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**

Multivoting

Multivoting is 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. The result is **a short list** identifying what is **important to the team** .

Benefits of Multivoting

Use Multivoting whenever a brainstorming session has generated a list of items that is *too extensive* for all items to be addressed at once. Because multivoting provides a quick and easy way for a **team** to identify the most popular or highest priority items on a list -- those that are worthy of immediate attention -- this tool can be helpful when you need to:

- **Reduces a large list of items** to a workable number quickly, with limited discussion and little difficulty.
- **Prioritizes team issues** without creating a situation in which there are *winners* and *losers* in the group that generated the list.
- **Identifies important items** on a large list.

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

Procedures for Multivoting

Follow these steps to conduct Multivoting:

Step 1 - Work from a large list of items developed by brainstorming or another appropriate idea-generating technique.

Step 2 - Assign a letter to each item to avoid confusion of item designations with the vote tally.

Step 3 - Vote on 1/3 of the list

- Each team member selects the most important one-third (or no more than one-half) of the items by listing the letters which appear next to those items. For example, if there are 60 items, each person should choose the 20 items (one-third of the total) he or she thinks are most important.

- Each team member may cast only *one vote per idea* and must cast *all allotted votes.*

- Voting may be done either by a show of hands or by paper ballot when the team chooses to preserve confidentiality.

Step 4 - Tally the votes . Place a tally or checkmark next to each item for each vote it received. Retain the items with the most votes for the next round of voting.

◆ **Use rule of thumb**

Scholtes (*The Team Handbook*, p. 2-41) provides the following "rule of thumb" in deciding how many items to eliminate in each round, depending on the size of the group:

- If the team has 5 or fewer members, eliminate those items that receive 2 or fewer votes.
- If the team has 6 to 15 members, eliminate all items that receive 3 or fewer votes.
- If the team has more than 15 members, eliminate all items that receive 4 or fewer votes.

Step 5 - Repeat the process . In the second round, each person again selects the top one-third of the items. Repeat steps 3 and 4 until only a few items remain.

The items that were not identified as priorities should be retained as backup data or for future use by the team in its improvement efforts.

Multivoting Example
First Vote Tally

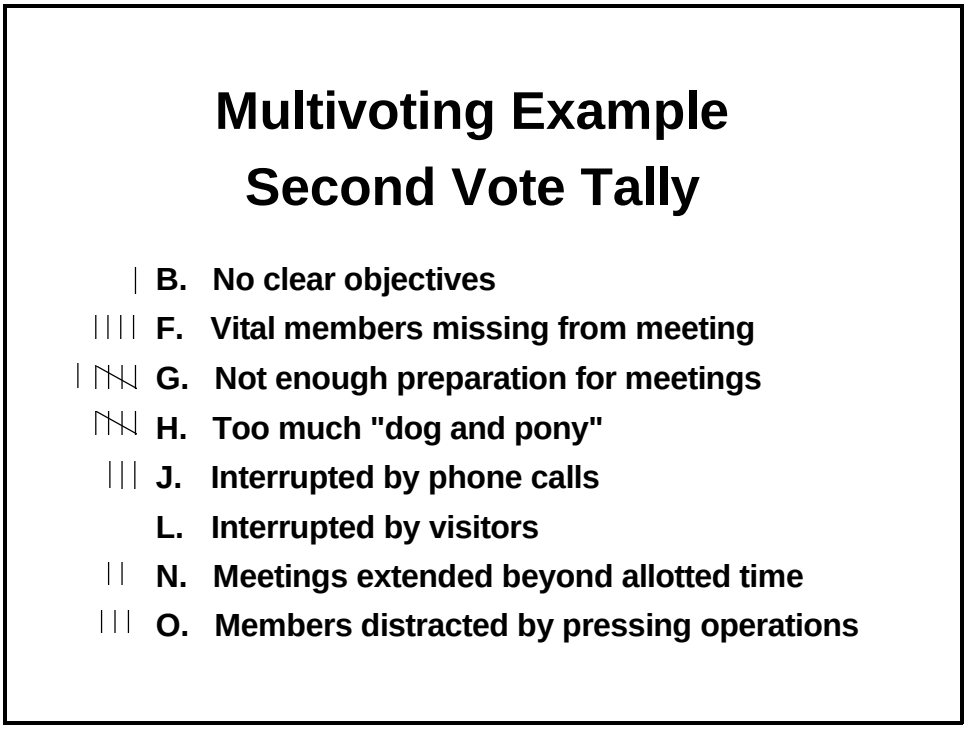
|	A.	No agenda	|	I.	Problems not mentioned
||||	B.	No clear objectives	𝍸	J.	Interrupted by phone calls
||	C.	Going off on tangents	||	K.	Few meaningful metrics
|	D.	Extraneous topics	||||	L.	Interrupted by visitors
||	E.	Too many "sea stories"	|||	M.	No administrative support
𝍸 |	F.	Vital members missing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

Multivoting Example - First Vote Tally

Members of a Command's Planning Board for Training conducted meetings which were not always as productive as they might have been. The XO called a meeting to identify the reasons for the lack of meeting productivity and to determine which reasons the team thought most important. The group brainstormed the issue of *"Lack of meeting productivity"* and produced the following list:

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*

The team used Multivoting to reduce this list to a manageable size. Each of the 6 members of the team was allowed 8 votes (half the number of items). The votes were tallied and the top 8 items were carried forward to the second round.



Multivoting Example - Second Vote Tally

The eight items that had four or more votes in the first round were reduced to a list of three in a second round of voting. The group chose to focus on problems F, G, and H.

Multivoting Exercise

SIGNS OF FEAR IN THE WORKPLACE

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

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

Multivoting Exercise

The ESC wants to take action to improve the climate by reducing fear in the organization. Although all of the members agree that fear should be reduced, some do not believe that fear is a widespread issue. The team has decided to identify:

"Signs of fear within the workplace"

Exercise: For the purposes of this exercise the teams can either use the list provided in this viewgraph or brainstorm its own list. If you choose to use this example, make copy of the handout **"Signs of fear in the work place"** for each *person*. Hand out a copy of the **"Multivoting Exercise Tally Sheet"** for each *team or group*. (A master copy of these two handouts are located at the end of Module 5).

Ensure the teams follow the procedures for Multivoting. Record the votes using the tally sheet provided by the instructor. Remind the teams to apply the "rule of thumb" for the team size.

Time: 20 minutes

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**

Nominal Group Technique (NGT)

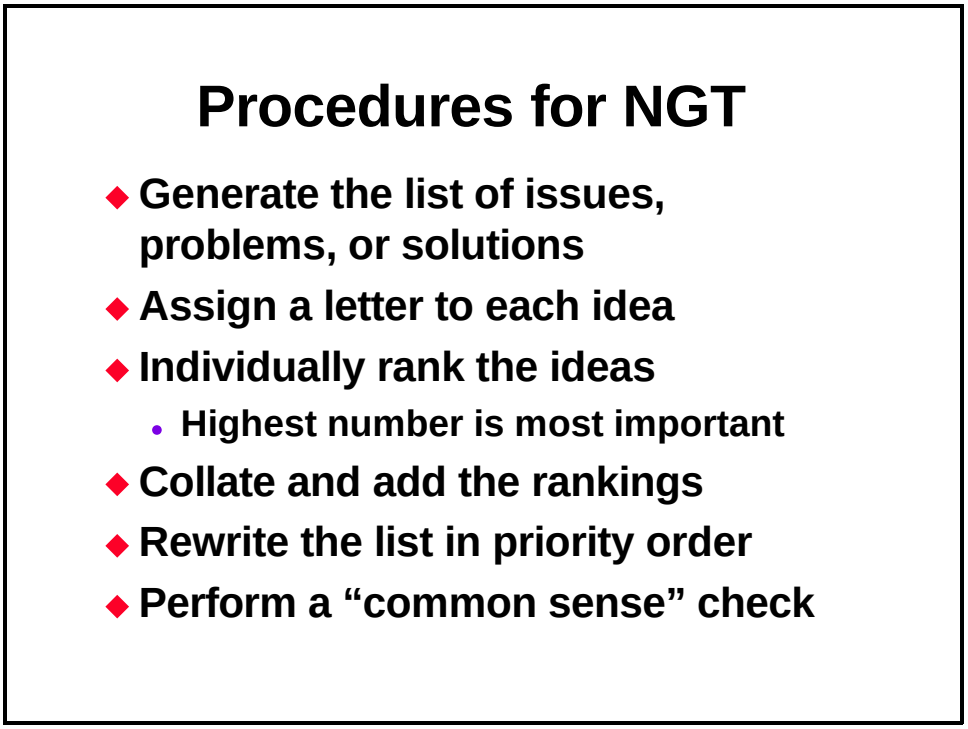
A tool frequently used by teams to **help** them make decisions is Nominal Group Technique, or NGT. NGT is a *weighted ranking* method that enables a group to generate and prioritize a large number of issues within a structure that gives everyone an equal voice. The tool is called *nominal* because there is limited interaction between members of the group during the NGT process.

Benefits of using NGT

When a team needs to create a list of options and rank them, using NGT effectively neutralizes the domination of the loudest person, or the person with the most authority, over the decision-making process. This tool can also help a team achieve consensus about the relative importance of issues. The final result may not be everyone's first priority, but they can support.

NGT is a good tool to use when dealing with controversial or emotional issues, or when a group is “stuck”.

- **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**

This is typically done by brainstorming, but may also be done by individual written ballot. Introduce and clarify the issue to be addressed by the team. Write the issue on a chartpack where everybody can see it. Allow for clarification (or elimination / combination of duplicates), but do not let the group engage in a discussion of the issue itself. Remember to define unclear terms.

◆ **Assign a letter to each idea**

The facilitator assigns a letter designation to avoid confusion with the vote tally and to avoid an implied ranking.

◆ **Individually rank the ideas**

Each team member writes down the items by their letter designations and assigns them a numeric value based on his or her judgment of what is most important and what is least important.

- **Highest number is most important.** The highest number is assigned to the most important idea and the lowest to the least important idea. For example, if there are 8 items lettered A to H, the most important receives an 8 and the least important, a 1.

- **Collate and add the rankings**

Transcribe the team rankings onto a chartpack, writing each number next to the corresponding idea. The idea with the highest point total is the one of most importance to the whole team. It is the highest priority item.

- **Rewrite the list in priority order**

Rewrite the list of ideas in the order of their importance to the team.

- **Perform a "common sense" check**

Does the prioritization make sense?

★ **Additional Information:** An alternative approach is to use the **"one-half-plus-one rule"** (described in *The Memory Jogger II*, p. 93). When there is a list with many items to rank, you may want to limit the number of items to consider. In this case, team members rank one-half the number of items on the list plus one. For example, if there were 20 items on the list, team members would rank 11 ideas. The most important item receives the highest value -- in this case, 11.

NGT Example #1 - "Problems in the workplace"

Issue	PO1 Jones	MAJ Smith	SGT Able	MR Good	ENS 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 #1 - "Problems in the workplace"

Members of an organization have been tasked to study **"problems in the workplace"** . The team has some opinionated members who think they know the most important problem. Several team members, however, are not vocalizing their position. They decide to use NGT to generate a list of issues and prioritize them. The following list was generated:

A. Ineffective organizational structure
B. Poor communications outside the office
C. Lack of training
D. Poor communications within the office
E. Unclear mission and objectives
F. Poor distribution of office mail
G. Lack of feedback on reports to management

Each team member writes the letters A through G on a piece of paper. Then, each member ranks each issue from 1 to 4 (with the most important receiving 4 and the least important receiving 1), using each number only once. Using NGT, the issues were prioritized. The issue the team will tackle first is item E, unclear mission and objectives.

