exactly as presented**
- ◆ **No discussion of input**
- ◆ **Build on others' ideas**
- ◆ **Maintain a brisk pace**
- ◆ **Active participation by everyone**



Steps for Brainstorming

◆ Generate the ideas

- Clearly state the topic
- Review the guidelines
- Collect everyone's ideas
- Record and display ideas

◆ Clarify, combine, cancel

- Clarify the meaning of each item
- Combine like items
- Cancel the obvious far out items



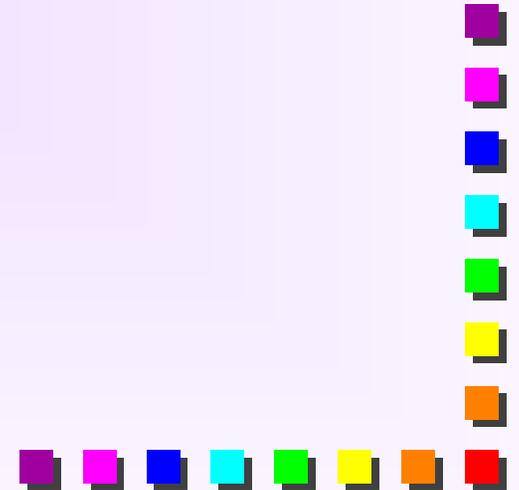
Brainstorming Example

*What can be done to ensure
the proper disposal of
recyclable material on base?*



Brainstorming

Exercise



Affinity Diagram

A tool that organizes large amounts of language data (ideas, opinions, issues) into groupings based on their natural relationships

Use the Affinity Process to:

- ◆ Sift through large volumes of data
- ◆ Encourage new patterns of thinking



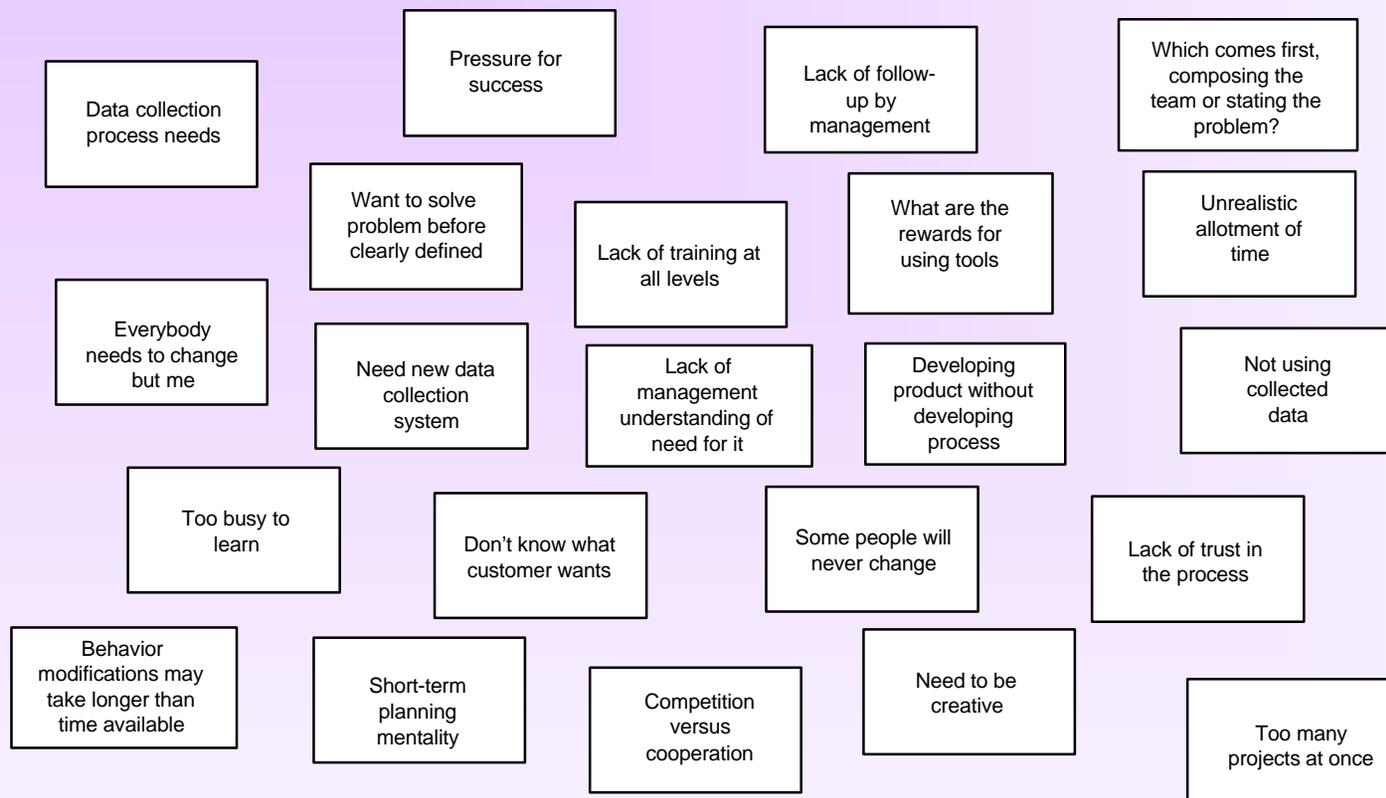
Guidelines for Creating an Affinity Diagram

- ◆ **“Affinitize” silently**
- ◆ **Go for gut reactions**
- ◆ **Handle disagreements simply**
- ◆ **Generally not used for less than 15 items**



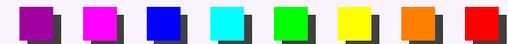
Step 1 - Display the Generated Ideas

Issues in Implementing Continuous Process Improvement



Step 2 - Sort Ideas into Related Groups

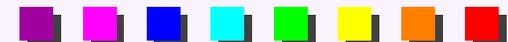
Issues in Implementing Continuous Process Improvement



Step 3 - Create Header Cards

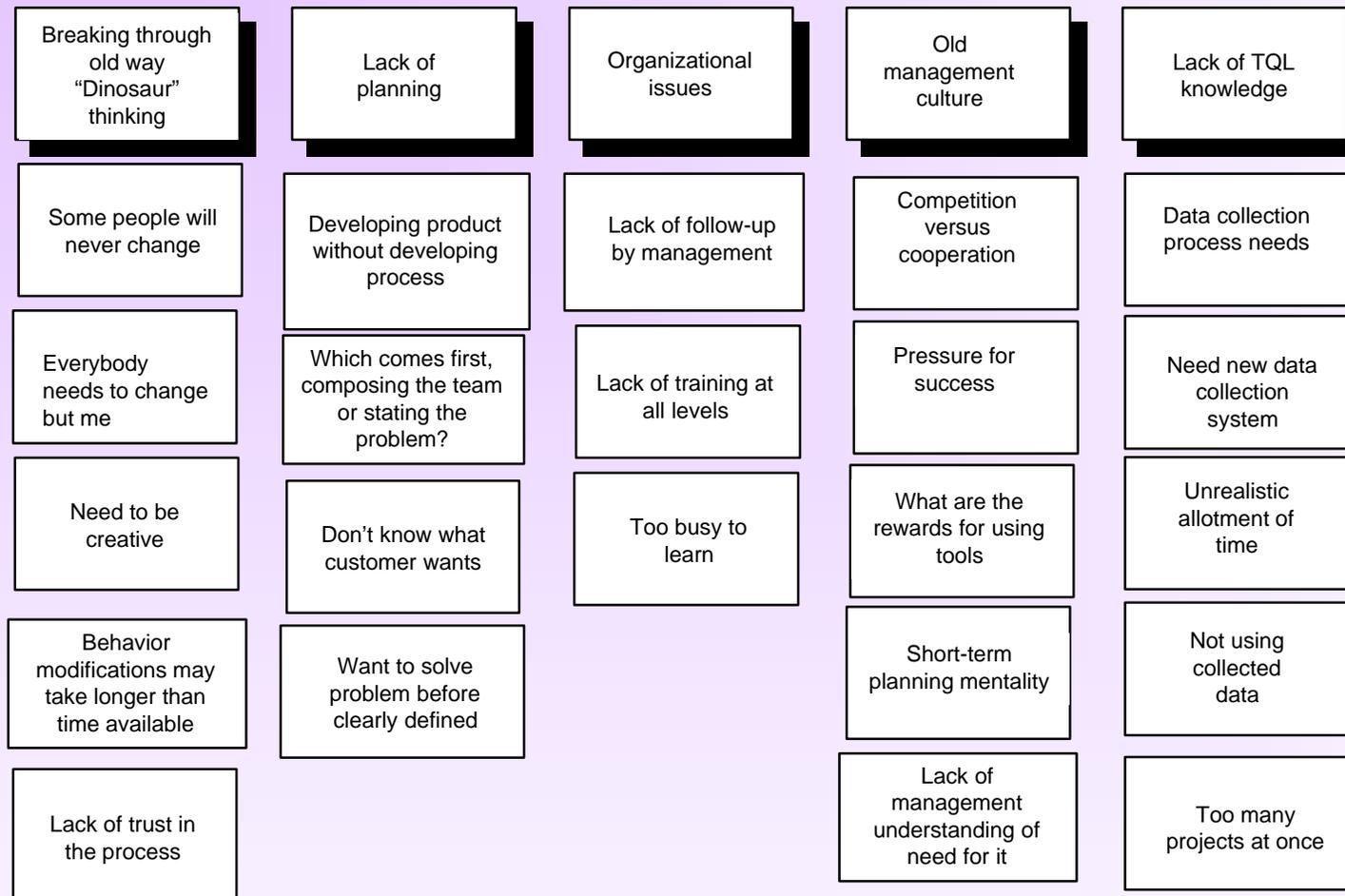
Issues in Implementing Continuous Process Improvement

(Header Cards)



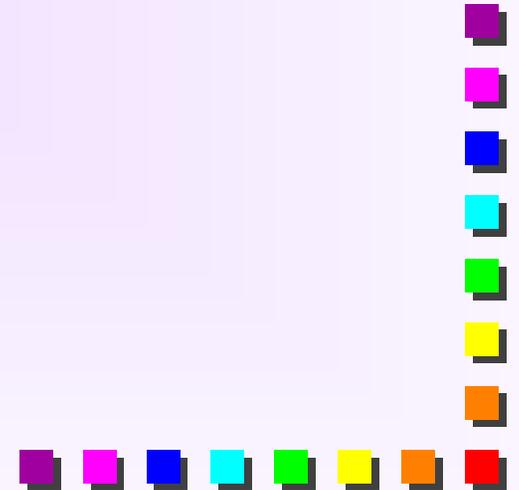
Step 4 - Draw the Finished Affinity Diagram

Issues in Implementing Continuous Process Improvement



Affinity Exercise

*Use the list generated during
the Brainstorming Exercise*



Cause and Effect Diagram

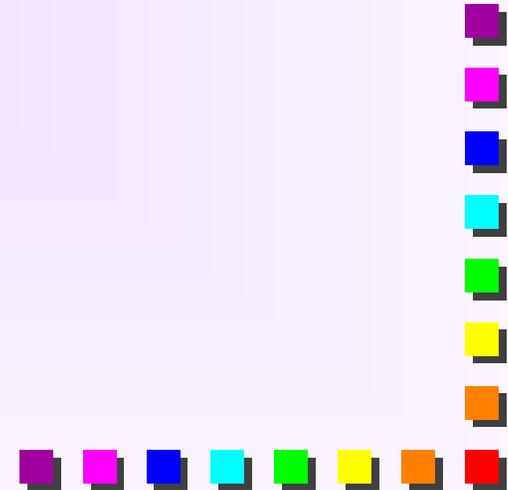
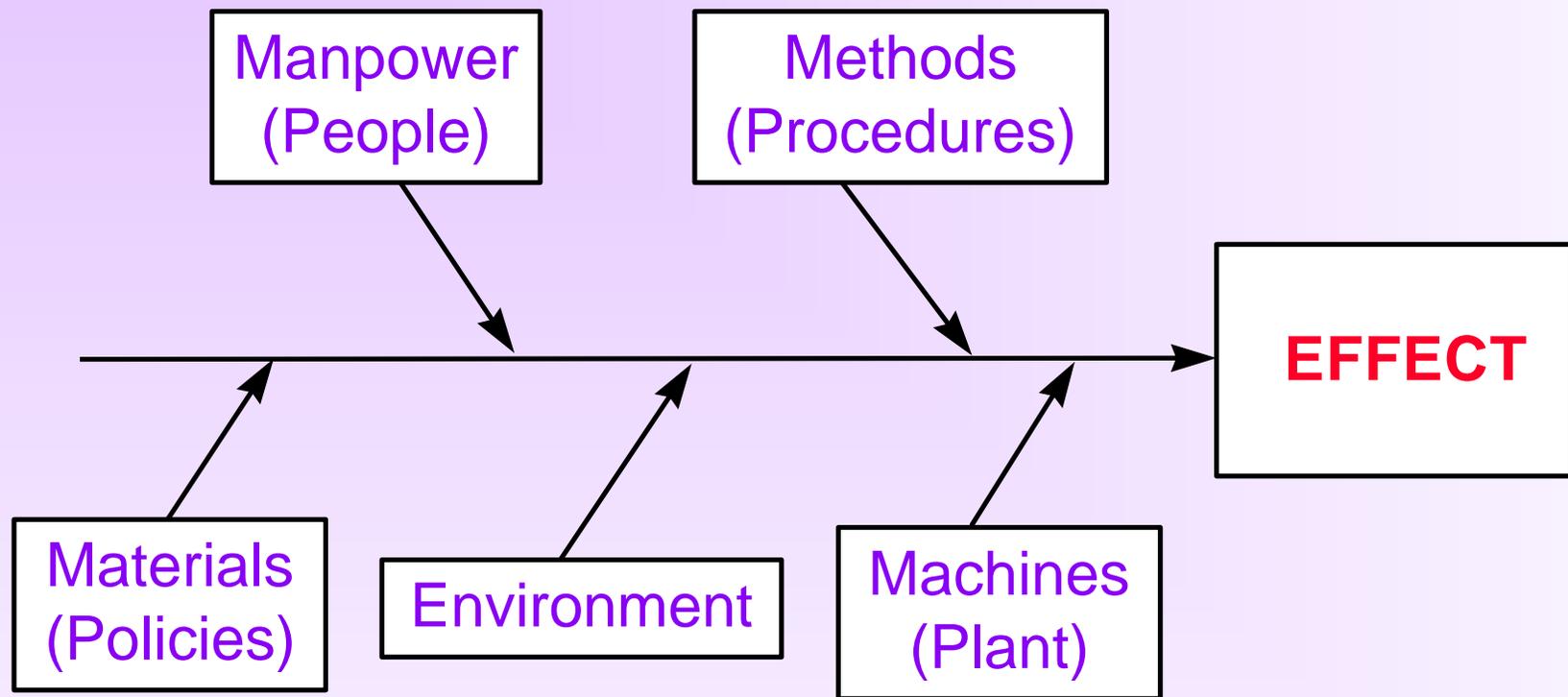
A graphic tool that helps identify, sort, and display possible causes of a problem or quality characteristic

