Pareto Chart

Usage

Pareto analysis is a way of organizing data to show what major factor(s) are significantly contributing to the effect being analyzed (i.e., how much each cause contributes to the problem at hand). Such analysis can help you:

- choose a starting point for problem solving
- identify the Root Cause of a problem
- monitor success in a process improvement program

A Pareto Chart is a type of histogram in which the height of each bar represents the relative contribution of that element to the overall problem. Consistent with the "80-20" rule ("80% of the results are produced by 20% of the causes"), Pareto Charts usually reveal that a majority of the problematic results of a process can be traced to only a few specific causes.

Having identified the Root Causes with a Pareto Chart, you can then make changes to the process, confident that you are working with the "vital few" sources of problems rather than the "trivial many".

Instructions

To construct a Pareto Chart, follow these instructions:

1. Use data collected in a Checksheet.
2. Select the categories of information to be included, and establish a standard unit of measurement.
3. Rank the data in descending order.
4. Construct a vertical bar chart with the categories listed left to right in *descending* order:

- The horizontal (X) axis represents the categories or defect types.
- The left vertical (Y) axis represents the statistic of interest (e.g., cumulative total of occurrences, number of defects).
- The right vertical (Y) axis represents a *cumulative* percent of occurrences.

5. Analyze the pattern displayed:

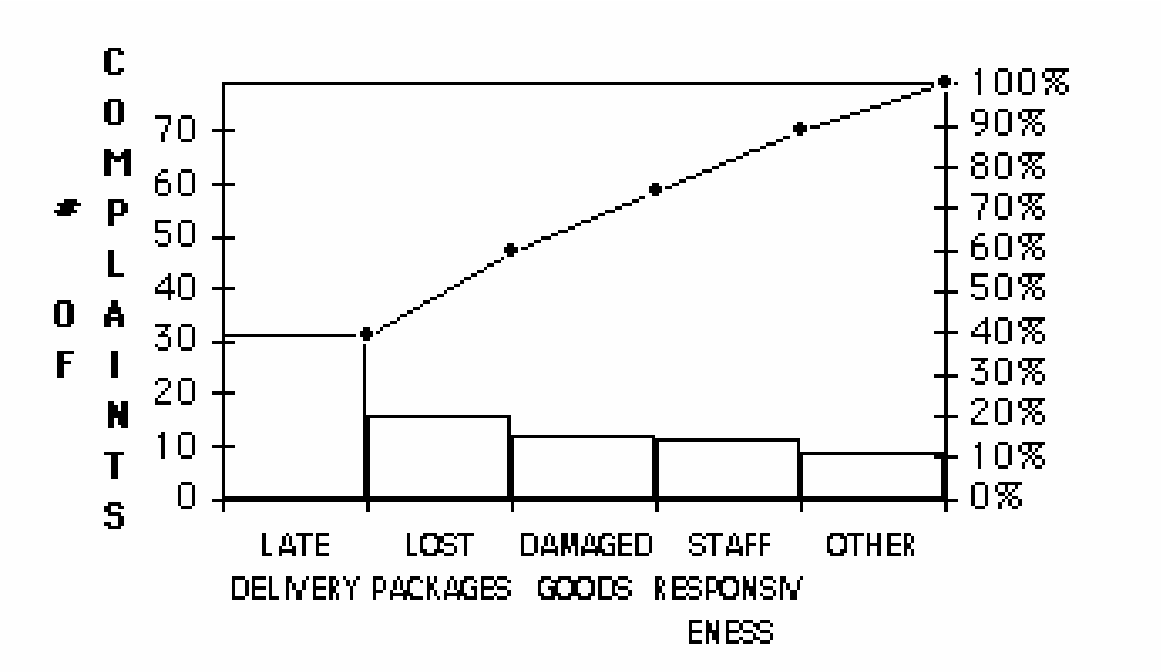
- If the pattern is relatively flat (i.e., different categories contribute equally to the result), reconsider your categories (e.g., restratify the data) and make a new Chart.
- If the pattern is steeply descending, note which categories are represented in the first few bars: these are the categories representing the Root Cause(s) in which to intervene in the target process.