NGT Example #2 -

"Why is our ship dragging anchor in heavy weather?"

CAUSES:	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

NGT Example #2 - "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. The CO wants to know, in priority order, what the possible causes of this problem are.

By brainstorming the group came up with the following possible reasons:

A. Haven't set the anchor properly
B. Not enough chain out
C. Bottom not assessed properly for holding characteristics
D. Ship isn't steaming at anchor to relieve strain
E. Piling too much anchor chain on the flukes
F. Inadequate navigational fixes to determine when dragging anchor
G. Quartermasters not notifying Command Duty Officer (CDO) of changes in the weather (winds increasing) early enough

The question before the group now is which potential cause should be investigated first. (Not all can be investigated at once.)

The Weapons Officer asserts very strongly that the primary cause is that there is not enough chain out. However, the rest of the group continues to discuss some of the other issues. The XO decides to use NGT to prioritize the list for the CO.

The XO assigns identifying letters to the possible reasons that were listed and everyone in the meeting ranks them. The XO reports the prioritized list to the CO.

NGT Exercise

Conduct NGT to rank order your list from the Brainstorming Exercise

NGT Exercise

This exercise will give your team an opportunity to practice NGT. The results you'll get depend on the knowledge and experience of your team.

Exercise: Have each of the teams take the list from their Brainstorming Exercise and use NGT to rank order their top five.

Time: 20 minutes

NGT Optional Exercise #1

A ship received a message from the Battle Group Commander regarding the degraded state of readiness of its fire control systems and requesting a prioritized list of probable causes for this situation within 24 hours. The ship's XO called a meeting of the Weapons Officer, the Fire Control Officer, and their senior enlisted technicians to discuss the problem and develop the prioritized list. The group defined the issue as:

"Why are the fire control systems operating in a progressively degraded state of readiness?"

They generated the following list of possible reasons:

A. Lack of key technicians
B. Deployed without critical test equipment
C. Deficiency of on-board critical spare parts
D. Inadequate overhaul funding precluded reliability upgrade modifications
E. Inadequate technical manual support
F. Inadequate engineering technical support
G. Scheduling of maintenance periods inadequate

Acting as the XO (team leader), lead an NGT session to prioritize these ideas for presentation to the CO.

- List these ideas on a chartpack.
- Assign sequential letters to the list of ideas.
- Distribute paper to the team members and ask them to rank the items in order of importance giving the most important the highest number value (7) and the least important the lowest value (1).
- Collect the sheets and write each numerical ranking on the chartpack next to the applicable item.
- Add up the rankings for each item and use the totals to determine the highest priority items.

NGT Optional Exercise #2:

A new Aviation Maintenance Officer (AMO) checked into a squadron which had failed its last two corrosion control inspections. The AMO got the squadron's shop heads together to identify and prioritize the possible causes for the inspection failures. They defined the issue as:

"Why have we failed our last two corrosion control inspections?"

Identified the following possible causes.

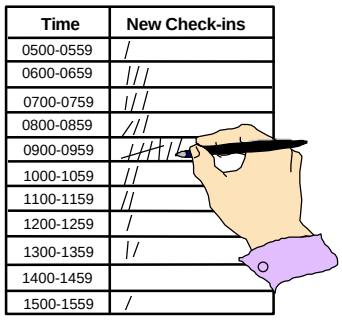
A. Lack of painting facilities
B. Untrained junior personnel assigned to the corrosion control work center
C. Aircraft not removed from the flight schedule for sufficient periods for phased maintenance
D. Incomplete documentation of work completed
E. Frequent rotation of personnel in corrosion control work center
F. Lack of personnel for assignment to work center
G. Too much salt in the air
H. Deployment of aircraft to ships
I. Lack of a MOS/NEC for corrosion control specialist
J. Overload of operational commitments precludes normal maintenance schedules

The AMO realized that the list of 10 causes might be too long and suggested that the team reduce it. The authors of two of the ideas -- "Too much salt in the air" and "Deployment of aircraft to ships" -- realized that these are issues which the team could not change and withdrew them.

Acting as the AMO (team leader), conduct a NGT session to prioritize the remaining items on the list. Apply the one-half-plus-one rule to determine how many items each team member should rank. Then follow the process you have learned to identify the highest priority items before going to the see the Operations Officer to discuss the removal of aircraft from the flight schedule for phased maintenance.

Checksheets

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

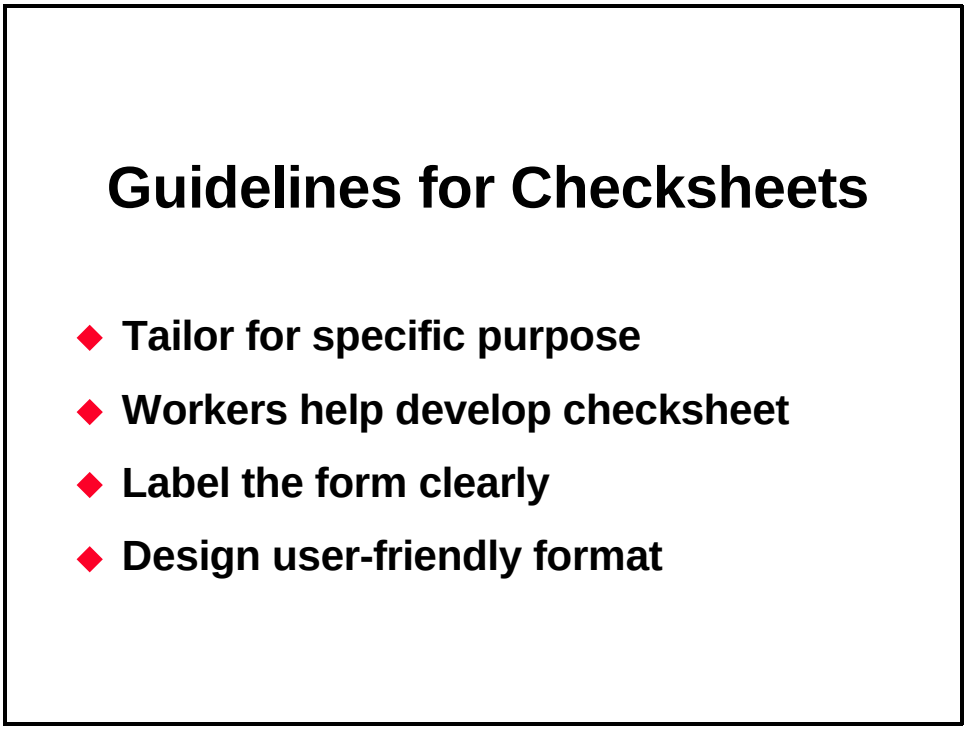


Time	New Check-ins
0500-0559	/
0600-0659	///
0700-0759	// /
0800-0859	///
0900-0959	//// //
1000-1059	//
1100-1159	//
1200-1259	/
1300-1359	//
1400-1459	
1500-1559	/

Checksheets

Data are frequently collected using **checksheets --** structured forms that enable you to collect and organize data systematically. Because each checksheet is used for collecting and recording data unique to a specific process, it can be constructed in whatever shape, size, and format are appropriate for the data collection task at hand. Checksheets have three important uses:

- **Record information for further analysis** using tools such as a Pareto Charts, Histograms, and Run Charts.
- **Provide historical record** of the process over time.
- **Introduce data collection methods** to workers and supervisors who may not be familiar or comfortable with collecting data as a regular part of their jobs.



Guidelines for Checksheets

Here are some guidelines to help you develop useful forms:

- **Tailor for a specific purpose**

There is no standardized format that you can apply to all checksheets. A well-designed checksheet is the launching pad for an effective analysis in which data become meaningful information. It is important to have a clear understanding why you are collecting this data. Training is important as to the “why” and the “how” of developing and using checksheets.

- **Workers help develop checksheet**

Involve the process workers in developing the checksheet for their process. They probably know best how to design the checksheet based upon the data being collected. It will also reduce fear in collecting the data if workers understand you’re collecting data on the “process” and not “them”.

- **Label the form clearly**

Organize your form so that the data are recorded in the sequence seen by a person viewing the process. This reduces the possibility of data being recorded in the wrong column or not being recorded.

◆ Design user-friendly format

Make sure the checksheet can be easily and consistently understood and used by all of the workers who are recording data.

- Include brief instructions on the back of the form.
- Create a format that gives you the most information with the least amount of effort. For example, design your checksheet so that data can be recorded using only a check mark, slant mark, number, or letter.
- Provide enough space for the collectors to record all of the data.
- Designate a place for recording the date and time the data were collected. These elements are required when the data are used with Run Charts or other tools which require the date and time of each observation.
- Provide a place to enter the name of the individual collecting the data.
- Allow enough space so data collectors can write in comments on unusual events. This information could be entered on the back of the form.