Benefits of Cause and Effect Diagrams

- ◆ Uses an orderly, easy-to-read format
- ◆ Increases knowledge of the process
- ◆ Indicates possible causes of variation
- ◆ Identifies areas for collecting data



Basic Layout of Cause and Effect Diagrams

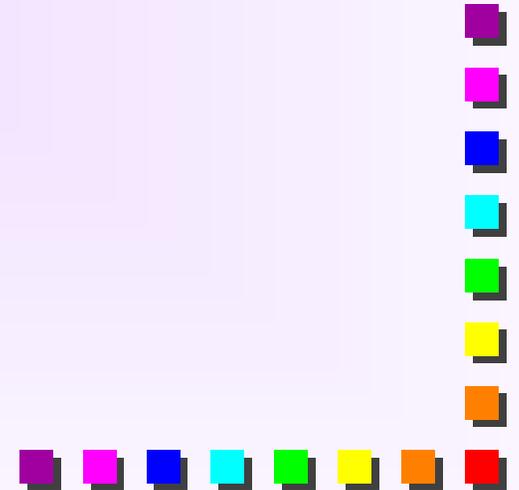
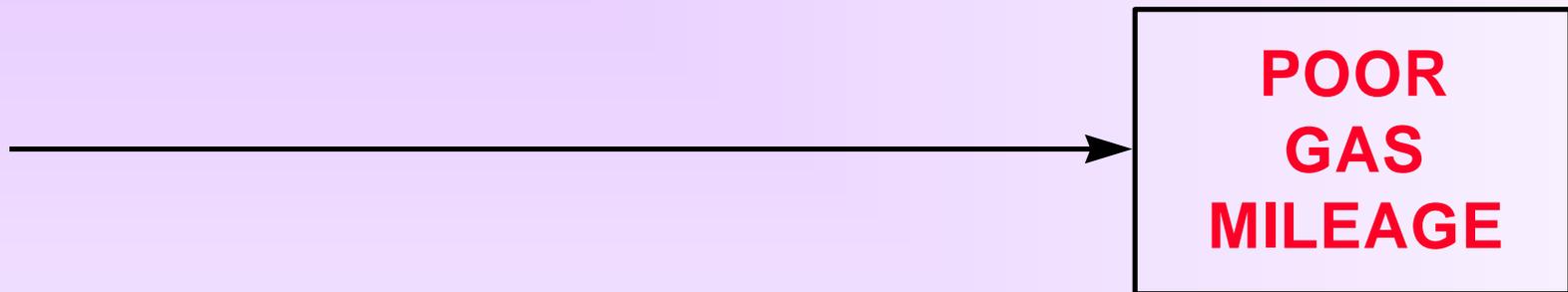


Step 1 - Identify and define the effect

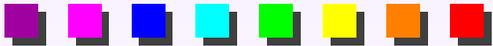
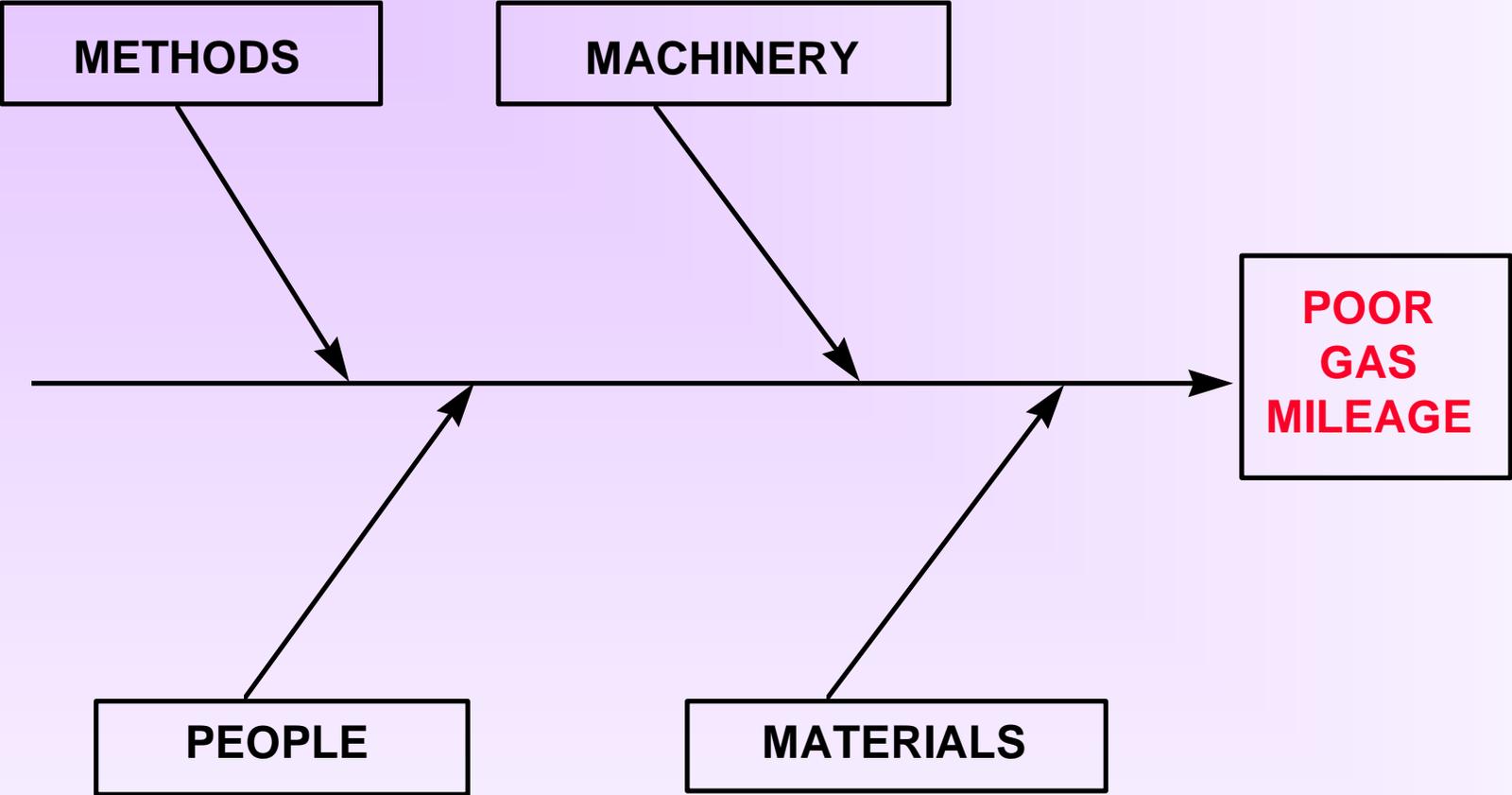
- ◆ **Decide on the effect to examine**
- ◆ **Develop clear definitions**
- ◆ **Phrase effect as**
 - **positive (an objective) or**
 - **negative (a problem)**



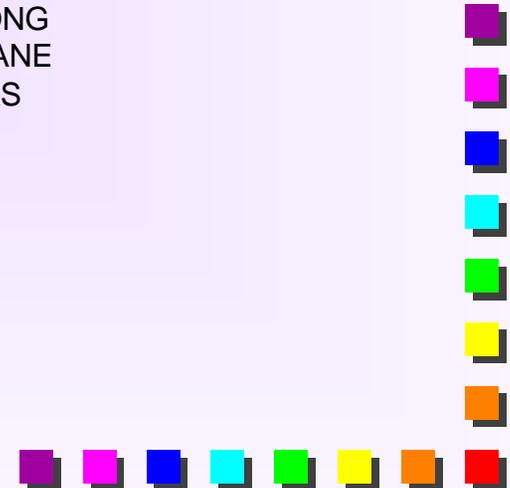
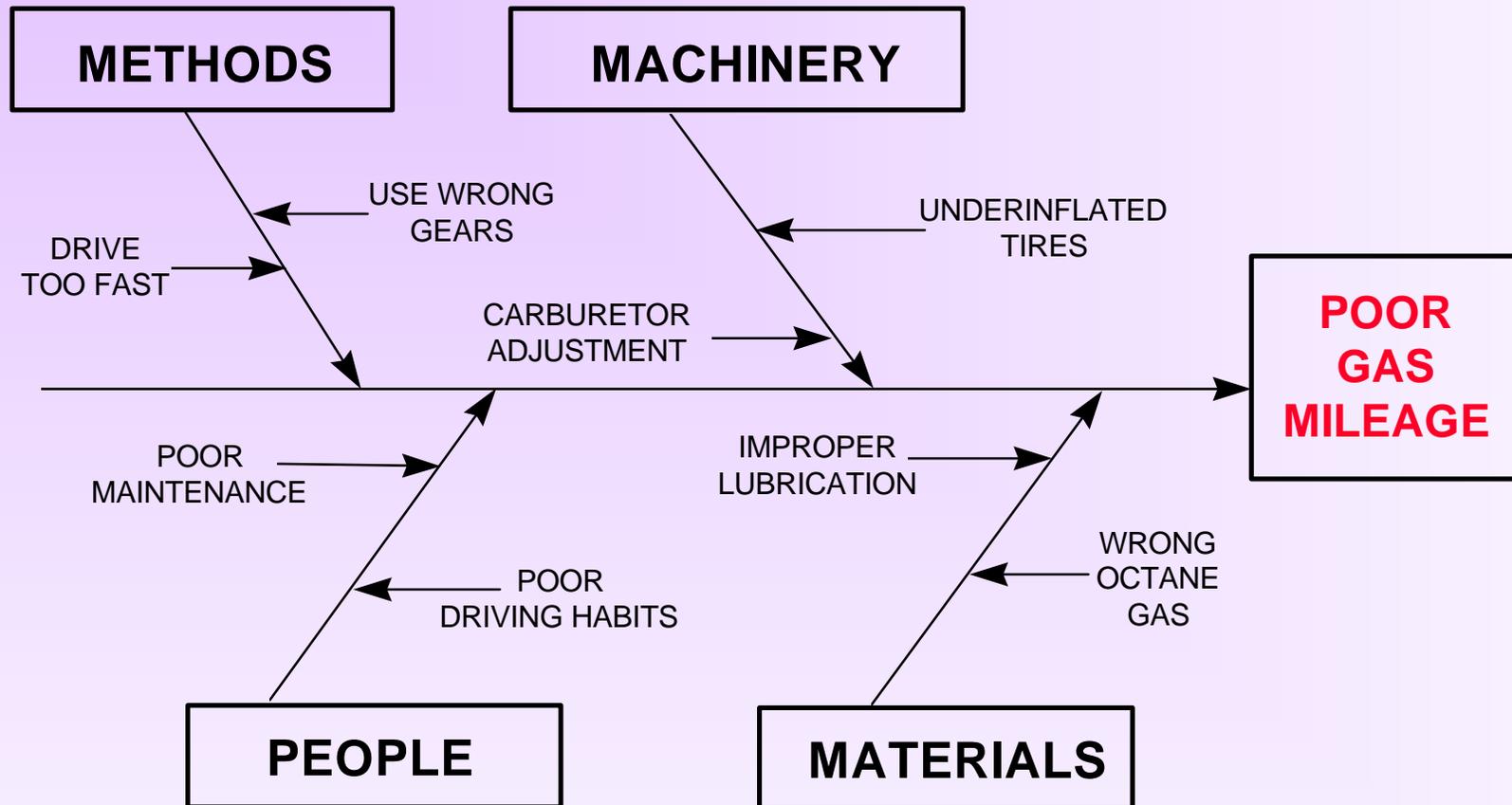
Step 2 - Fill in the effect box and draw the spine