Tips

Some points to keep in mind:

- Use common sense -- the most frequent or most costly events are not always the most important. For example, two fatal accidents deserve more attention than 100 cut fingers.
- Mark the chart clearly to show the standard of measurement.
- Clearly indicate somewhere on the chart the period over which the data was collected.
- "Normalize" the data, if possible (convert the data to a truly common scale), to allow the data to be used in future Pareto Charts to demonstrate changes.
- Keep the data axis constant when comparing charts that demonstrate improvement.

Example



Cause/Effect Diagram (Fishbone)

Usage

Use the Cause/Effect Diagram (also known as a **Fishbone Diagram** or **Ishikawa Diagram**) to:

- organize and display the various theories about what the Root Causes of the the problem may be
- focus attention on one specific problem
- encourage innovative thinking
- provide a graphic representation of relationships

Instructions

To construct a Cause/Effect Diagram, follow these instructions:

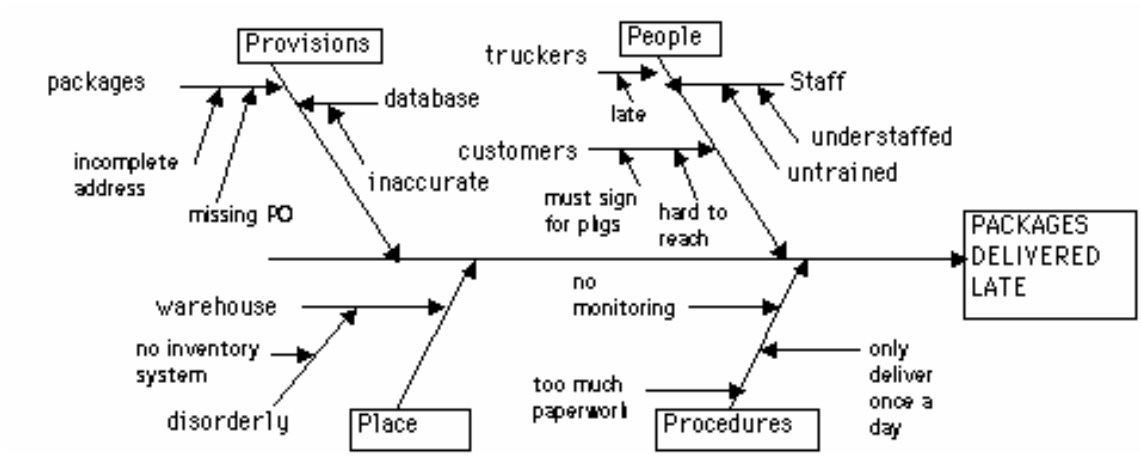
1. Clearly define the effect or symptom for which the causes must be identified.
2. Place the effect or symptom being explored at the right, enclosed in a box.
3. Draw the central spine as a thick line pointing to it from the left.
4. Brainstorm (or construct an Affinity Diagram) to identify the "major categories" of possible causes (not less than 2 and normally not more than 6).
5. Place each of the identified "major categories" of causes in a box and connect it to the central spine by a line at an angle of about 70 degrees from the horizontal.
6. Within each "major category" (starting with the one that seems most likely to hold the Root Cause), ask "Why does this (i.e., the effect or symptom being explored) happen? Why does this condition exist?"
7. Continue to add clauses to each branch until the fishbone is completed.
8. Once all the bones have been completed, identify the likely, actionable Root Cause.

Tips

Some points to keep in mind:

- Make sure everyone agrees on the problem statement or effect.
- Resist the temptation to state solutions rather than causes.
- Try not to solve problems outside of the group's experience or control.
- Take special note of causes that appear repeatedly.
- Reach a team consensus; if you have identified more causes that you can work with comfortably, have team members vote (e.g., using Multivoting) for the most likely causes, and concentrate on items that receive the most votes.
- Test the most likely cause and verify with data.