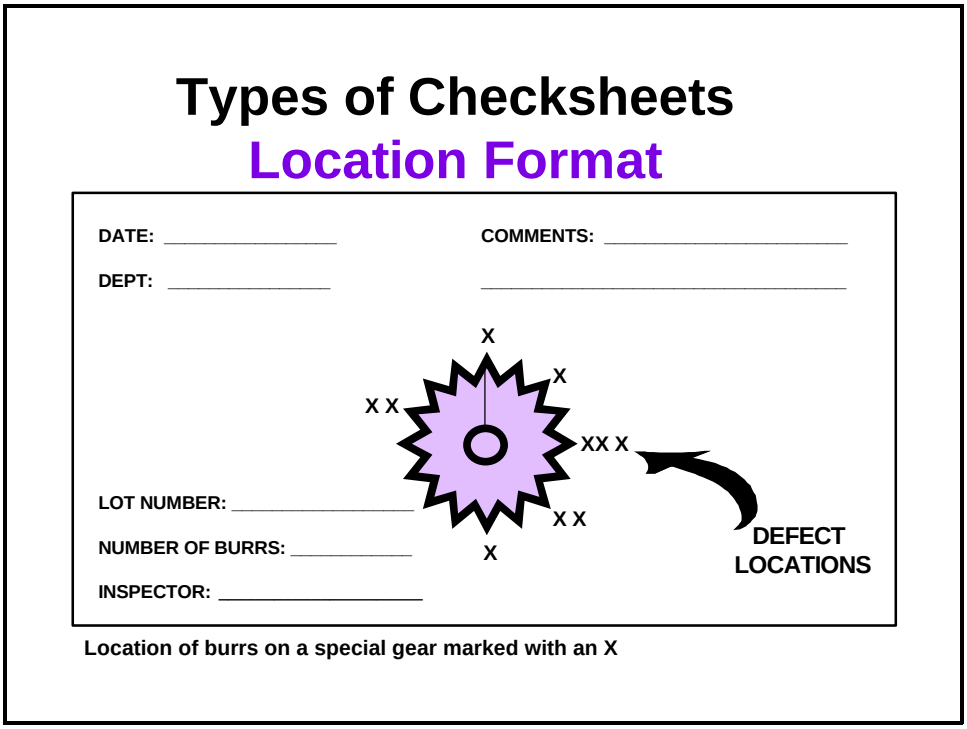
Types of Checksheets
Tally Format

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 - Tally Format

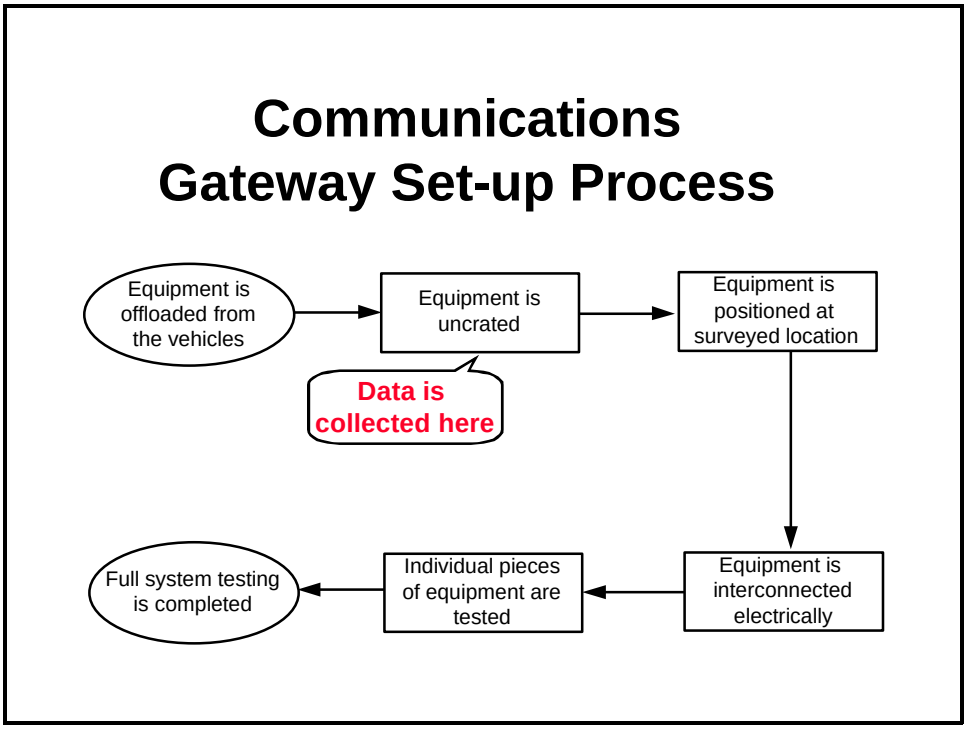
The most common types of checksheets are tally format and location format. Although there are many different types of checksheets, make sure that it is clear, complete, and user-friendly.

A **tally format** checksheet is easy to use when you simply want to count how often something happens or to record a measurement. Depending on the type of data required, the data collector simply makes a checkmark in a column to indicate the presence of a characteristic, or records a measurement, such as temperature in degrees centigrade, weight in pounds, diameter in inches, or time in seconds.



Type of Checksheets - Location Format

A location checksheet allows you **to mark a diagram showing the exact physical location of a defect or characteristic** . An insurance adjuster's pictorial claim form detailing your latest bumper bruise is an example of a location checksheet. This viewgraph shows the location of burrs found on a special gear.



Communication Gateway Set-up Process

Now you will work through an example that illustrates how to determine where to collect data and how to use checksheets to capture them.

EXAMPLE - Communications Gateway Site Setup Time

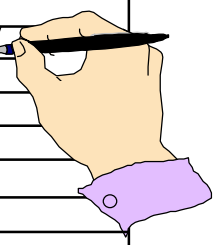
A team of Marines is investigating methods for improving the process to set up a communications gateway site for a tactical data link interface with Navy ships and aircraft. They want to reduce the time it takes to set up the site.

- They develop a flowchart of their process and identify possible bottlenecks and slow operations.
- They decided they can improve their set-up time by focusing on the steps of the process dealing with unpacking the equipment.
- They opt to use a checksheet to take baseline data on that portion of the process as well as on the overall time to complete the installation and checkout.

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	𝍸	0750-0799	𝍸 |
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 #1

This example, from the Communication Gateway Site Set-up, illustrates the point that you should collect data from the key process step or steps where the outcome can be most affected. But beware of making assumptions based only on a flowchart. You should collect some initial data on all critical steps in the process. Then you should collect detailed data about steps that initially showed great variability, or those that took the longest to perform. Only when these data have been analyzed can the root causes be identified and acted upon.

☞ **Instructor Direction:** Have the students give some examples of checksheets that they have used.

Remember, there are various types of data collection forms. Every checksheet is unique to the process you are investigating. The following examples of checksheets are designed for specific purposes. Careful design of your checksheet may allow you to collect two or more factors on a single form. This is illustrated in Checksheet Example #3, which shows data collected for faults occurring on three shifts for each of two machines.

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

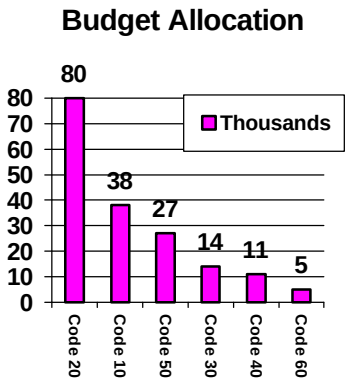
EQUIPMENT BREAKDOWN DATA

	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

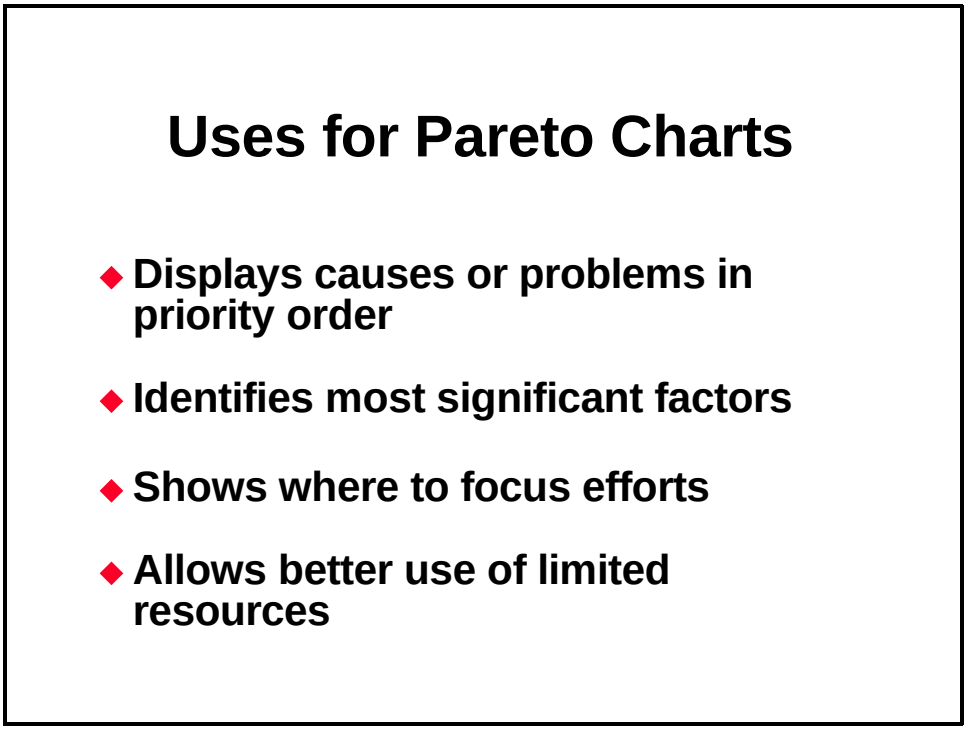
- Bar chart arranged in descending order of height from left to right
- Bars on left relatively more important than those on right
- Separates the "vital few" from the "useful many" (Pareto Principle)



Pareto Chart

A Pareto Chart is a series of bars whose heights reflect the frequency or impact of problems. The bars are arranged in descending order of height from left to right. This means the categories represented by the tall bars on the left are relatively more significant than those on the right. The chart gets its name from the Pareto Principle, which postulates that 80 percent of the trouble comes from 20 percent of the problems.

You can think of the benefits of using Pareto Charts in economic terms. “A Pareto Chart breaks a big problem into smaller pieces (and) identifies the biggest contributors. . . (It can) help us get the most improvement with the resources available by showing where to focus efforts in order to maximize achievements. The Pareto Principle states that a small number of causes accounts for most of the problems. Focusing efforts on the ‘vital few’ causes is usually a better use of valuable resources” (Joiner Associates, 1990, p13).



Uses for Pareto Charts

A Pareto Chart is a good tool to use when the process you are investigating produces data that can be categorized and you can count the number of times each category occurs.

No matter where you are in your process improvement efforts, Pareto Charts can be helpful, ". . . early on to identify which problem should be studied, later to narrow down which causes of the problem to address first. Since they draw everyone's attention to the 'vital few' important factors where the payback is likely to be greatest, (they) can be used to build consensus. In general, teams should focus their attention first on the biggest problems -- those with the highest bars" Scholtes, P.R. (1988).

Making *problem-solving* decisions isn't the only use of the Pareto Principle. Since Pareto Charts convey information in a way that enables you to see clearly the choices that should be made, they can be used to *set priorities* for many practical applications in your command.

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

Constructing a Pareto Chart

To construct a Pareto Chart, you need to start with *meaningful* data which you have collected and categorized. The data collection portion of this module describes the process of collecting and categorizing data. The following steps are for constructing a Pareto Chart. They have been adapted from the Team Handbook (Joiner).

Step 1 - Record the raw data. List each category and its associated data count.

Step 2 - Order the data. Prepare a data sheet, put the categories in order, and place the largest count first.

Step 3 - Label the vertical axis. Make sure the labels are spaced in equal intervals from 0 to a round number equal to or just larger than the total of all counts. Provide a caption to describe the unit of measurement being used.

Step 4 - Label the horizontal axis. Make the widths of all of the bars the same and label the categories from largest to smallest. An "other" category can be used last to capture several smaller sets of data. Provide a caption to describe them. If the contributor names are long, label the axis A, B, C, etc. and provide a key.

Step 5 - Plot a bar for each category. The height of each bar should equal the count for that category. The widths of the bars should be identical.

Step 6 - Add up the cumulative counts. Each category's cumulative count is the count for that category added to the counts for all larger categories.

Step 7 - Draw the cumulative line. Label the right axis from 0 to 100%, and line up the 100% with the grand total on the left axis. For each category, put a dot as high as the cumulative total and in line with the right edge of that category's bar. Connect all the dots with straight lines. (Some sources consider the cumulative line an option, but the percentages are what differentiates a Pareto Chart from an ordinary bar chart.)

Step 8 - Add title, legend, and date.

Step 9 - Analyze the Pareto Chart. Look for the **break point** on the cumulative percent graph. It can be identified by a marked change in the slope of the graph. These **break points** in the heights of the bars are an indicator of the most important categories. This separates the “significant few” from the” trivial many”. This information is useful when you are establishing priorities.

NOTE: The **significant few-trivial many** principle does not always hold. No matter how many data are categorized, they can be ranked and made into a Pareto Chart. But sometimes no single bar is dramatically different from the others, and the Pareto chart looks flat or gently sloping. To attack the tall bar in that situation is no help. You need to look for another way to categorize the data because the chart is telling you nothing in the data is truly significant or remarkable. In other words, you are looking at the wrong things to solve your problem or improve your process.

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 - Checksheet

A team is responsible for the quality of the BEQ/BOQ. They want to improve the service provided but are not sure where to begin or where to concentrate their efforts. The team decides to keep track of the complaints received over a three-month period. The data collected is shown by checksheet in Example #1.