Step 3 - Identify the main branches

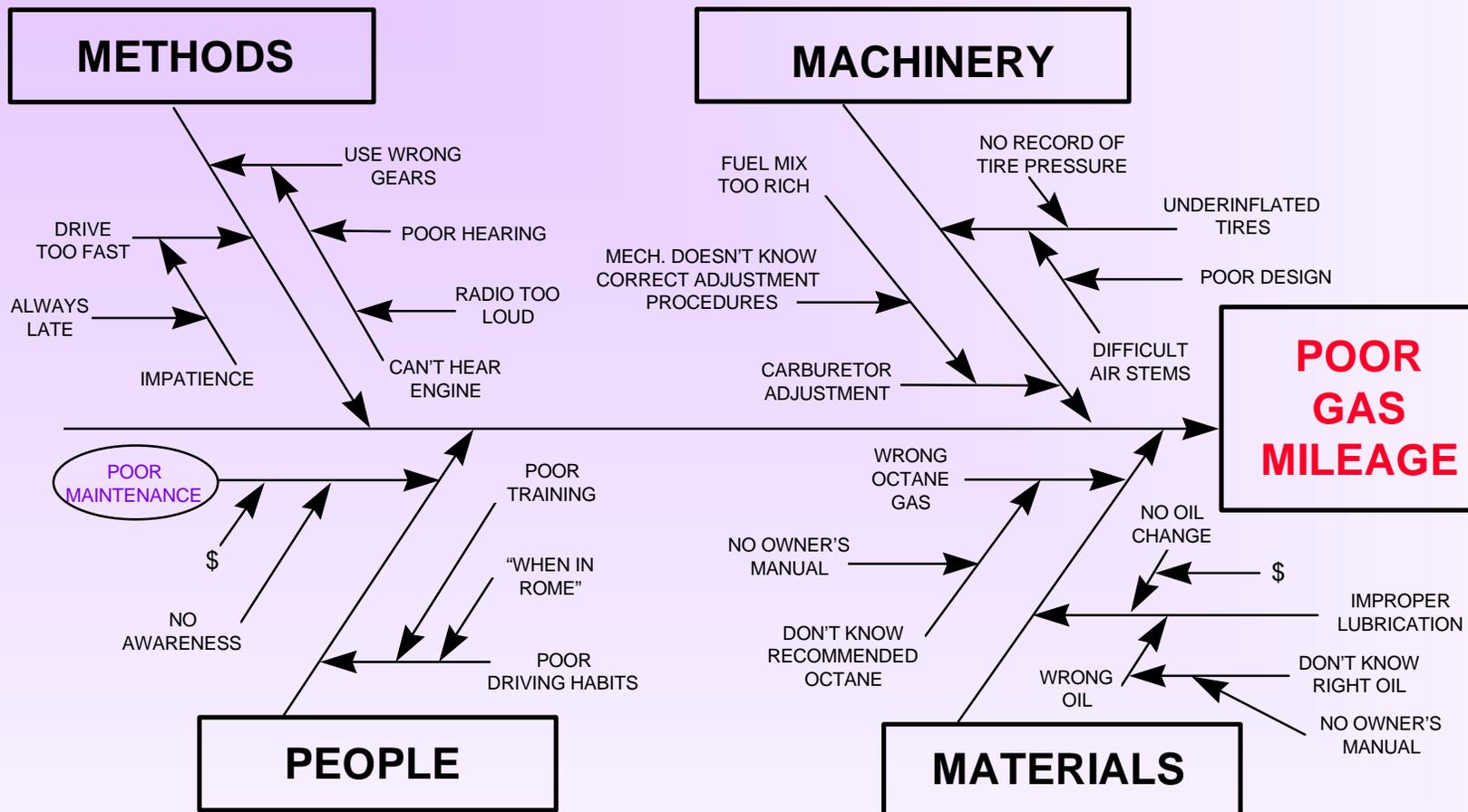


Step 4 - Identify causes influencing the effect

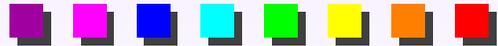
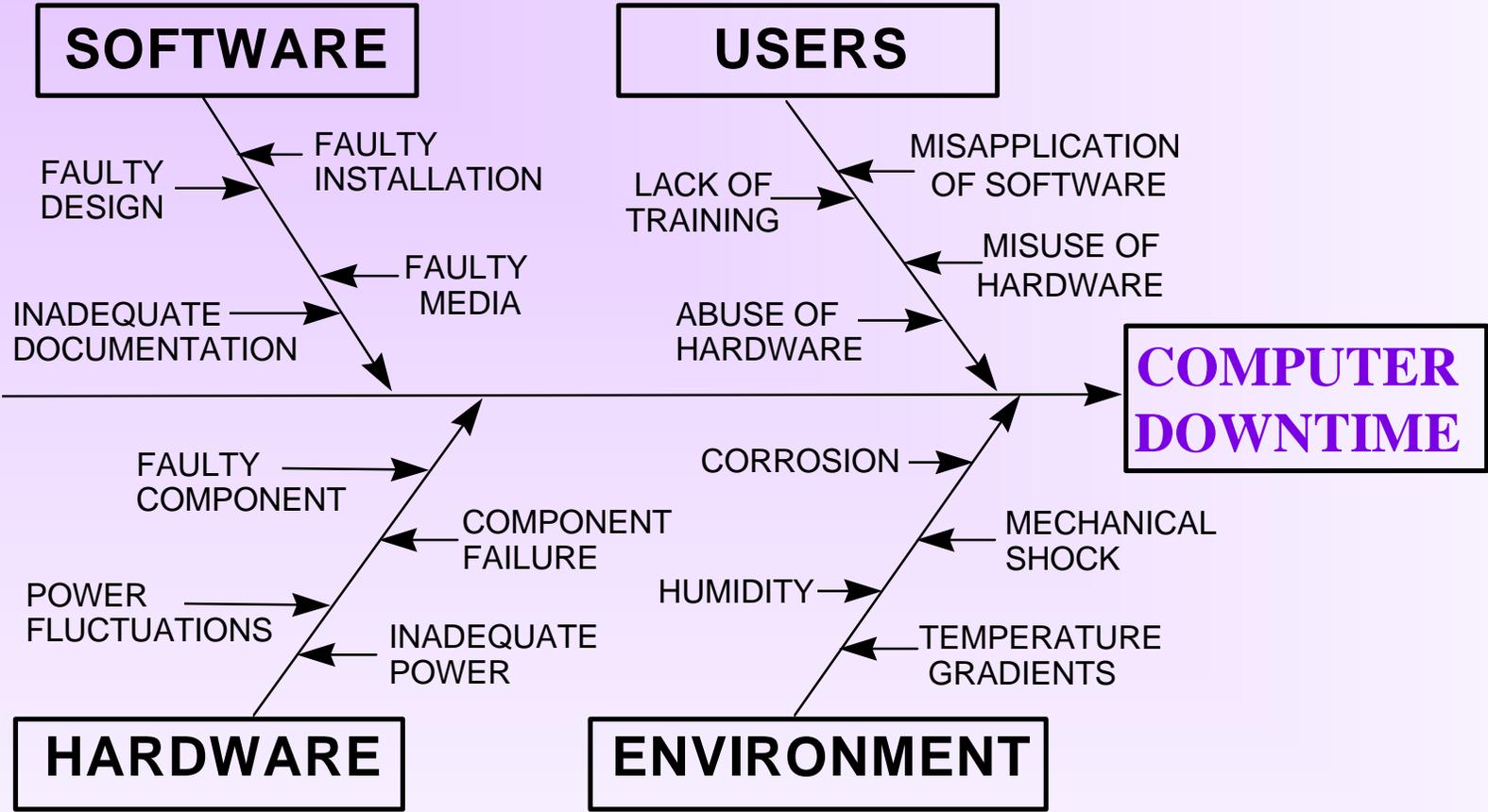


Step 5 - Add detailed levels

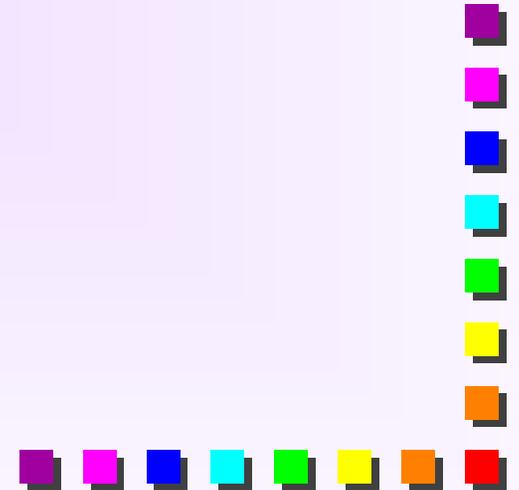
Step 6 - Analyze the diagram



Cause and Effect Diagram Example



Cause and Effect Diagram Exercise



Multivoting

A repetitive process used by a team to select the most important or popular items from a large list of items generated by the team

Benefits of Multivoting

- ∪ **Reduces a larger list of items**
- ∪ **Prioritizes team issues**
- ∪ **Identifies important items**



Procedures for Multivoting

Step 1 - Work from a large list

Step 2 - Assign a letter to each item

Step 3 - Vote on 1/3 of the list

Step 4 - Tally the votes

◆ **Use rule of thumb**

Step 5 - Repeat the process



Multivoting Example

First Vote Tally

- | | | | |
|--|--|----|--|
| | A. No agenda | | I. Problems not mentioned |
| | B. No clear objectives | | J. Interrupted by phone calls |
| | C. Going off on tangents | | K. Few meaningful metrics |
| | D. Extraneous topics | | L. Interrupted by visitors |
| | E. Too many "sea stories" | | M. No administrative support |
| | F. Vital members missing from meeting | | N. Meetings extended beyond allotted time |
| | G. Not enough preparation for meetings | | O. Members distracted by pressing operations |
| | H. Too much "dog and pony" | P. | Unclear charts |



Multivoting Example

Second Vote Tally

- | B. No clear objectives
- |||| F. Vital members missing from meeting
- | ~~||||~~ G. Not enough preparation for meetings
- ~~||||~~ H. Too much "dog and pony"
- ||| J. Interrupted by phone calls
- L. Interrupted by visitors
- || N. Meetings extended beyond allotted time
- ||| O. Members distracted by pressing operations



Multivoting Exercise

SIGNS OF FEAR IN THE WORKPLACE

- | | | |
|---|--|---|
| a. Flooded with detail | o. We vs. they | ac. Concern with return on investment |
| b. "Don't rock the boat" | p. Resisting requests | ad. Focus on grades, instead of learning |
| c. Mixed messages | q. Tampering | ae. Lack of new ideas |
| d. Attacks/defensiveness | r. Staffing redundancies | af. Fear that some work can be done by fewer people |
| e. People afraid to say "I don't know" | s. Constantly changing policies | ag. Resistance to change |
| f. Chronic indecision | t. Myopic vision | ah. Avoidance of risk-taking |
| g. "This too shall pass" | u. Isolation | ai. "Just doing my job" |
| h. News always good | v. Micromanaging | aj. Stress |
| i. Withholding information | w. Goals without a plan for achieving them | ak. Recurrent absenteeism |
| j. Changing subject | x. Blame others | al. Widespread dissatisfaction |
| k. Self-protective behaviors | y. Denial | am. Deadline anxiety |
| l. Hidden agenda syndrome | z. Resistance to new knowledge | an. Enforcement approach to rules |
| m. Turf battles | aa. People afraid to ask questions | ao. Turnover of creative thinkers |
| n. Not willing to accept responsibility | ab. "This is good for my people, not for me" | |

Source: *Managing Fear in the Workplace*, TQLO Publication No. 93-01



Nominal Group Technique (NGT)

A weighted ranking method that allows a group to generate and prioritize a large number of issues within a structure that gives everyone an equal voice

Benefits of using NGT

- ∪ Reduces the number of issues
- ∪ Ensures all team members participate
- ∪ Rank-order issues or items by priority
- ∪ Allows for private input



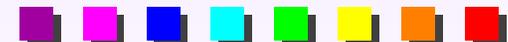
Procedures for NGT

- ◆ **Generate the list of issues, problems, or solutions**
- ◆ **Assign a letter to each idea**
- ◆ **Individually rank the ideas**
 - **Highest number is most important**
- ◆ **Collate and add the rankings**
- ◆ **Rewrite the list in priority order**
- ◆ **Perform a “common sense” check**



NGT Example #1 - “Problems in the workplace”

	PO1	MAJ	SGT	MR	ENS		
Issue	Jones	Smith	Able	Good	Feller	Total	Priority
A	4	2		2	2	10	2
B			3			3	6
C	3	1	2	1		7	5
D					1	1	7
E	2	3	1	3	3	12	1
F				4	4	8	4
G	1	4	4			9	3



NGT Example #2 -

“Why is our ship dragging anchor in heavy weather?”

CAUSES:

A. Haven't set the anchor properly

B. Not enough chain out

C. Bottom not assessed properly

D. Ship isn't steaming at anchor properly

E. Piling too much anchor chain on the flukes

F. Inadequate navigational fixes

G. QMs not notifying CDO of weather changes

RANKING:

6, 7, 6, 4, 4, 7, 4 = 38

5, 5, 7, 5, 5, 6, 7 = 40

7, 6, 5, 6, 7, 5, 6 = 42

1, 1, 1, 2, 1, 2, 1 = 9

2, 2, 4, 3, 3, 3, 3 = 20

3, 4, 3, 7, 6, 4, 2 = 29

4, 3, 2, 1, 2, 1, 5 = 18

PRIORITIZATION: C, B, A, F, E, G, D



NGT Exercise

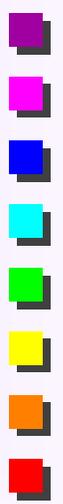
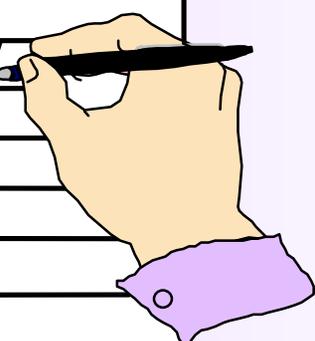
***Conduct NGT to rank order
your list from the
Brainstorming Exercise***



Checksheets

- ◆ Record data for further analysis
- ◆ Provide historical record
- ◆ Introduce data collection methods

Time	New Check-ins
0500-0559	/
0600-0659	///
0700-0759	///
0800-0859	///
0900-0959	####
1000-1059	//
1100-1159	//
1200-1259	/
1300-1359	//
1400-1459	
1500-1559	/



Guidelines for Checksheets

- ◆ Tailor for specific purpose
- ◆ Workers help develop checksheet
- ◆ Label the form clearly
- ◆ Design user-friendly format



Types of Checksheets

Tally Format

JULY 94								
DEFECT	12	13	14	15	16	17	18	TOTAL
WRONG NSN								8
FAULTY MATERIAL								5
PMS NOT DONE								16
INSTALL PROBLEMS								2



Types of Checksheets

Location Format

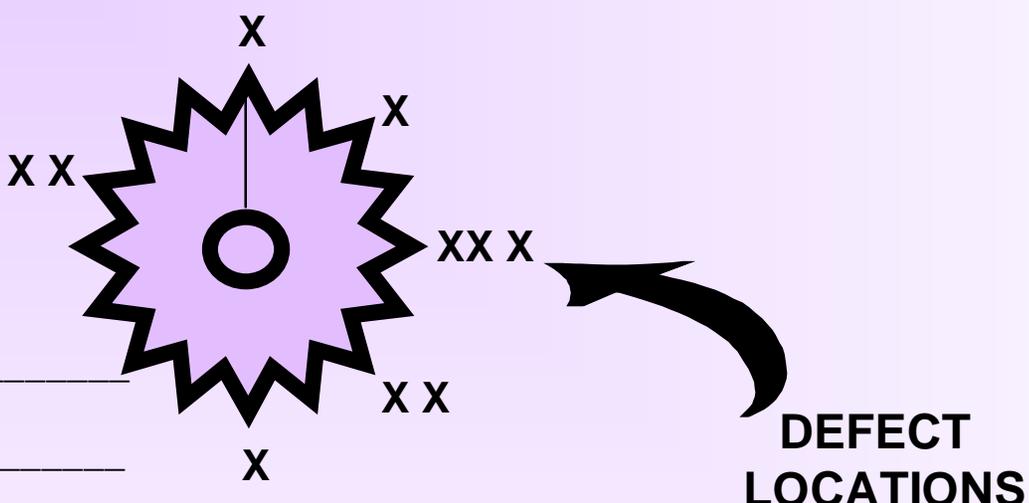
DATE: _____ COMMENTS: _____

DEPT: _____

LOT NUMBER: _____

NUMBER OF BURRS: _____

INSPECTOR: _____

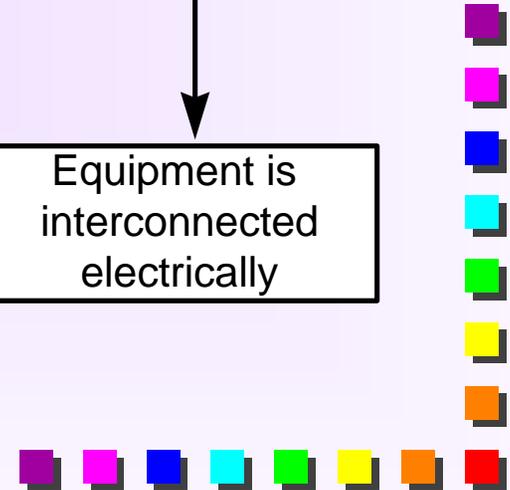
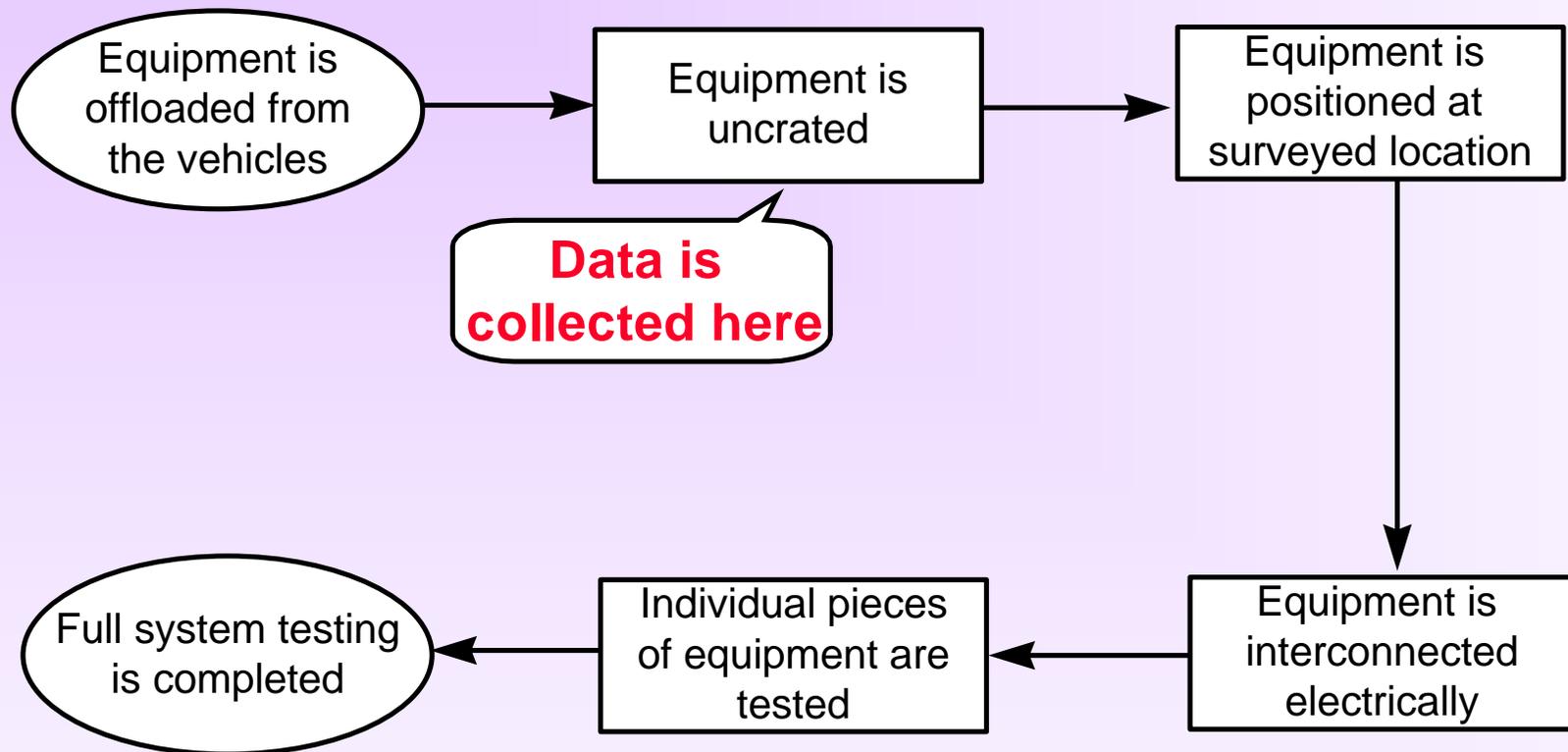


The diagram shows a gear with several 'X' marks indicating burr locations. The marks are: one 'X' at the top, one 'X' at the top-right, two 'X's at the left, three 'X's at the right, two 'X's at the bottom-right, and one 'X' at the bottom. A large black arrow points from the text 'DEFECT LOCATIONS' to the gear diagram.

Location of burrs on a special gear marked with an X



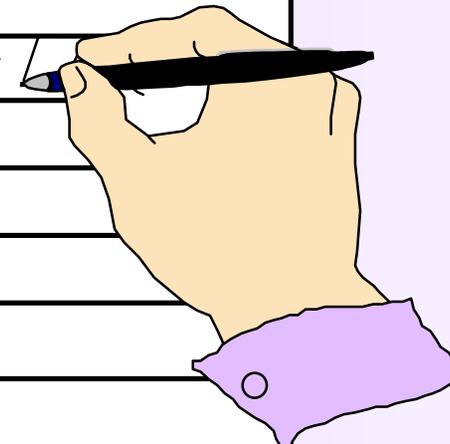
Communications Gateway Set-up Process



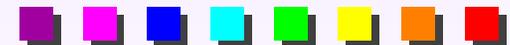
Checksheet Example #1

Uncrating Equipment

UNCRATING (IN MINS)		TOTAL TIME (IN MINS)	
160-179		0550-0599	
180-199		0600-0649	
200-219		0650-0699	
220-239		0700-0749	
240-259	###	0750-0799	###
260-279		0800-0849	
280-299		0850-0899	
300-319		0900-0949	
320-339		0950-0999	
340-359		1000-1049	
360-379		1050-1099	



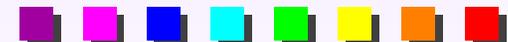
LEGEND: Elapsed time (in mins) to uncrate equipment - 19 August 94 - MCBH Kaneohe Bay, Hawaii



Checksheet Example #2

GEAR DEFECT DATA

Defect Category	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	Total
I.D. Size Wrong	I			I	II					I		5
O.D. Size Wrong		I										1
Nicks		II			II	II	II		I	I	II	12
Burrs			I	I	I		I	I	I	I	II	9
Tooth Geometry	I							I				2
Blemishes	I	II		I		I		I			II	8
Other			I									1
Total	3	5	2	3	5	3	3	3	2	3	6	38



Checksheet Example #3

EQUIPMENT BREAKDOWN DATA

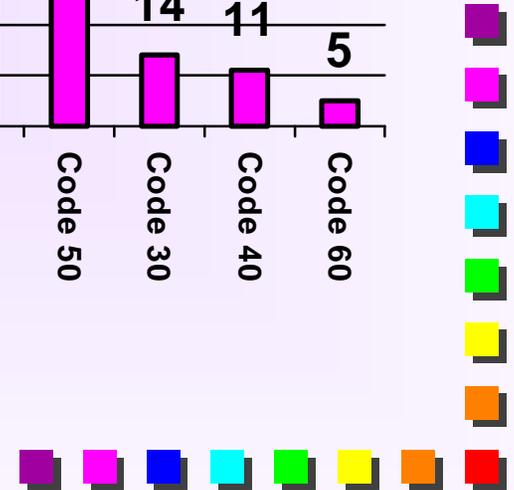
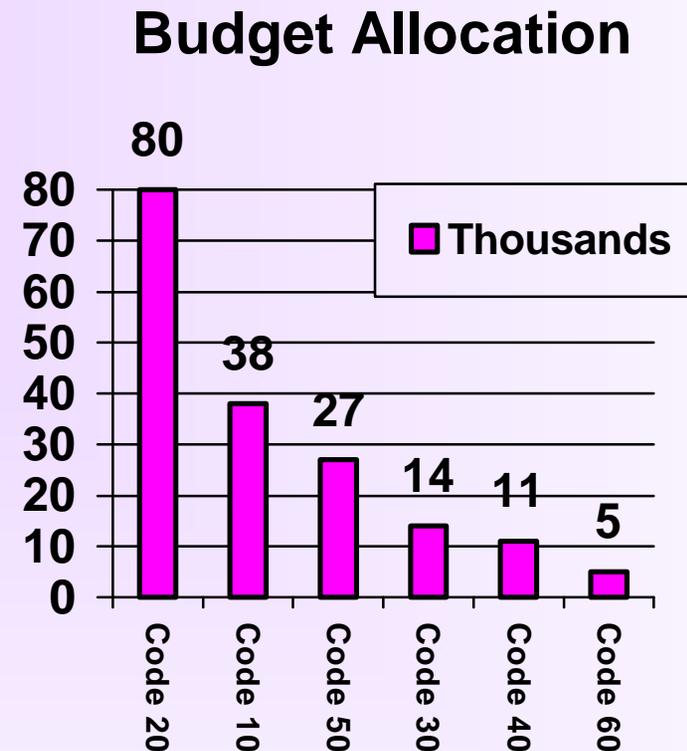
	Machine A			Machine B			
Time OOC	Shift 1	Shift 2	Shift 3	Shift 1	Shift 2	Shift 3	Total
00-29 Mins		M				E	2
30-59 Mins	C			M			2
60-89 Mins			E	E	H		3
90-119 Mins		H				M	2
120-159 Mins			H				1
Total	1	2	2	2	1	2	10