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 - Data Sheet

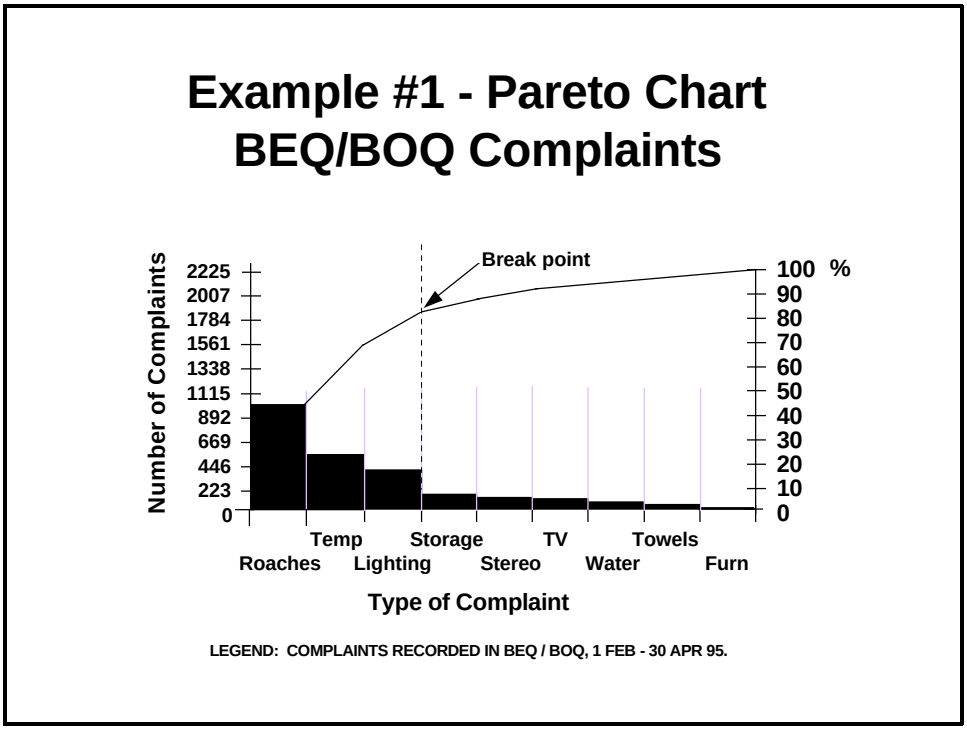
Now let's compare the Data Sheet and Pareto Chart prepared for Example #1.

Now answer the following questions:

1. **Does the Pareto Principle apply?**

2. **Where should you concentrate your efforts?**

3. **Do your proposed efforts pass a sanity check? In other words, do the top problems really stand out as most important to you and your customers?**



Example #1 - Pareto Chart

Did you come up with the following points in discussing the questions?

1. In this problem, the Pareto Principle is very much in evidence. Notice the sharp change of slope after the first three items. Most Pareto Charts will have such a break point.

2. Attacking the problems to the left of the break point will have the greatest payoff. In fact, if you solve these problems, you will have dealt with 81.7 percent of the deficiencies uncovered in your customer survey. Therefore, this is where you should concentrate your initial efforts.

   Later, you can do another Pareto analysis which will probably show some of the lesser problems becoming more dominant.

3. How about your sanity check? Well, not only is the cockroach problem number one in your survey, but from a health standpoint, it merits immediate action.

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 - Checksheet

A command is trying to improve safety within their organization. Lately, there seems to be a rash of injuries in the Maintenance Department. A decision was made to check out this perception by recording data **by department** for three months. Examining the checksheet in Example #2, it appears that the perception is correct.

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		

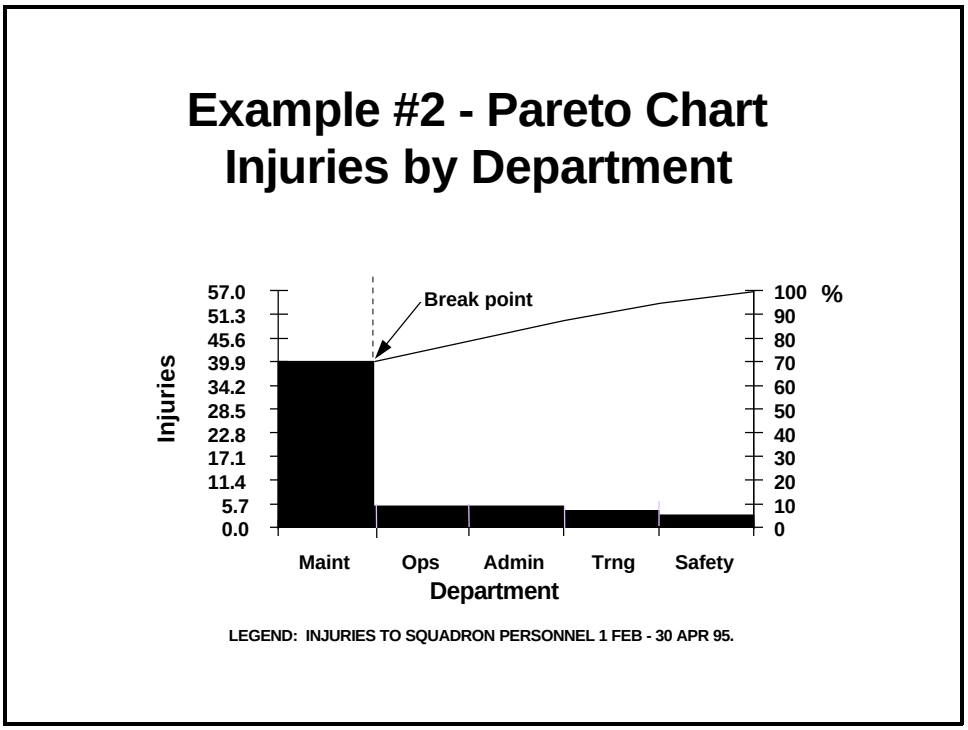
* Percent column does not equal 100% because of rounding.

Example #2 - Data Sheet

Compare the Data Sheet and Pareto Chart for Example #2. The data show the total injuries by department.

Answer the following questions:

1. **Does the Pareto Principle apply?**
2. **Where should you concentrate your efforts?**
3. **Do your proposed solutions pass a "sanity" check?**



Example #2 - Pareto Chart

Looking at the Pareto Chart, it appears that the suspicions are confirmed. Maintenance has the most injuries. The command is ready to focus on the safety problems in that department. How about that all-important “common sense” check? The command decides to look at the data another way.

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 - Checksheet

Another way of looking at the data is by the number of personnel assigned to each department. Here are numbers by department:

Maintenance	**200**
Operations	**12**
Administration	**10**
Safety	**6**
Training	**5**

Dividing injuries by personnel assigned gives you a **ratio** as indicated by the checksheet in Example #3.

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.

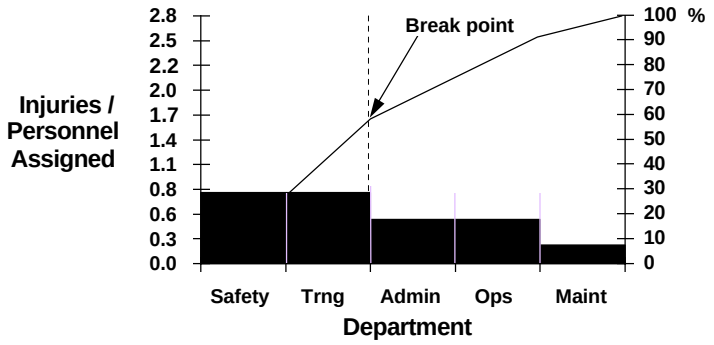
Example #3 - Data Sheet

Compare the Data Sheet and Pareto Chart for Example #3. The data is ordered in a Data Sheet and drawn in a Pareto Chart for the ratio of injuries to personnel assigned.

Answer the following questions:

1. **Does the Pareto Principle apply?**
2. **Where should you concentrate your efforts?**
3. **Do your proposed solutions pass a "sanity" check?**

Example #3 - Pareto Chart
Injuries by Personnel Assigned



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

Example #3 - Pareto Chart

When the number of personnel in the various departments is considered, we can now see that Maintenance has the lowest injury rates.

Its important to look at the data from different perspectives. The "Pareto Principle" allows you to pursue your search for the best application of your time, energy, and dollars even further.

With the knowledge you gain from a more detailed analysis, you now have even more insight into how to solve a particular problem and what your focus should be.

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

Histogram

A Histogram is a vertical bar chart that depicts the distribution of a set of data. Unlike Control Charts (which we discussed in Module 3-3 Variation), a Histogram does not reflect process performance over time. It's helpful to think of a Histogram as being like a snapshot, while a Control Chart is more like a movie.

When to use Histograms

When you are unsure what to do with a large set of measurements presented in a table, you can use a Histogram to organize and display the data in a more user-friendly format. A Histogram will make it easy to see where the majority of values falls in a measurement scale, and how much variation there is. It is helpful to construct a Histogram when you want to:

- **Summarize large data sets graphically**

When you see a set of data presented in a table, it is often difficult to spot patterns or trends. You can make it much easier to understand by summarizing it on a tally sheet and organizing it into a Histogram.

- **Compare process results to specifications**

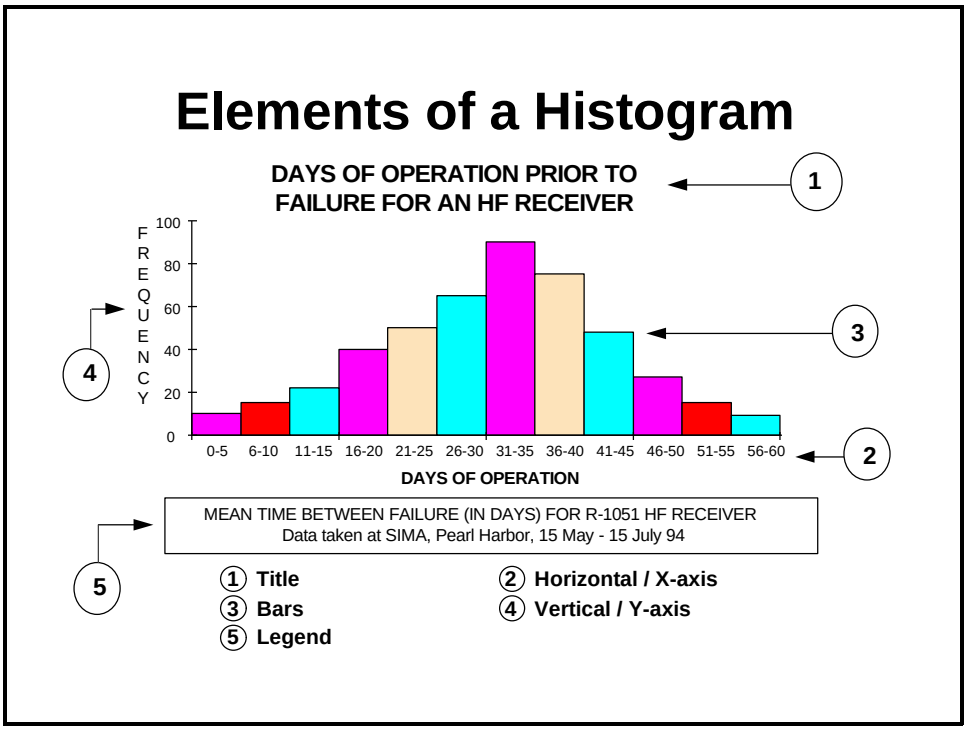
If you add the process specification limits to your Histogram, you can determine quickly whether the current process was able to produce "good" products. Specification limits may take the form of length, weight, density, quantity of materials to be delivered, or whatever is important for the product of a given process. **Recall from Module 3-3 (Variation), that you can not assess capability unless you first have a stable process.**

- **Communicate information to the team**

The team members can easily see the values which occur most frequently. When you use a Histogram to summarize large data sets, or to compare measurements to specification limits, you are employing a powerful tool for communicating information.