FAULTS: M = Mechanical, E = Electrical, C = Coolant, H = Hydraulic



Pareto Chart

- ◆ Bar chart arranged in descending order of height from left to right
- ◆ Bars on left relatively more important than those on right
- ◆ Separates the "vital few" from the "useful many" (Pareto Principle)



Uses for Pareto Charts

- ◆ **Displays causes or problems in priority order**
- ◆ **Identifies most significant factors**
- ◆ **Shows where to focus efforts**
- ◆ **Allows better use of limited resources**



Constructing a Pareto Chart

Step 1 - Record the raw data

Step 2 - Order the data

Step 3 - Label the vertical axis

Step 4 - Label the horizontal axis

Step 5 - Plot a bar for each category

Step 6 - Add up the cumulative counts

Step 7 - Draw a cumulative line

Step 8 - Add title, legend, and date

Step 9 - Analyze the Pareto Chart



Example #1 - Checksheet

BEQ/BOQ Complaints

Complaint	Feb	Mar	Apr	Total
Loud stereo noise after 2300	30	50	17	97
Insufficient hot water	23	20	11	54
Towels too small and/or thin	12	8	12	32
Inadequate lighting	175	100	75	350
Poor quality TV reception	10	13	60	83
Worn-out furniture	1	4	10	15
Insufficient storage space	25	52	50	127
Cockroaches	324	265	373	962
Rooms too warm or too cold	300	110	95	505



Example #1 - Data Sheet

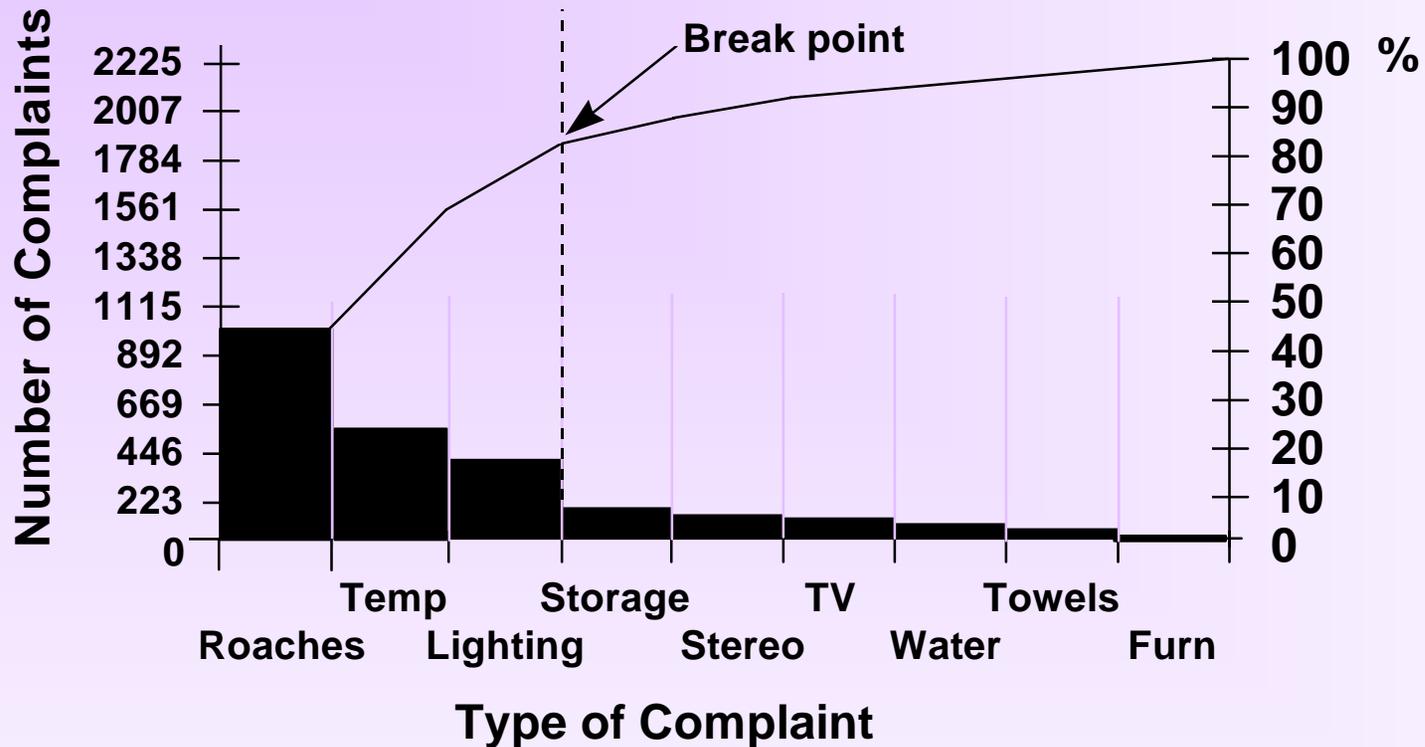
BEQ/BOQ Complaints

Category	Amount	Percent *	Cum. %
Cockroaches	962	43.2	43.2
Rooms too warm or cold	505	22.7	65.9
Inadequate lighting	350	15.7	81.7
Insufficient storage space	127	5.7	87.4
Loud stereo noise after 2300	97	4.4	91.7
Poor quality TV reception	83	3.7	95.5
Insufficient hot water	54	2.4	97.9
Towels too small and/or thin	32	1.4	99.3
Worn-out furniture	15	0.7	100.0
Total	2225		

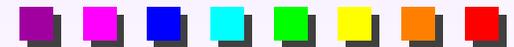
* Percent column does not equal 100% because of rounding.



Example #1 - Pareto Chart BEQ/BOQ Complaints



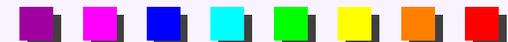
LEGEND: COMPLAINTS RECORDED IN BEQ / BOQ, 1 FEB - 30 APR 95.



Example #2 - Checksheet

Injuries by Department

	FALL	EYE INJURY	CUT / ABRASION	SPORT	MOTOR VEHICLE
ADMIN	0	0	2	3	0
OPS	1	0	1	2	1
MAINT	7	3	5	16	9
SAFETY	0	0	1	1	1
TRAIN	0	1	0	1	2

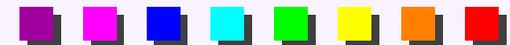


Example #2 - Data Sheet

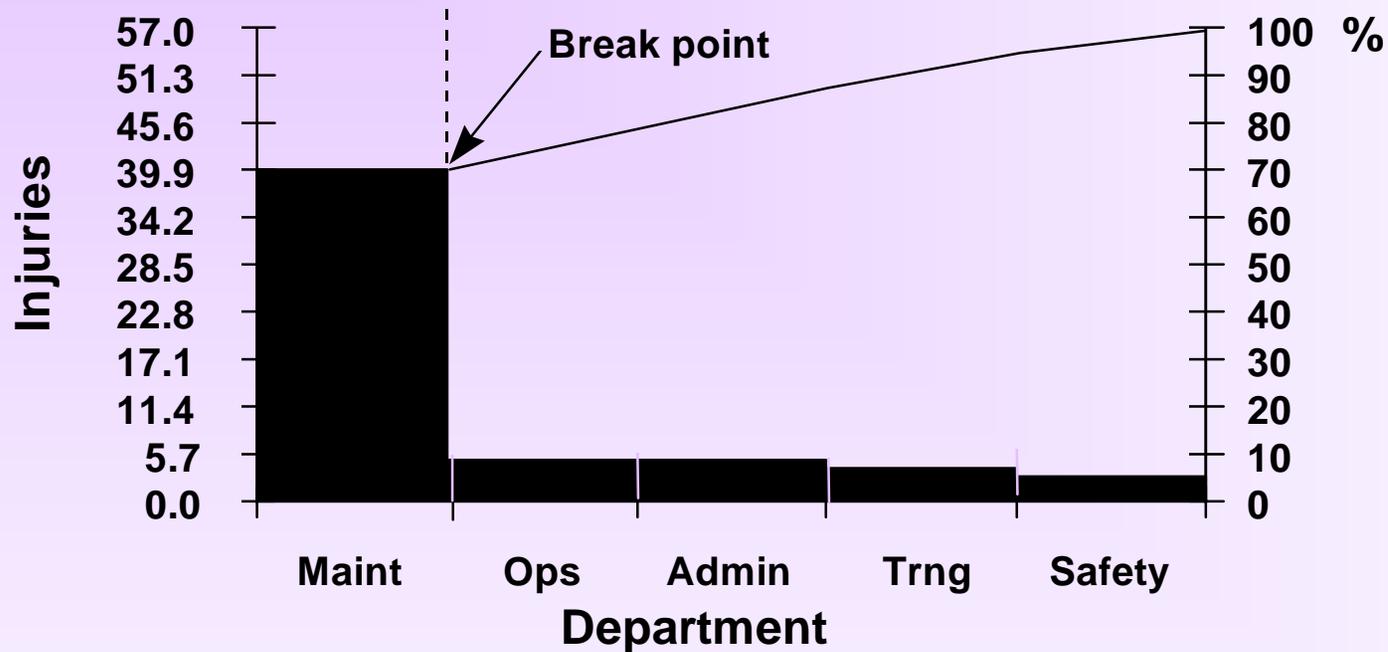
Injuries by Department

Category	No. Injuries	Percent *	Cum. %
Maintenance	40	70.2	70.2
Operations	5	8.8	78.9
Admin	5	8.8	87.7
Training	4	7.0	94.7
Safety	3	5.3	100.0
Total	57		

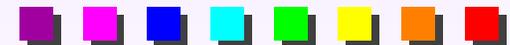
* Percent column does not equal 100% because of rounding.



Example #2 - Pareto Chart Injuries by Department



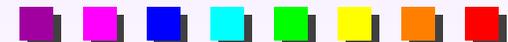
LEGEND: INJURIES TO SQUADRON PERSONNEL 1 FEB - 30 APR 95.



Example #3 - Checksheet

Injuries by Personnel Assigned

	FALL	EYE INJURY	CUT / ABRASION	SPORT	MOTOR VEHICLE
ADMIN	0.0	0.0	0.2	0.3	0.0
OPS	0.1	0.0	0.1	0.2	0.1
MAINT	0.035	0.015	0.025	0.08	0.045
SAFETY	0.0	0.0	0.2	0.2	0.2
TRAIN	0.0	0.2	0.0	0.2	0.4

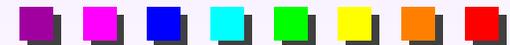


Example #3 - Data Sheet

Injuries by Personnel Assigned

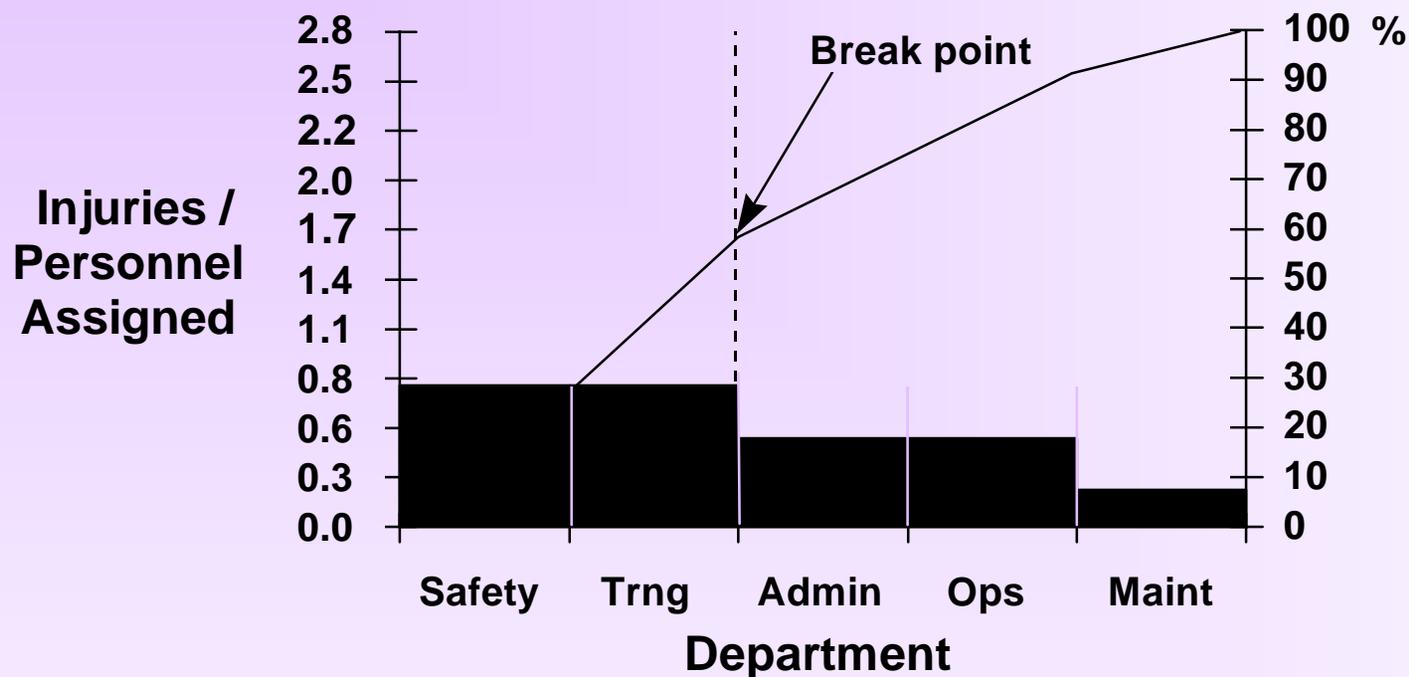
Category	Injury Rate	Percent *	Cum. %
Safety	0.800	28.5	28.5
Training	0.800	28.5	57.0
Admin	0.500	17.8	74.8
Operations	0.500	17.7	92.7
Maintenance	0.200	7.3	100.0
Total	2.806		

* Percent column does not equal 100% because of rounding.