- **Assist in decision-making**

Certain shapes, sizes, and the spread of data have meanings that can help you in investigating problems and making decisions. But always bear in mind that if the data you have in hand aren't recent, or you don't know how the data were collected, it's a waste of time trying to chart them. Measurements cannot be used for making decisions or predictions when they were produced by a process that is different from the current one, or were collected under unknown conditions.



Elements of a Histogram

1. **Title**: The title briefly describes the information that is contained in the Histogram.

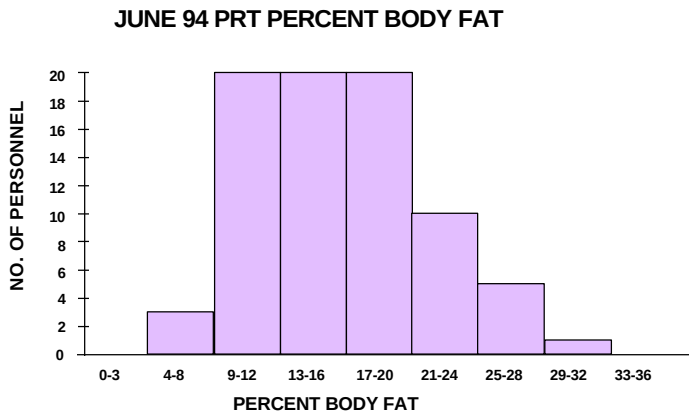
2. **Horizontal or X-Axis** : The horizontal or X-axis shows you the scale of values into which the measurements fit. These measurements are generally grouped into intervals to help you summarize large data sets. Individual data points are not displayed.

3. **Bars**: The bars have two important characteristics—height and width. The height represents the number of times the values within an interval occurred. The width represents the length of the interval covered by the bar. It is the same for all bars.

4. **Vertical or Y-Axis** : The vertical or Y-axis is the scale that shows you the number of times the values within an interval occurred. The number of times is also referred to as "frequency."

5. **Legend**: The legend provides additional information that documents where the data came from and how the measurements were gathered.

Histogram Example #1



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

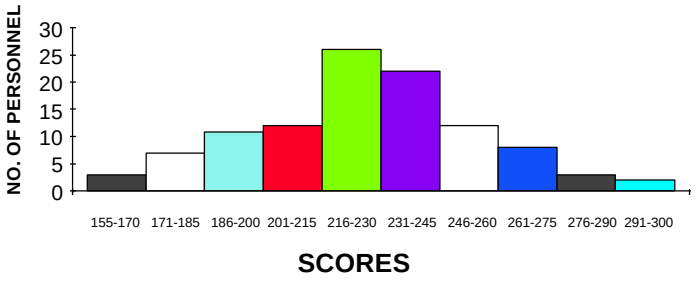
Histogram Example #1:

A command fitness coordinator is responsible for the semiannual Physical Readiness Test (PRT) screening for *percent body fat*. Prior to one PRT, the percent of body fat for the 80 personnel assigned to the command are recorded. These are the data collected:

PERCENT BODY FAT RECORDED

11	22	15	7	13	20	25	12	16	19
4	14	11	16	18	32	10	16	17	10
8	11	23	14	16	10	5	21	26	10
23	12	10	16	17	24	11	20	9	13
24	10	16	18	22	15	13	19	15	24
11	20	15	13	9	18	22	16	18	9
14	20	11	19	10	17	15	12	17	11
17	11	15	11	15	16	12	28	14	13

Histogram Example #2



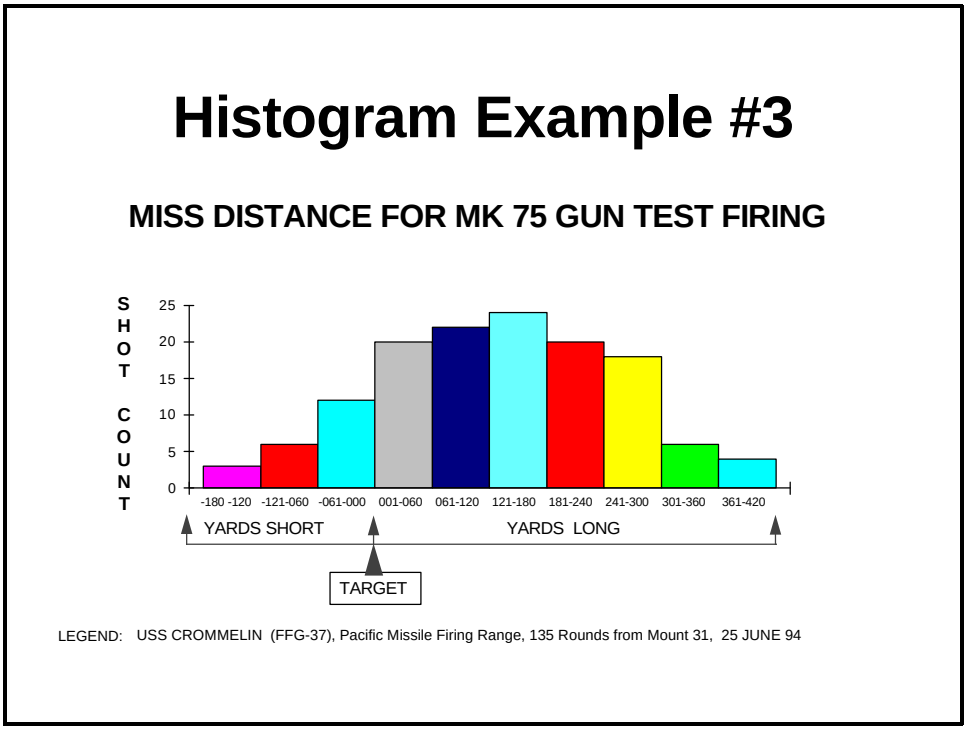
LEGEND: MCBH KANEOHE BAY, HI; AVERAGE OF 4 SCORES PER CLASS, 105 CLASSES, 1 JUNE 94 - 15 JULY 94

Histogram Example #2:

A Marine Corps small arms instructor was performing an analysis of 9 mm pistol marksmanship scores to improve training methods. For every class of 25, the instructor recorded the scores for each student who occupied the first four firing positions at the small arms range. The instructor then averaged the scores for each class, maintaining a database on 105 classes. These are the data collected:

AVERAGE SMALL ARMS SCORES

160	190	155	300	280	185	250	285	200	165
175	190	210	225	275	240	170	185	215	220
270	265	255	235	170	175	185	195	200	260
180	245	270	200	200	220	265	270	250	230
255	180	260	240	245	170	205	260	215	185
255	245	210	225	225	235	230	230	195	225
230	255	235	195	220	210	235	240	200	220
195	235	230	215	225	235	225	200	245	230
220	215	225	250	220	245	195	235	225	230
210	240	215	230	220	225	200	235	215	240
220	230	225	215	225					



Histogram Example #3

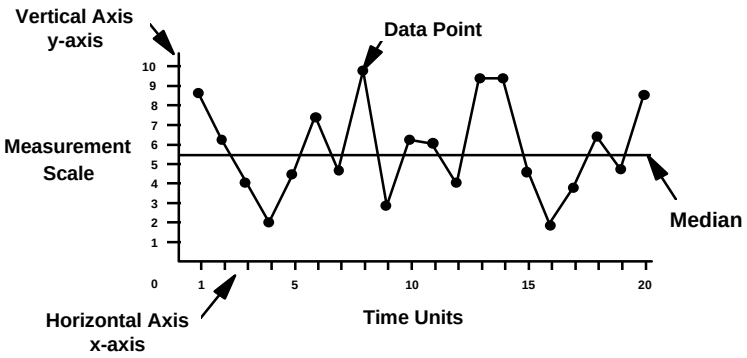
A ship was conducting a Naval Gunfire Support exercise and collected data from one of its gun mounts. As the rounds landed, the specific range intervals were recorded as follows:

-180	to -120	3
-121	to -060	5
-061	to 000	13
001	to 060	20
061	to 120	22
121	to 180	24
181	to 240	19
241	to 300	13
301	to 360	6
361	to 420	4

The data were plotted in a Histogram as indicated in Example #3.

Run Chart

A line graph of data points plotted over time



Elements of a Run Chart

Run Chart

A Run Chart is the most basic tool used to display how a process performs over time. It is a line graph of data points plotted in *chronological order* -- that is, the sequence in which process events occurred. These data points represent measurements, counts, or percentages of process output.

A Run Chart is a time ordered plot of data. The points on the chart are joined by straight lines. This is to indicate that the data are plotted in the order in which they occurred.

They are a popular way to display information. They can be found everyday in the newspaper. For example, the financial section might show the number of small businesses operating each month for the past two years. The weather page might present a run chart showing use of electricity by the hour during a heat wave. The sports page might show the number of free throws a basketball player makes each game. The points might show, for example, weekly figures on sales, quality incoming and outgoing, complaints of customers, inventory, absenteeism, accidents, accounts receivable, etc.

Elements of a Run Chart

The **y-axis** is the vertical side of the graph. The vertical axis presents the measurement scale for the performance.

The **x-axis** is the horizontal side of the graph. The horizontal axis presents the sampling schedule in time units.

The **data point** represents the performance of an individual or a sample at a specific time. You might use a frequency (the total units produced over a specified time), a percentage (frequency of events to the total number of occurrences), or the range (the difference between the largest, or highest and the smallest, or lowest value in a set of data).

The **centerline** on the run chart is usually represented by the **median**.

★ **Additional Information:**

Median: It is the middle value when all the values are arranged in numerical order, It is defined as the value where 50 percent of the data occur above it and 50 percent below it. Used as the **Centerline** on a Run Chart.

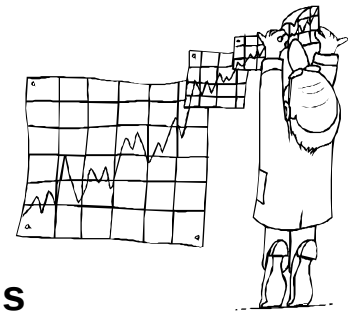
Mean: It is the sum of all the values in a data set, divided by the total number of values.

Mode: It is the most frequently occurring value in the data set.

Range: The difference between the largest and smallest values in the data. Used when constructing the Y-axis of a Run Chart.

Uses for Run Charts

- **Communicate process performance**
- **Analyze data for patterns**
- **Assess process stability**



Uses for Run Charts

- **Communicate process performance**

Data in columns on a report do not give you a perspective of what is happening, whereas a run chart portrays information over time. Run Charts provide a graphic display of information. They provide you a graphical tool to help you look at process performance over time.