Example #3 - Pareto Chart

Injuries by Personnel Assigned



LEGEND: INJURIES TO SQUADRON PERSONNEL 1 FEB - 30 APR 95.
 BASED ON NUMBER OF PERSONNEL ASSIGNED.



Histogram

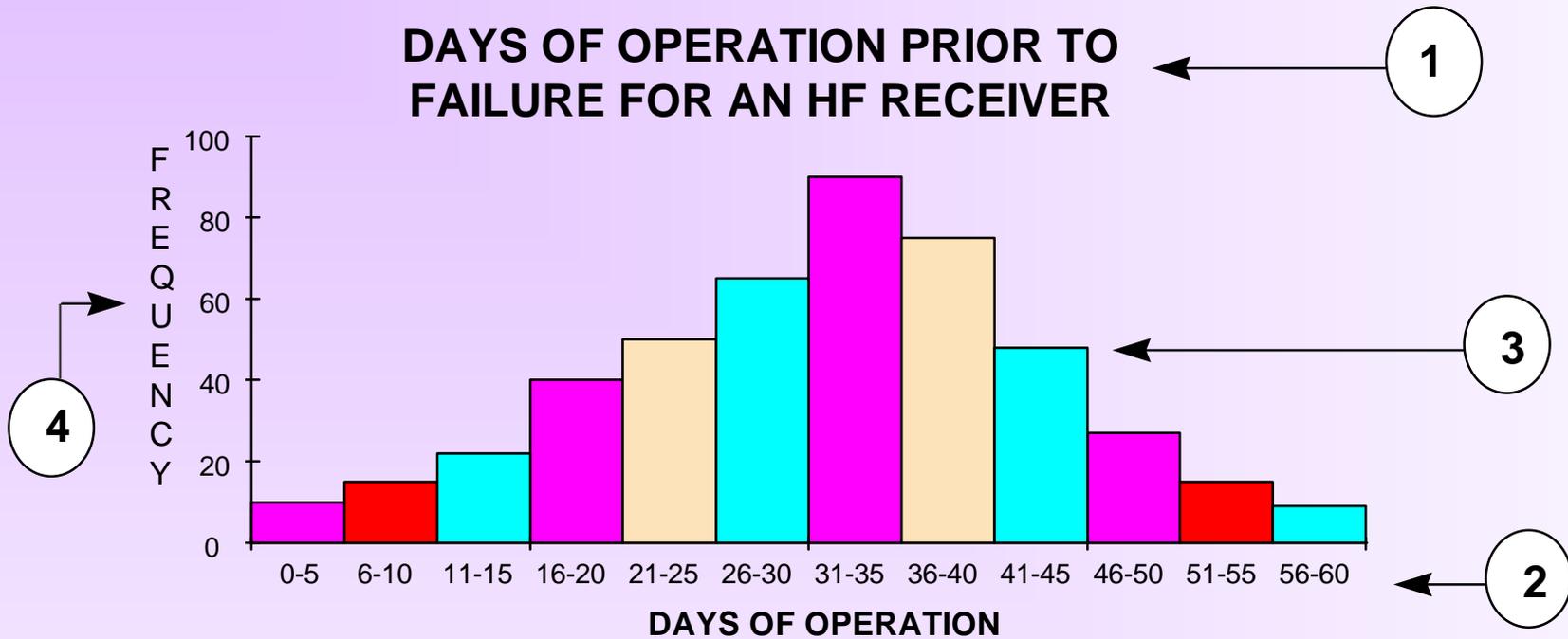
- ◆ A bar graph that shows the distribution of data
- ◆ A snapshot of data taken from a process

When to use Histograms

- ∪ Summarize large data sets graphically
- ∪ Compare process results to specifications
- ∪ Communicate information to the team
- ∪ Assist in decision-making



Elements of a Histogram



MEAN TIME BETWEEN FAILURE (IN DAYS) FOR R-1051 HF RECEIVER
Data taken at SIMA, Pearl Harbor, 15 May - 15 July 94

⑤

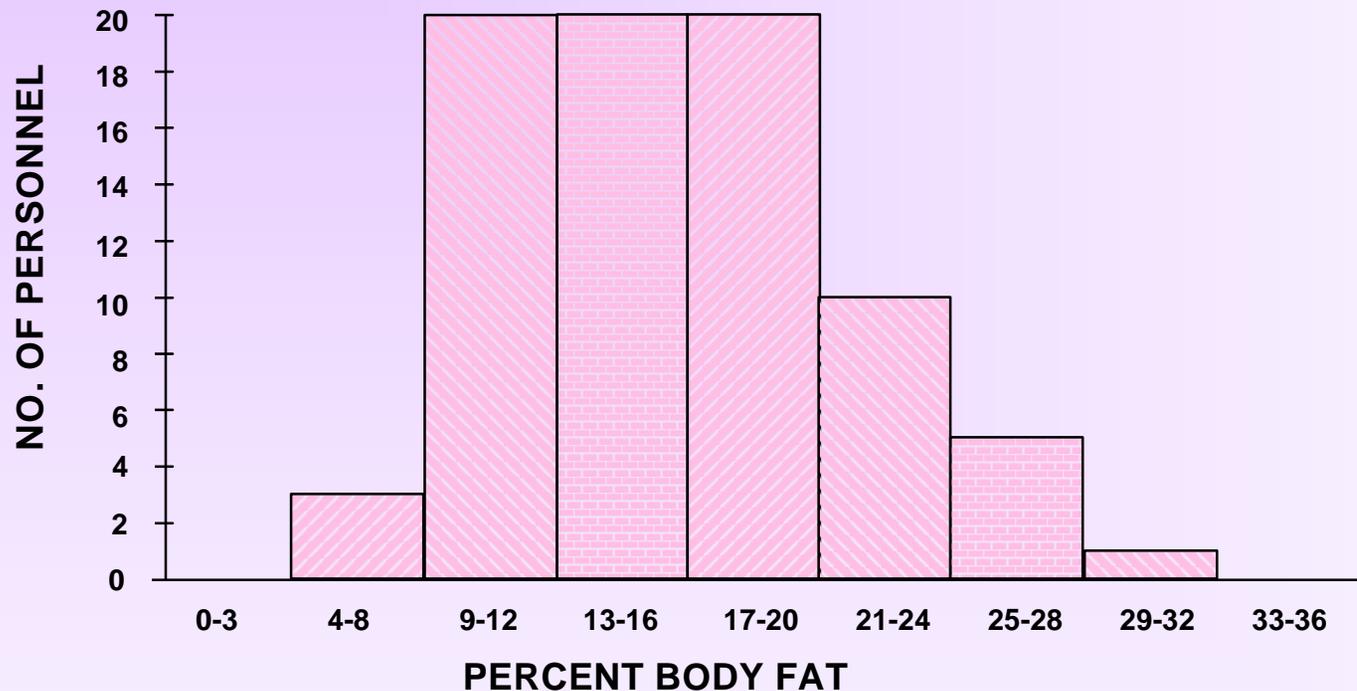
- ① Title
- ③ Bars
- ⑤ Legend

- ② Horizontal / X-axis
- ④ Vertical / Y-axis



Histogram Example #1

JUNE 94 PRT PERCENT BODY FAT

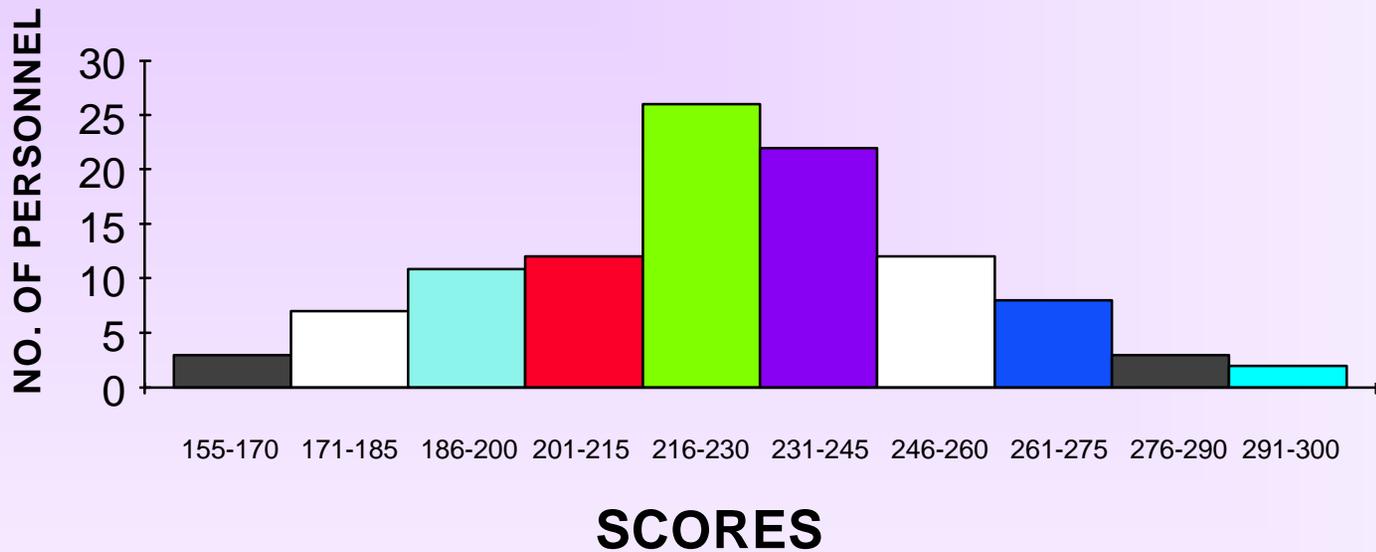


LEGEND: USS LEADER (MSO-490), 25 JUNE 94, ALL 80 PERSONNEL SAMPLED

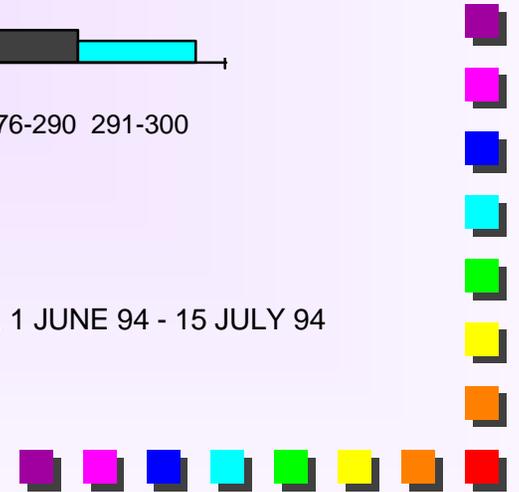


Histogram Example #2

MARKSMANSHIP SCORES FOR 9mm PISTOL

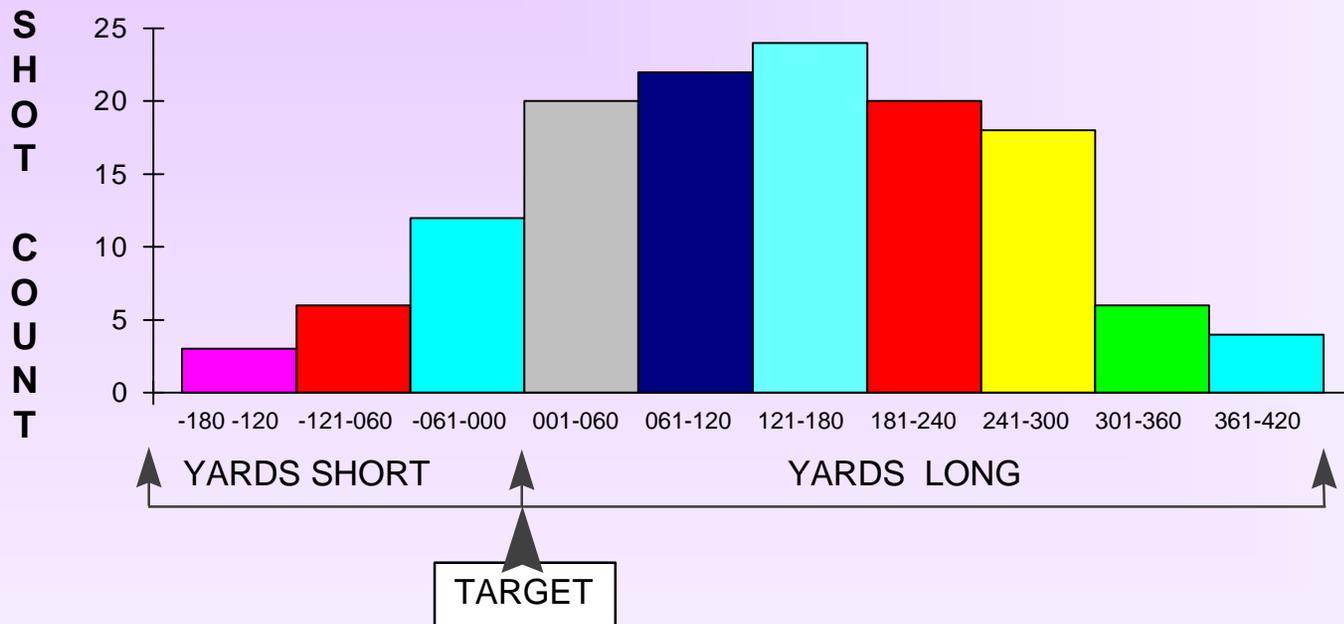


LEGEND: MCBH KANEHOE BAY, HI; AVERAGE OF 4 SCORES PER CLASS, 105 CLASSES, 1 JUNE 94 - 15 JULY 94

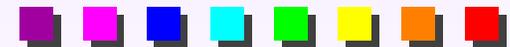


Histogram Example #3

MISS DISTANCE FOR MK 75 GUN TEST FIRING

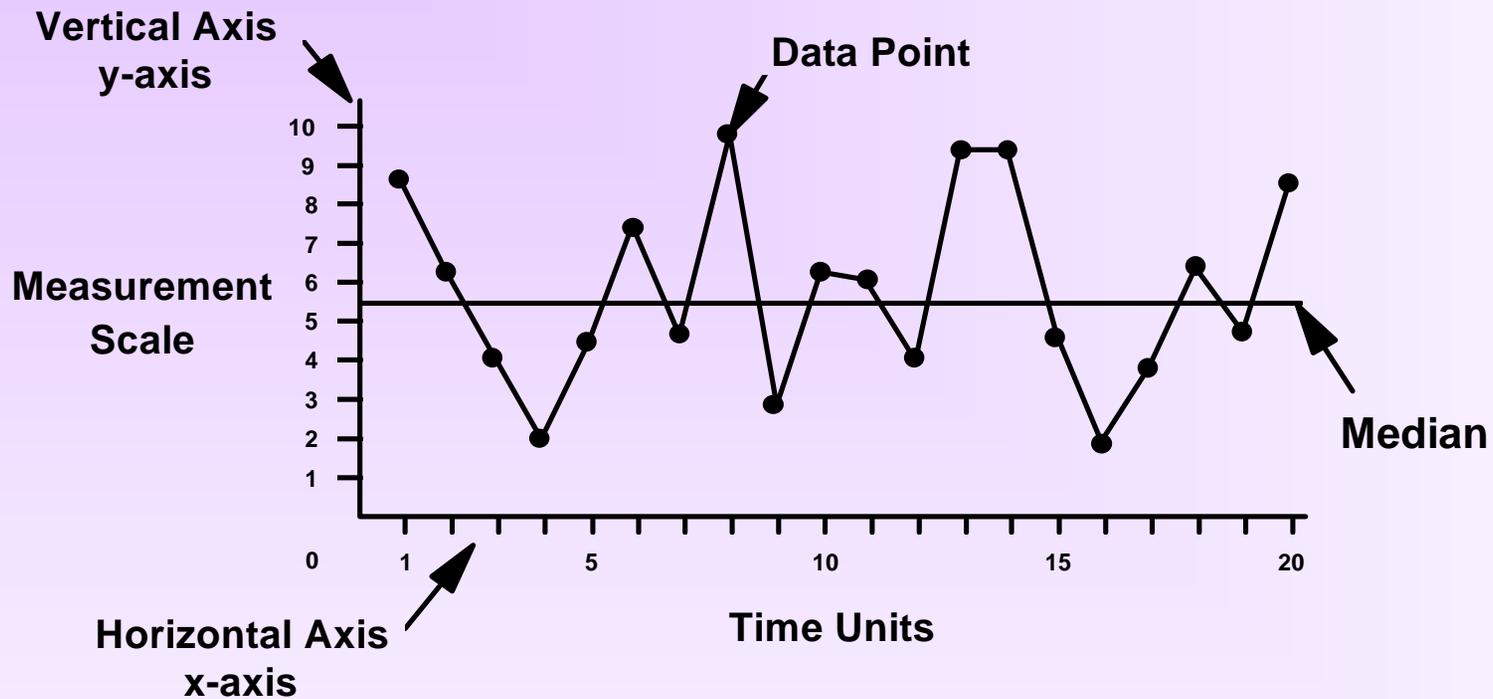


LEGEND: USS CROMMELIN (FFG-37), Pacific Missile Firing Range, 135 Rounds from Mount 31, 25 JUNE 94

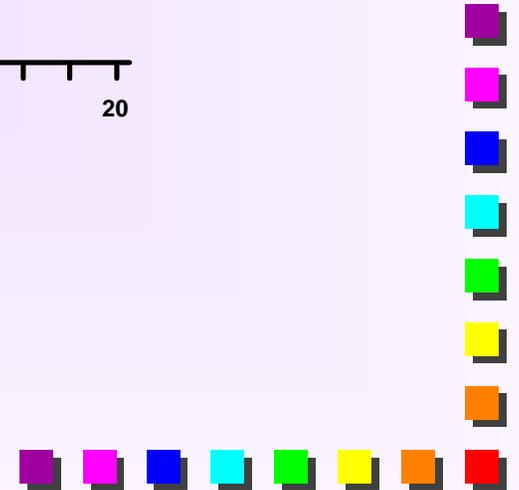


Run Chart

A line graph of data points plotted over time



Elements of a Run Chart



Uses for Run Charts

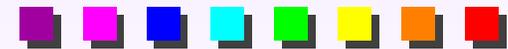
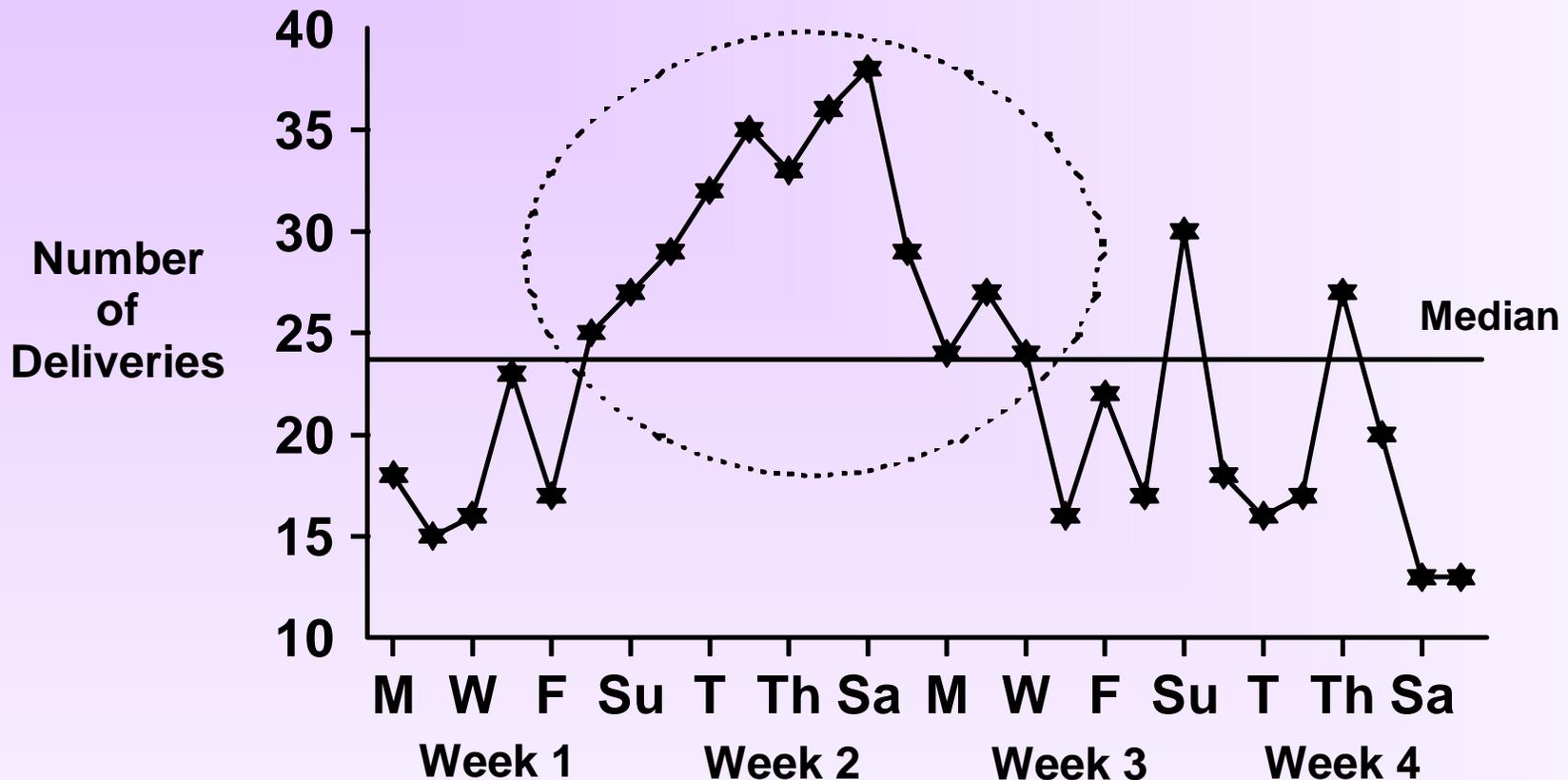
- ◆ **Communicate process performance**

- ◆ **Analyze data for patterns**

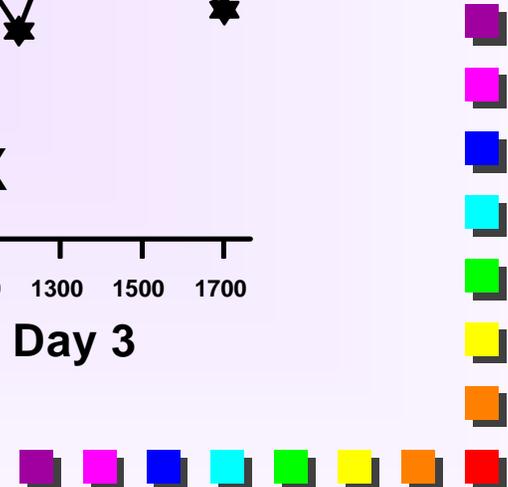
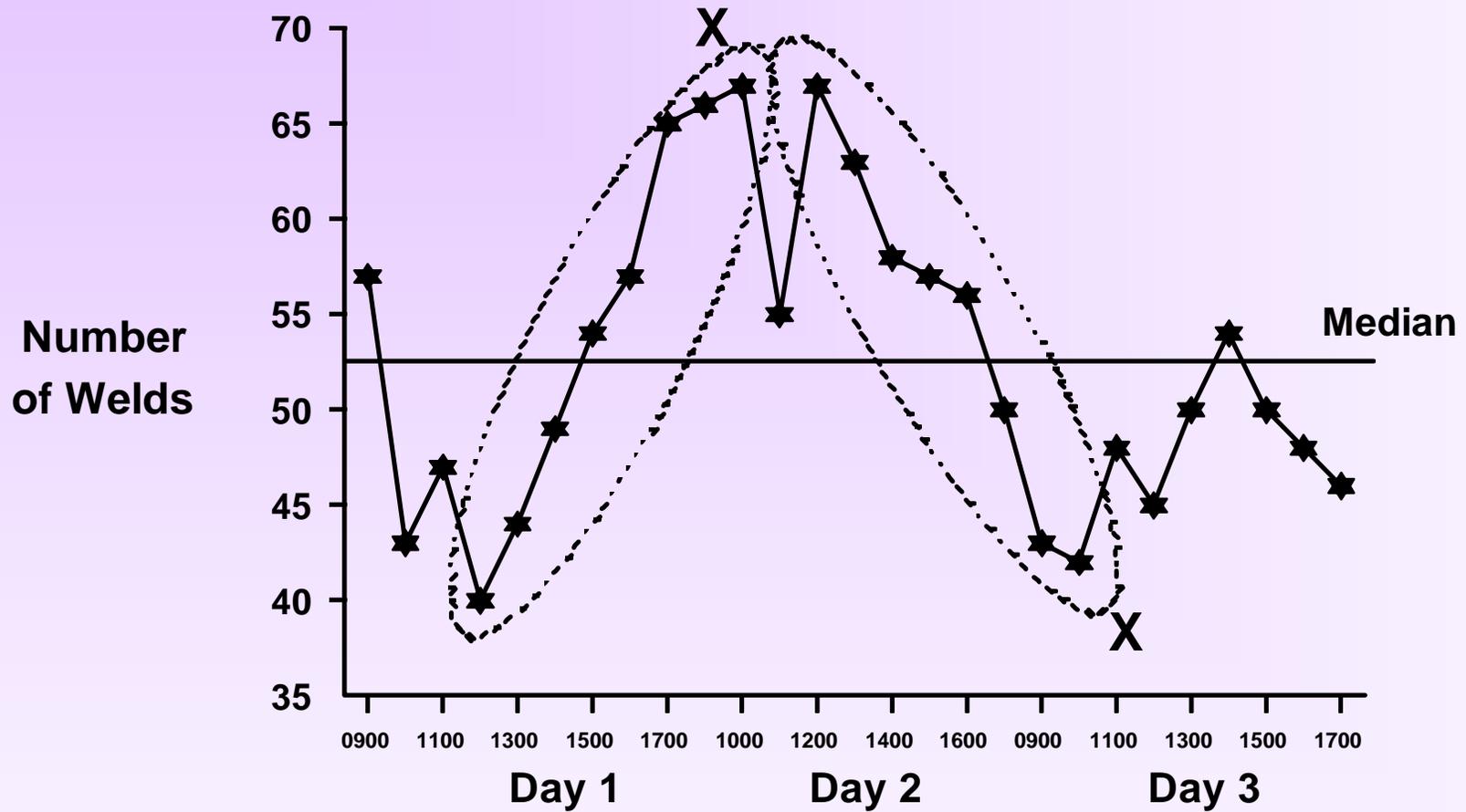
- ◆ **Assess process stability**