- **Analyze data for patterns**

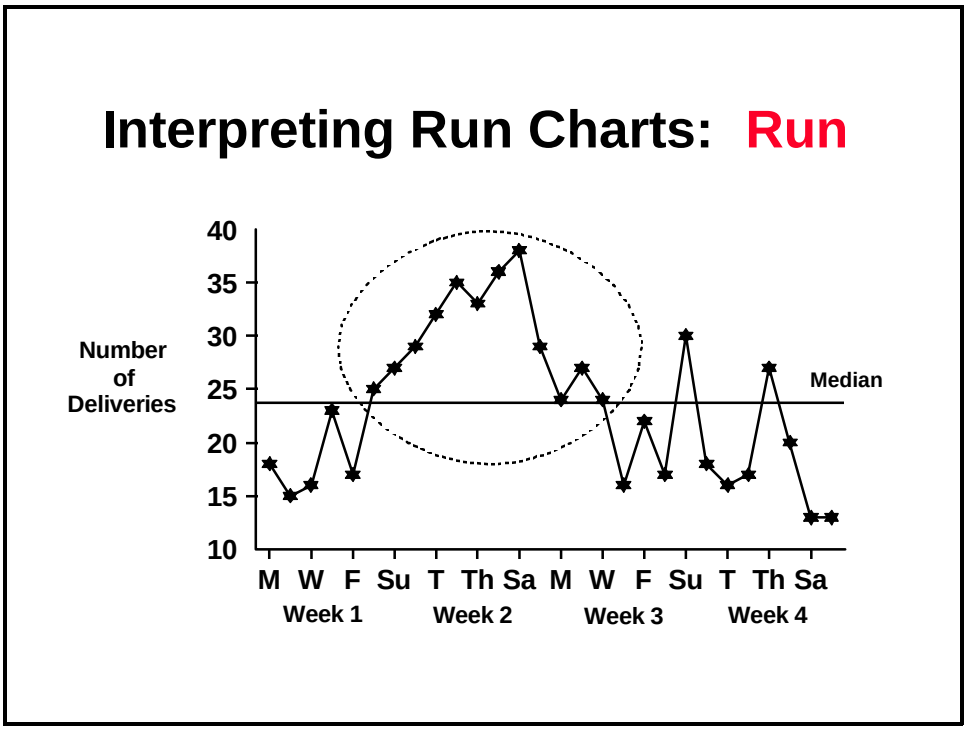
One of the most valuable uses of Run Charts is to identify meaningful trends or shifts in performance measured. For example, when monitoring any system, it is expected that there will be an equal number of points falling above and below the median.

You want to be able to detect trends or other patterns over time so you can take action on the process. Tools such as Pareto Charts and Histograms, do not incorporate the time-ordering of the data, hence are of limited value for prediction.

◆ **Assess process stability**

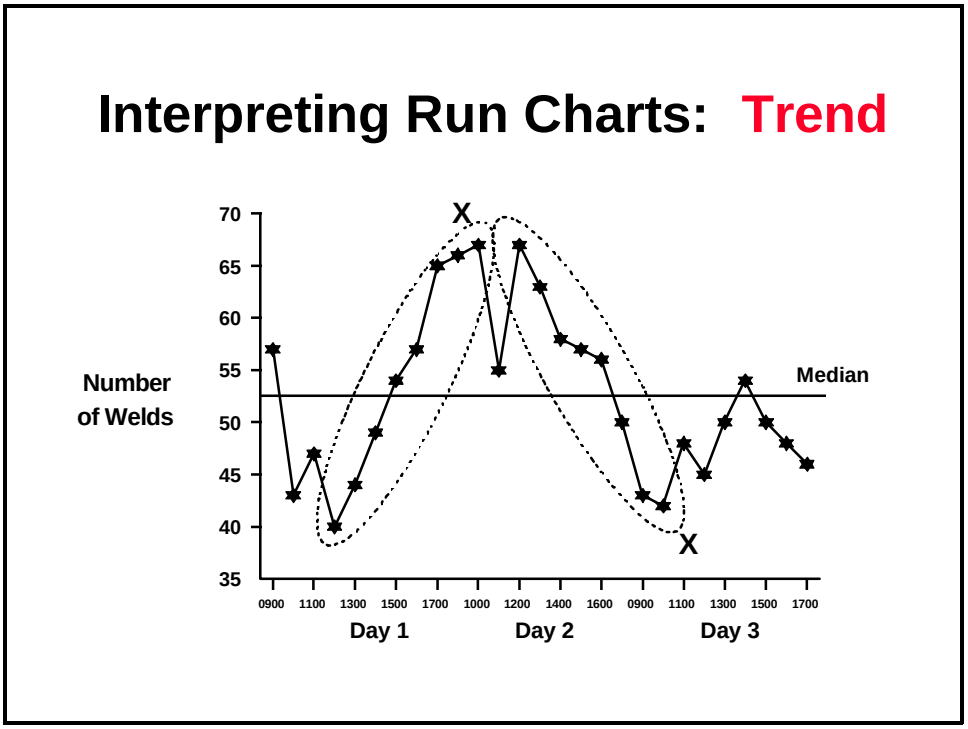
Run Charts display data in the **sequence in which they occurred** .
This enables you to visualize how your process is performing and helps you to detect signals of special causes of variation.

A Run Chart itself will not eliminate or incorporate the special cause; only action based on knowledge of the process can do that. It detects the existence of special causes of variation. It does not find the cause.



Interpreting Run Charts: Run

A sequence of 9 consecutive points or more on the same side (above or below) of the median is an unusual event. Such a pattern should always be investigated. Remember, because we are using the median we would expect half the values to be above and half to be below. Given this, two or three successive points above or below the median are not unusual. A run of 9 consecutive points on the same side of the median is a very unlikely event. This pattern indicates a special cause of variation because the likelihood (probability) that these events are due to chance is so low.



Interpreting Run Charts: Trend

A sequence of 7 or more points steadily increasing or decreasing with no change in the direction is called a trend. A repeated value also stops the trend. The last point of the sequence signals the trend. However, it's important to investigate the special cause starting with the first point of the trend.

You will have to determine if a trend is good or bad when it goes up or down. For example, if you are charting the number of defects, a downward trend is good. By contrast, if you are charting sales a downward trend is bad. Either way, you still need to investigate the cause -- either eliminate it or make it part of the process.

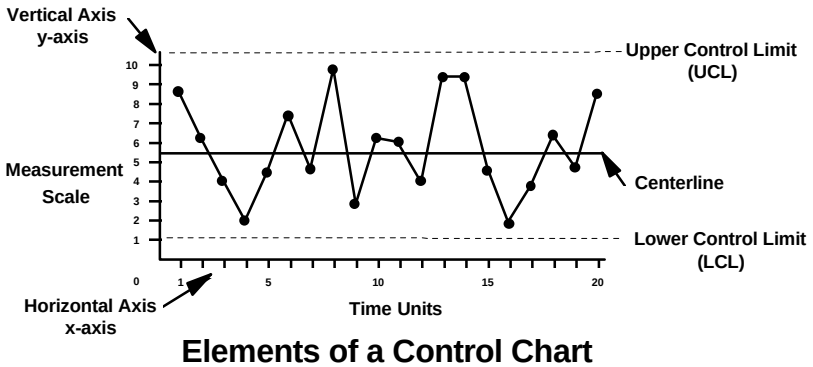
It's important to establish the rules for identifying runs and trends in advance. We establish these rules for determining special causes signals based on knowledge of the process and the impact of identifying a false signal. A false signal could lead us to take action when we shouldn't do anything. As a rule of thumb, the greater the number of points we allow before taking action, the more conservative the rule. When we have limited knowledge of the process, use the most conservative rules. That is, investigate runs of 9 points and trends of 7 points.

These rules of thumb vary slightly depending on the source you consult. Deming, in *Out of the Crisis*, suggests a run of 7 and a trend of 7 or more. The *Memory Jogger* suggests a run of 9 and a trend of 6 or more. Heero Hacquebord suggests 8 or more points for runs and 6 or more for trends. However, no one suggests using runs of less than 7 or trends of less than 6 as signals of special causes. As the number of points is reduced, the probability of a false signal is increased.

These two patterns (sequence of 9 points on the same side of the median and sequence of 7 points going up or down with no reversals) should not happen due to chance. The probability is high that these events occurred because of some special cause. Therefore, you need to investigate further.

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

Control Chart

The Control Chart is a statistical tool that presents a graphic display of process variation over time.

Control Charts are the tools we need to differentiate between the two primary sources of variation in a process or system, common and special causes. Despite their names, these charts do not control anything! The users of the charts must take the information in them to investigate **why** the data appear as they do. Then, they will be able to determine what actions need to be taken.

Elements of a Control Chart

The major elements of the Control Chart consist of the data points, the centerline, the upper and lower control limits, and the vertical and horizontal axes.

The **vertical axis** reflects the type of data collected. The data will be either units of measurement, frequency (count), or the percentage of occurrence of an event.

The **horizontal axis** reflects a measurement of time. Regardless of the type of data collected, this axis reflects the chronological order in which the data were collected.

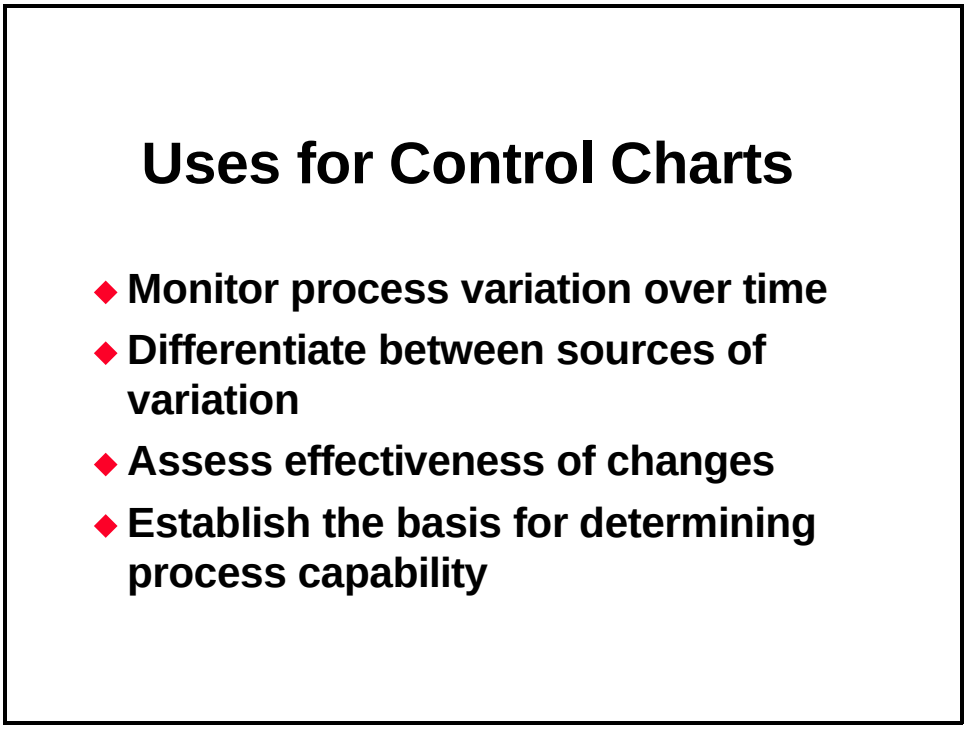
The **data points** can be individual measurements or a statistic based on the measurements. Each data point represents a sample from the process of interest. This sample may range from a measurement based on a case of one to a sample based on a large number of cases. Depending on the type of chart being used, these data points could be measures of either attribute or variables data.

The **centerline** represents a measure of location. Generally, this is the **mean** or average of all the plotted data.