Interpreting Run Charts: **Run**

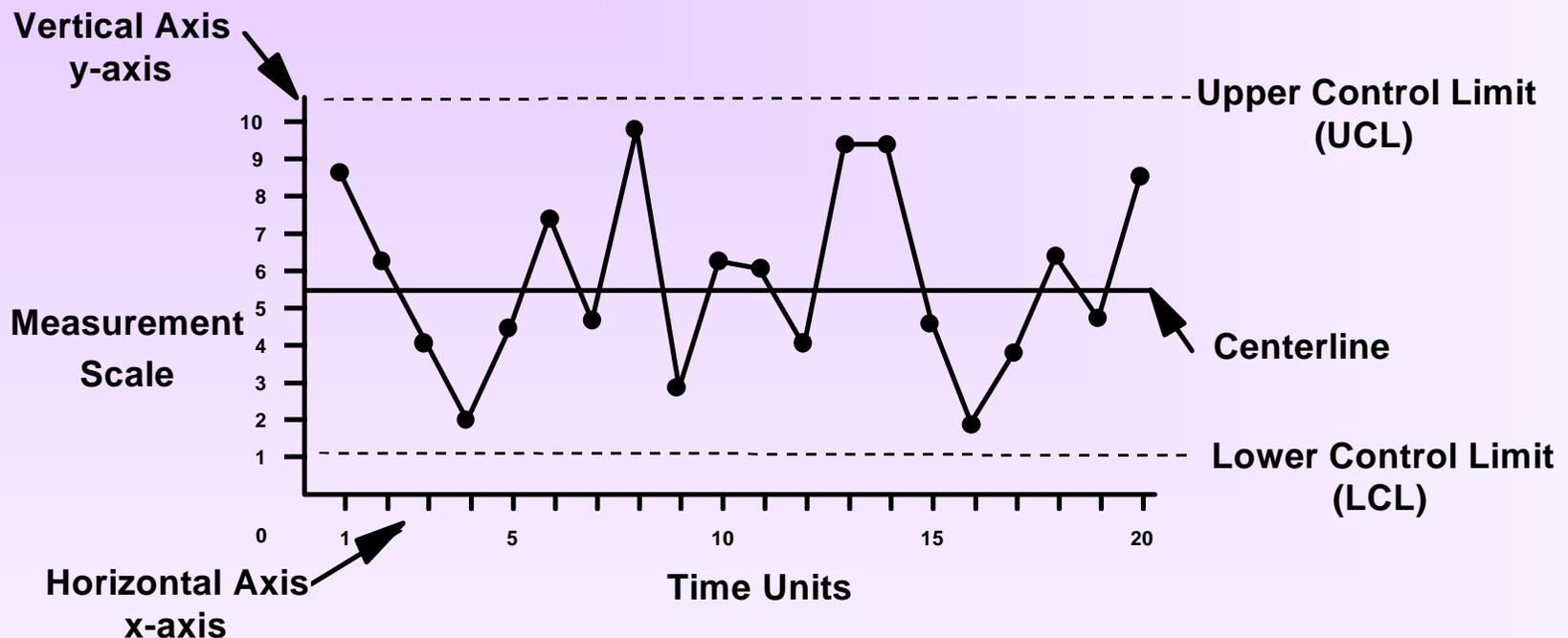


Interpreting Run Charts: Trend



Control Chart

A statistical tool used to distinguish between process variation resulting from common causes and variation resulting from special causes



Elements of a Control Chart

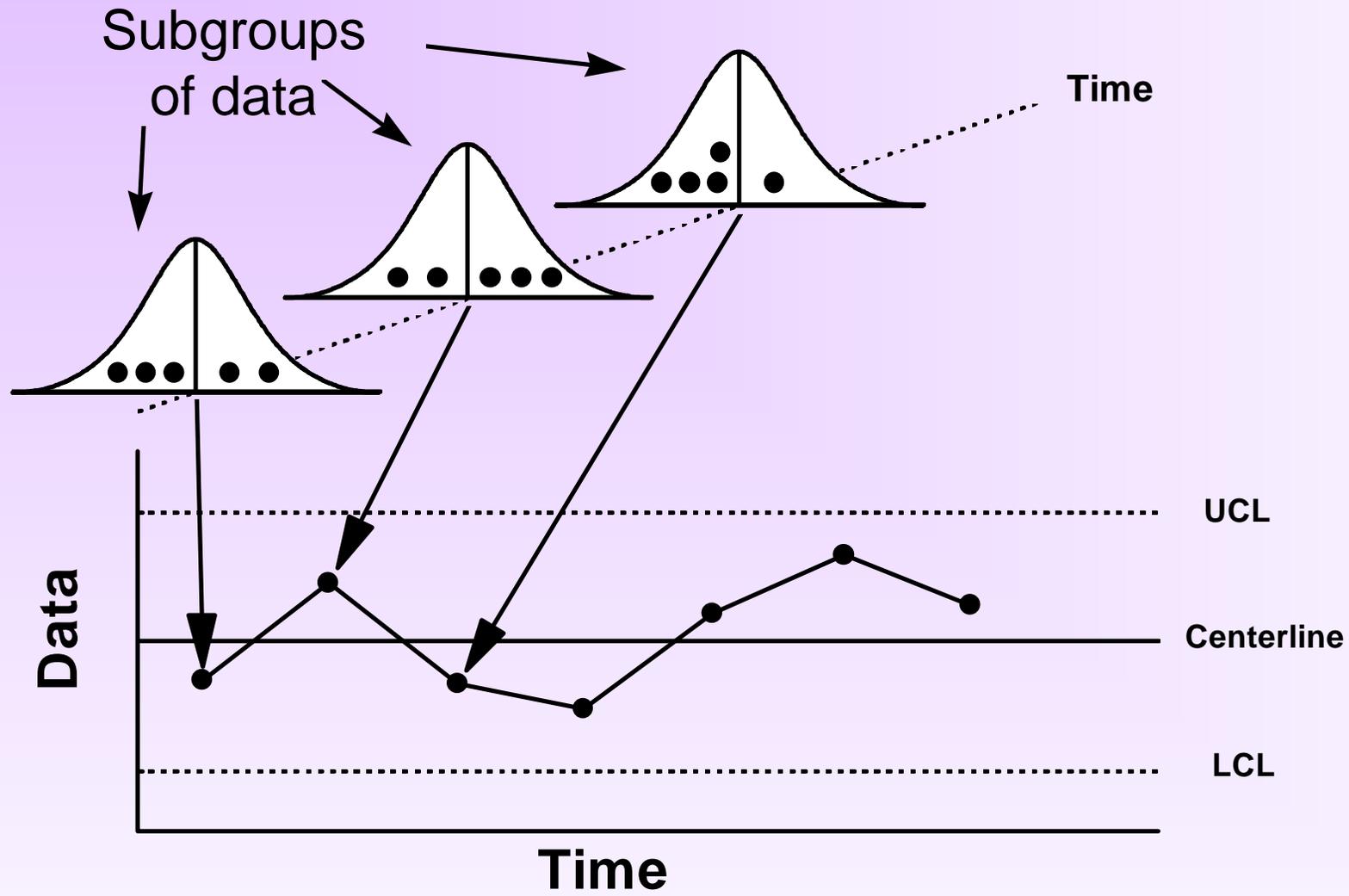


Uses for Control Charts

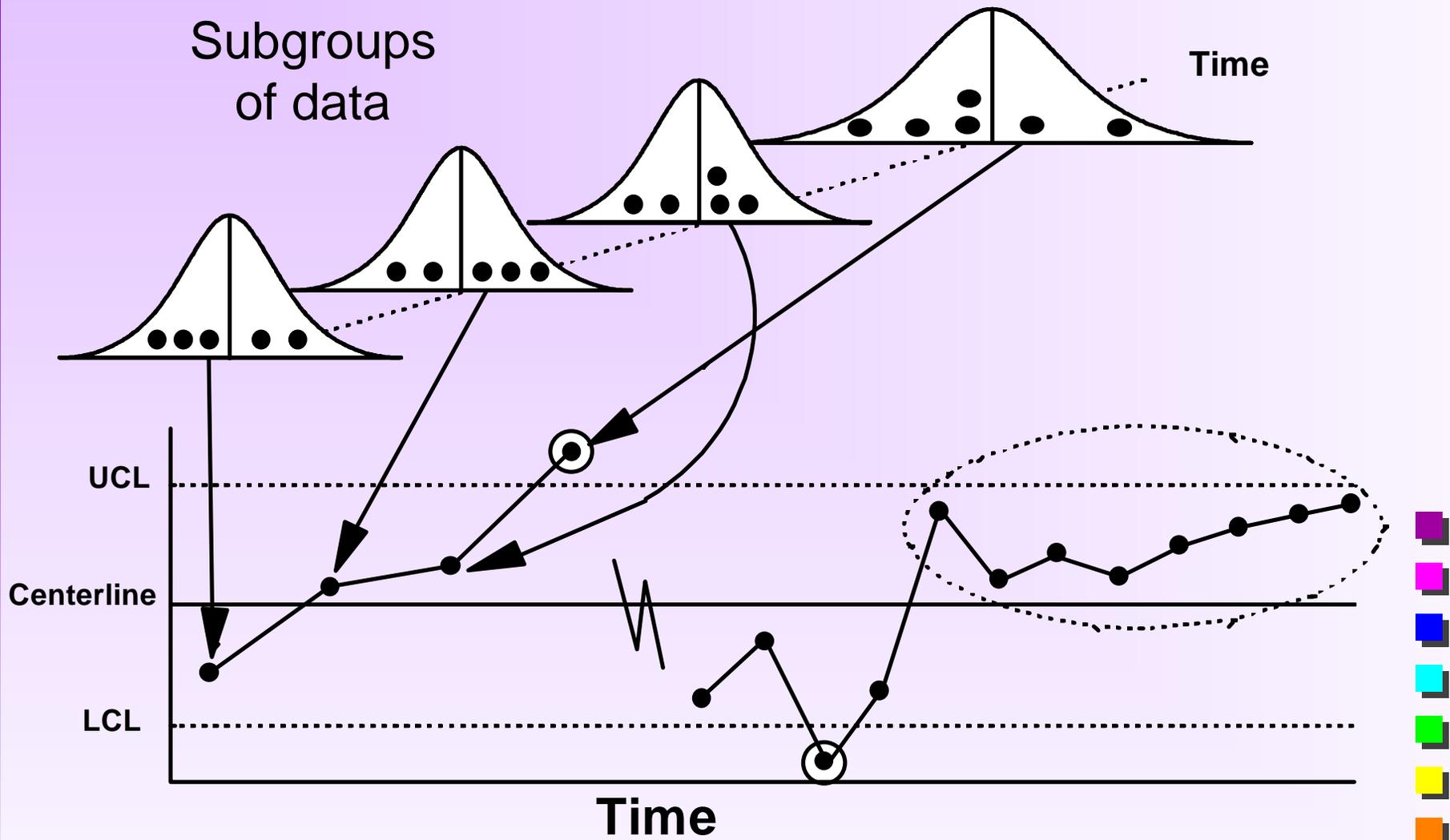
- v Monitor process variation over time
- v Differentiate between sources of variation
- v Assess effectiveness of changes
- v Establish the basis for determining process capability



Common Causes of Variation



Special Causes of Variation



Data Collection Plan

For obtaining useful information

Planning Considerations

- ◆ Why do we want the data?
- ◆ Where will we collect the data?
- ◆ What type of data will we collect?
 - Variables or Attribute data
- ◆ Who will collect the data?
- ◆ How do we collect the right data?



Module Summary

◆ Constructed and applied the following tools:

- Flowchart
- Brainstorming
- Affinity Diagram
- Cause and Effect Diagram
- NGT
- Multivoting
- Checksheet
- Pareto Chart
- Run Chart

◆ Described Histograms and Control Charts

◆ Discussed the importance of a Data Collection Plan