The **control limits** are the dashed horizontal lines above the centerline **(Upper Control Limit--UCL)** and below the centerline **(Lower Control Limit--LCL)** . These limits are indicators of variation from the centerline, or *dispersion*. They each represent three sigma units from the centerline. These indicators are calculated from the data. They are intended to reflect the natural variation of the process.

As you recall from Module 3-3 (Variation), one goal of using a Control Chart is to achieve and maintain **process stability** . Process stability is defined as a state in which a process has displayed a certain degree of consistency in the past and is expected to continue to do so in the future. This consistency is characterized by a stream of data falling within **control limits** based on **plus or minus 3 sigma units** of the centerline.

Control limits represent the limits of variation that should be expected from a process in a state of statistical control. When a process is in statistical control, any variation is the result of common causes that effect the entire production in a similar way. Control limits should not be confused with **specification limits** , which represent the desired process performance.



Uses for Control Charts

Control Charts are the most powerful tools available today to assess process variation. There are several types of control charts. They all have the same primary uses: to *make judgments* and to *maintain operations*.

When used to make judgments, they help ascertain whether a process is in statistical control. They are used to signal where common or special causes of variation are present. This information helps to determine what decisions should be made concerning what actions to take. These decisions include deciding whether to intervene and make changes, the types of changes to be made, and whether these changes have made a difference in the results.

When used to maintain operations, they help to identify present levels of functioning, substantiate whether or not improvements have occurred as a result of changes, when modifications need to be made in the future, and when process capability can be determined.

- **Monitor process variation over time**

  Control Charts are simple and effective tools to achieve statistical control. They provide process information as to when action should or should not be taken. This information can be maintained by those closest to the process so they can determine what is occurring in a timely manner.

- **Differentiate between sources of variation**

  By distinguishing between common and special causes of variation, it is easier to determine not only whether actions need to be taken but also where changes need to be made. Identifying the source of variation will help determine whether changes best can be made by the person closest to the process, by management, or by both.

- **Assess effectiveness of changes**

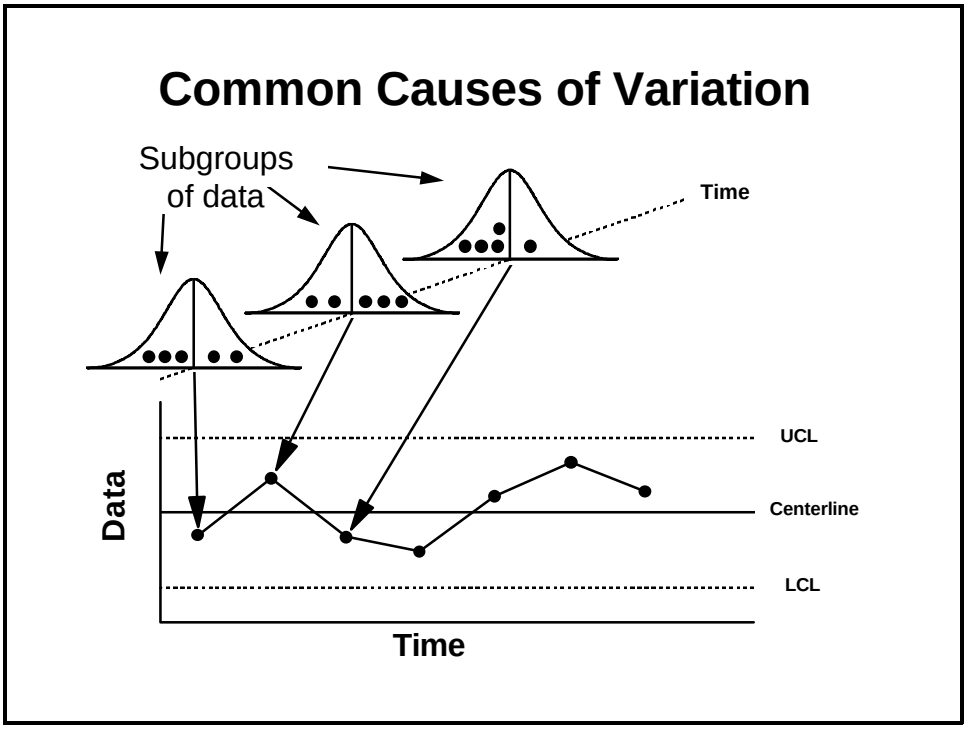
  Control Charts monitor stability and variation after a change has been implemented. Results can be compared before and after changes are made. In this way, it can be determined whether the changes led to improvements.

  A variety of changes can be assessed. Results can be evaluated in terms of how well the following questions were answered:

  Were the special causes removed?
  Is the process stable?
  Has the variation been reduced?
  How effective is the new process?

- **Establish the basis for determining process capability**

  Another important use for Control Charts is to determine when process capability can be assessed. Process capability cannot be meaningfully assessed until a process has become stable. A process must be stable before the extent to which it meets customer requirements can be determined with any degree of predictability.

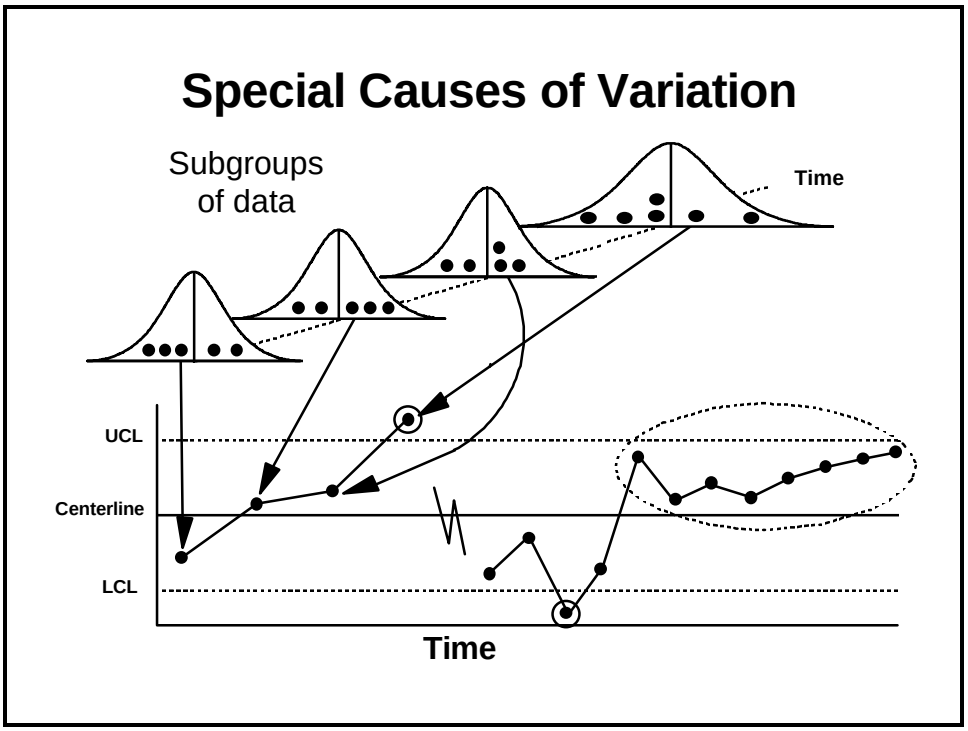


Common Causes of Variation

This viewgraph indicates how the data points in a Control Chart are based on a set of sample measurements (subgroups). While some variation does occur between the subgroups, they all fall within the expected limits (upper and lower control limits) and do not exhibit any particular pattern within these limits. Since the variation does not reflect any unexpected statistical results, this process is considered to be stable and in statistical control. This means that the variation is due to random or unspecified causes. This is the so-called natural variation that occurs within any predictable process.

Once a process has achieved statistical control, that is, only common causes of variation have been identified, can you leave it alone? Do you need to work on this process any more? Or, can you leave it and work on other processes?

Remember, the goal of total quality is continual improvement. Deming (1986) made it clear that good management requires the **continued** reduction of variation, even when a process is in a state of statistical control, and even when few or no defectives are being produced. When variation is further reduced, less rework is needed, less waste results, and costs decrease. The concept of continual improvement emphasizes reducing variation, that is, continuing to get better, even when things are going well.



Special Causes of Variation

Special causes of variation are indicated when the data show unexpected or unusual patterns. Special causes in the data reflect processes that are unstable, unpredictable, and out of statistical control.

The circled data points in the Control Chart shown are signals of special causes. It indicates a data point above the UCL. The statistical probability or likelihood of this point occurring by chance, or random variation, is very small. The probability that it occurred because of a specific cause is thus very high. The Control Chart doesn't tell you **why** the point occurred in this way. It allows you to decide whether the variation should be investigated or not. You must investigate if you want to find its cause and to prevent it from occurring in the future.

The second circled data point indicates a point that fell below the LCL. Again, this result is unusual and unexpected just based on chance. You must investigate **why** this occurred.

The group of data points encircled (oval) also indicates a particular pattern of responses that isn't random. The likelihood of this pattern occurring by chance is also very low. There must be some reason the data look the way they do. You need to investigate why!

★ **Additional Information:** There are many different types of Controls Charts but they can be basically grouped into two major categories: **Variables Control Charts** and **Attribute Control Charts.**

Variables Control Charts

This type of Control Chart is used when the data of interest are based on a continuous scale of some measurement, such as length, width, time to complete, or weight. The only two types of variables Control Charts that most of us will ever need are:

X-bar ($\overline{X}$) and Range (R)

This variables control chart is used when there is a rational basis for subgrouping samples. Each point on the X-bar (measure of location) portion of the chart represents the arithmetic mean of the samples in that subgroup. Each point on the R (measure of dispersion) portion of the chart represents the range (spread of values) *within* that subgroup.

Individual Values (X) and Moving Range (mR)

This variables control chart is used when there is no rational basis for subgrouping samples. Each point on the X (location) portion of the chart represents an individual measurement (sample). Each point on the R (dispersion) portion of the chart represents the range *between* successive samples, hence the term *moving range*.

Attribute Control Charts

Attribute Control Charts are used when count, percentage, or discrete data are used. The only type of attribute control chart we are likely to need is:

Individual Values (X) and Moving Range (mR)

The XmR chart is used for attribute data, because there is no rational basis for subgrouping discrete counts (such as number of defects, production levels, etc.). The description above applies here as well.

It is strongly encouraged to get additional training in Statistical Process Control (SPC) before you use Control Charts. The SAPI course is highly recommended.

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?**

Data Collection Plan

Data collection helps your team to assess the health of your process. A Data Collection Plan is nothing more than planning for and obtaining useful process information. Simply collecting data does not ensure that you will obtain relevant or specific enough data to tell you what is occurring in your process. The key issue is not: *How do we collect data?* The key issue is: *How do we obtain useful data?*

Every process improvement effort relies on data to provide a factual basis for making decisions throughout the Plan-Do-Check-Act cycle. Data collection enables a team to formulate and test working assumptions about a process. These hypotheses help to develop information that will lead to the improvement of the key quality characteristics of the product or service. Data collection improves your decision-making by helping you focus on objective information about what is happening in the process, rather than subjective opinions. In other words, *I think the problem is*... becomes... *The data indicate the problem is...*

Your team needs to develop the answers to the following questions as the basis for a sound Data Collection Plan.

◆ **Why do we want the data?**

The team must decide on a purpose for collecting the data. In the Plan Phase, your team should develop a **working hypothesis** which will serve as a guide to future investigation of the process. This hypothesis is an assumption based on already existing data and observations, such as your process flowcharts or a Cause and Effect Diagram the team has prepared. You develop working assumptions and collect data to determine the process changes that will improve the key quality characteristics of your product or service. Your proposed change should be stated as an "If . . . then" statement.

> ***IF*** *we change Step X in our process by doing . . ., we believe we will* ***THEN*** *improve Y, which is a key quality characteristic of our product or service.*

This action focuses your team on the specific quality characteristic you want to improve, and sets the stage for where and how you will collect the data.

◆ **Where will we collect the data?**

The location where data are collected must be identified clearly. This is not an easy step unless you tackle it from the following perspective:

- Refer to the flowcharts which depict both the current ("as is") state of the process and the proposed ("should be") state of the process after it has been modified. Focus on the process steps where the key quality characteristic you are trying to improve is produced.

- Collect data from these process steps. You must collect data twice. First, you **collect baseline data** before you make any changes in your process. These baseline data will serve as a yardstick against which to compare the results of the process after changes have been made. Then, you must **collect data after the change** has been imposed on the process. To compare the before and after process, you will probably want to translate your data into graphic form using a Pareto Chart, Run Chart, or Histogram.

- Collect data on the key quality characteristic of the product or service at the end of your process. Again, before and after data must be collected. The comparison of before and after data may indicate whether the change actually improved the output of the process.

◆ **What type of data will we collect?**

In general, data can be classified into two major types: **attribute data** and **variables data**.

- **Variables data** are based on the measurement of some characteristic along a continuum. Theoretically, they can take on an infinite number of values along this continuum. Examples include length, width, time, temperature, and weight. **Variables data** consist of data that fall along continua indicating various degrees of a particular variable. These degrees reflect an ordered relationship between values.

- **Attribute data** are based on the occurrence of discrete events, such as the number and types of defects, nonconforming units, and people late for class. **Attribute data** consist of data that fall into discrete categories. There is no relationship between categories other than they reflect a different type of category. Measures can be taken of the frequencies, counts, and percentages of events within these categories.

The type of data that is used will determine which statistical tool you use. For example, if you are concerned with customer satisfaction regarding "timely delivery" of your product or service, you need to identify what is important to them regarding this quality characteristic.

One consideration, after prioritizing customer requirements, might be to determine the relationship between on-time deliveries and late deliveries. A procedure could be developed to *count* the number of on-time deliveries for a period of time, or to review past records (if they exist) to identify the number of previous on-time deliveries. This information would give you the number of on-time deliveries or the ratio of on-time to late deliveries.

Another measurement you could collect in this situation is *delivery time*. You would need to determine a starting time, such as when an order was received, when it was completed, or what is appropriate. An ending time would also need to be determined, such as when it was mailed or received by the customer. In this situation you would be gathering information on a measure of *time*. This information would give you the amount of time it took to complete a product or service or the amount of time it took for a customer to receive an order, or whatever operational definition was used to determine delivery time. This type of measure is different from the count information discussed above.

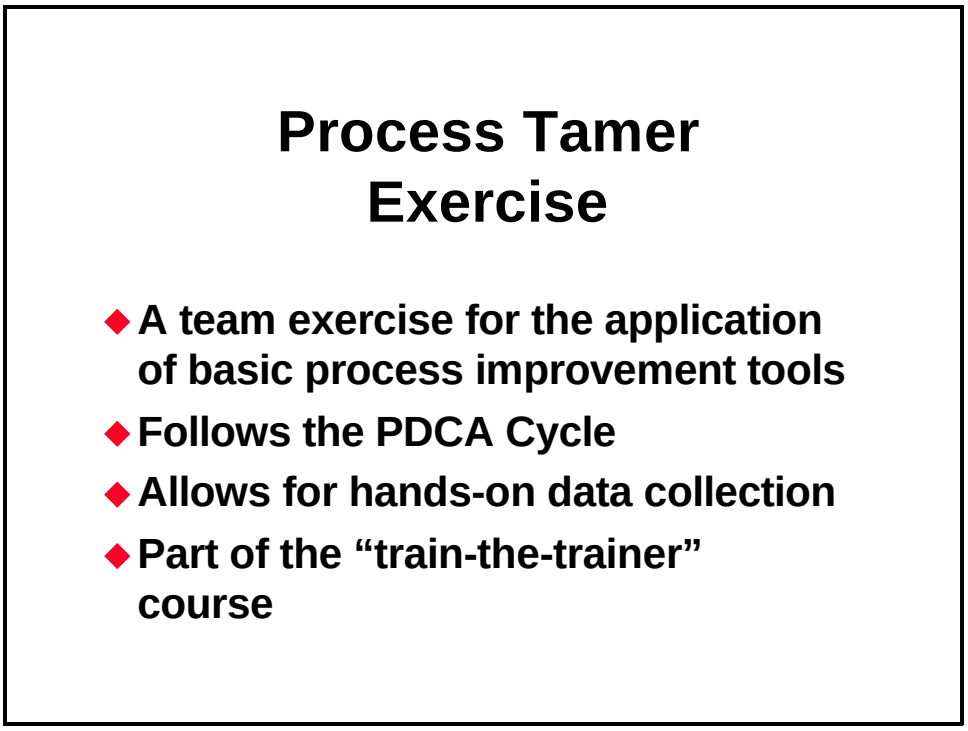
- **Who will collect the data?**

Many teams struggle with this question, but the answer is simple: Those closest to the data -- the process workers -- should usually collect the data. These people have the best opportunity to record the results. They also know the process best and can easily detect when problems occur. But remember, the people who are going to collect the data need training on how to do it and the resources necessary to obtain the information, such as time, paper, pencils, and measurement tools.

- **How do we collect the right data?**

You need to remember that you are collecting data for the purpose of improving the process, and thereby the product it produces. Clearly, you want to collect the data that best describe the situation at hand. If you are going to use the data to make predictions about the performance of the process, you should collect small samples at regular intervals -- depending on cycle time. Since it is important to collect those samples in a short interval of time, you may want to use consecutive units or every other unit.

But remember, the cost of obtaining the data, the availability of data, and the consequences of decisions made on the basis of the data should be taken into consideration when determining how much data should be obtained and how frequently it should be collected.



Process Tamer Exercise

- **A team exercise for the application of basic process improvement tools**

The Process Tamer is an integrated exercise that allows for the application of a variety of the basic process improvement tools.

- **Follows the PDCA cycle**

This exercise generally follows the PDCA cycle. It is not intended to demonstrate process improvement, but rather as an application of the PDCA in studying a process, forming a theory, and testing the theory. It provides an opportunity to measure process variation.

- **Allows for hands-on data collection**

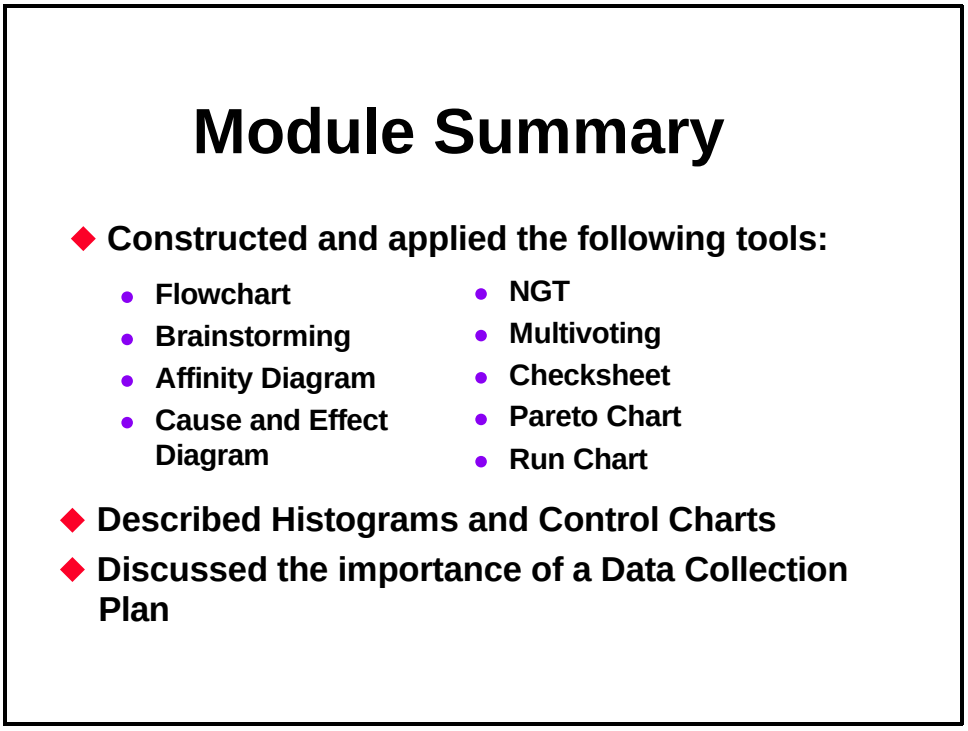
Each team member will be able to conduct portions of the exercise. A "predefined" process will be given to the team which allows for data collection using checksheets, run charts, and Pareto charts.

- **Part of the "train-the-trainer" course**

The Process Tamer is part of the five day "train-the-trainer" course. It is designed to embellish the course in the use of basic process improvement tools and not intended for the end-user course. This structured exercise provides additional training to the target

audience of TQ Coordinators and Quality Advisors.

Note: This viewgraph is not include in the end-user course.



Module Summary

- Constructed and applied the following tools:

  Flowchart
  Brainstorming
  Affinity Diagram
  Cause and Effect Diagram
  Nominal Group Technique (NGT)
  Multivoting
  Checksheet
  Pareto Chart
  Run Chart

- Described Histograms and Control Charts

- Discussed the importance of a Data Collection Plan

Multivoting Exercise Tally Sheet

A _____	M _____	Y _____	AK _____
B _____	N _____	Z _____	AL _____
C _____	O _____	AA _____	AM _____
D _____	P _____	AB _____	AN _____
E _____	Q _____	AC _____	AO _____
F _____	R _____	AD _____	AP _____
G _____	S _____	AE _____	AQ _____
H _____	T _____	AF _____	AR _____
I _____	U _____	AG _____	AS _____
J _____	V _____	AH _____	AT _____
K _____	W _____	AI _____	AU _____
L _____	X _____	AJ _____	AV _____

Multivoting Exercise

SIGNS OF FEAR IN THE WORKPLACE

a. Flooded with detail

b. "Don't rock the boat"

c. Mixed messages

d. Attacks/defensiveness

e. People afraid to say "I don't know"

f. Chronic indecision

g. "This too shall pass"

h. News always good

i. Withholding information

j. Changing subject

k. Self-protective behaviors

l. Hidden agenda syndrome

m. Turf battles

n. Not willing to accept responsibility

o. We vs. they

p. Resisting requests

q. Tampering

r. Staffing redundancies

s. Constantly changing policies

t. Myopic vision

u. Isolation

v. Micromanaging

w. Goals without a plan for achieving them

x. Blame others

y. Denial

z. Resistance to new knowledge

aa. People afraid to ask questions

ab. "This is good for my people, not for me"

ac. Concern with return on investment

ad. Focus on grades, instead of learning

ae. Lack of new ideas

af. Fear that some work can be done by fewer people

ag. Resistance to change

ah. Avoidance of risk-taking

ai. "Just doing my job"

aj. Stress

ak. Recurrent absenteeism

al. Widespread dissatisfaction

am. Deadline anxiety

an. Enforcement approach to rules

ao. Turnover of creative thinkers

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