Example


Provisions
packages
database
incomplete address
missing PO
inaccurate
People
truckers
Staff
late
understaffed
customers
untrained
must sign for pigs
hard to reach
PACKAGES DELIVERED LATE
warehouse
no monitoring
no inventory system
disorderly
Place
too much paperwork
Procedures
only deliver once a day

Scatter Diagram

Usage

Use a Scatter Diagram to:

- display what happens to one variable when another changes
- test possible cause-effect relationships (i.e., test a theory that two variables are related)

Instructions

To create a Scatter Diagram, follow these instructions:

1. Collect 50 to 100 paired samples of data that you think may be related.
2. Construct a data sheet with the information.
3. Create a graph on which to plot the data:
   - The horizontal (X) axis represents the measurement values of one variable (typically the presumed "cause" variable).
   - The vertical (Y) axis represents the measurement values of the second variable (typically the presumed "effect" variable).
4. Plot the data on the graph.
5. If values are repeated, circle the point as many times as necessary.

Tips

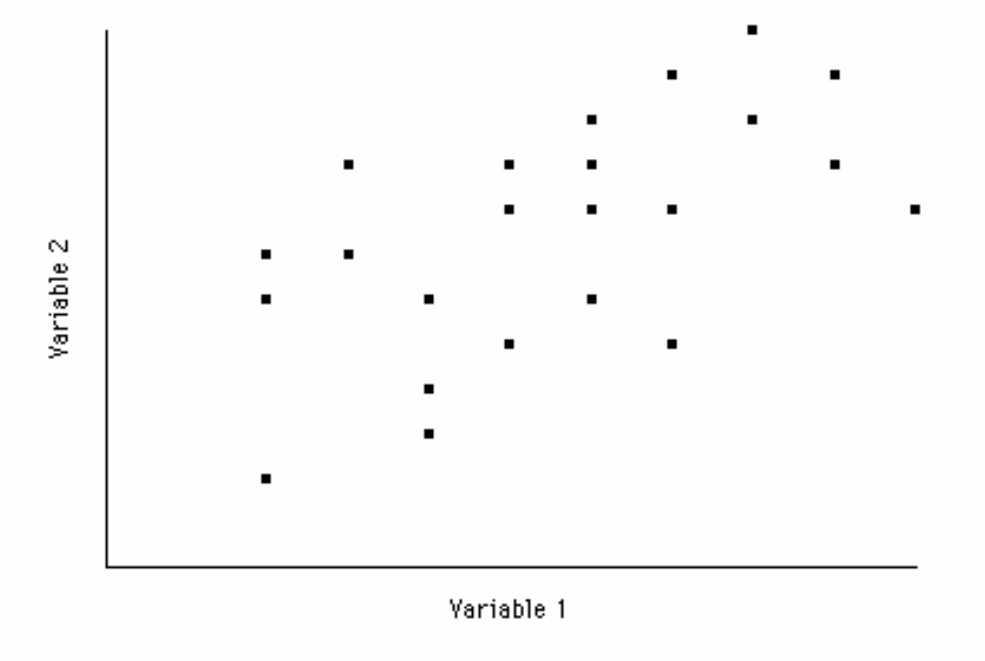
Some points to keep in mind:

- A Scatter Diagram cannot prove that one variable *causes* another. It can only show whether a *relationship* exists, and the strength or nature of that relationship.
- A negative relationship (i.e., as X increases, Y decreases) is as important as a positive relationship (i.e., as X increases, Y increases).

Example

Data used:

Var1	Var2		Var1	Var2
2	6		6	9
6	8		8	12
3	7		9	11
4	4		7	8
5	9		4	6
10	8		5	8
3	9		6	6
6	10		7	5
5	5		9	9
4	3		8	10
2	7		2	2
			7	11


Variable 2
Variable 1

Run Chart / Control Chart

Usage

Use a Run Chart (also known as a **Trend Chart** or a **Time Plot**) to:

- detect trends over time
- separate "common-cause variation" from "specific-cause variation"

If a Run Chart has sufficient data, you can also compute statistical "control limits" for the process, which give an indication of the expectable "normal" variation of the process. A Run Chart with the "control limits" plotted right on the graph is known as a **Control Chart**.

Instructions

To create a Run Chart, follow these instructions:

1. Create a chart to display the data:
- The horizontal (X) axis represents a measurement of time (e.g., day, hour, etc.)
- The vertical (Y) axis represents the measurement value.
2. Plot and connect the data points.
3. Add a line showing the average value.
4. To form a **Control Chart**, add statistically-determined upper and lower control limits to the chart.

Tips

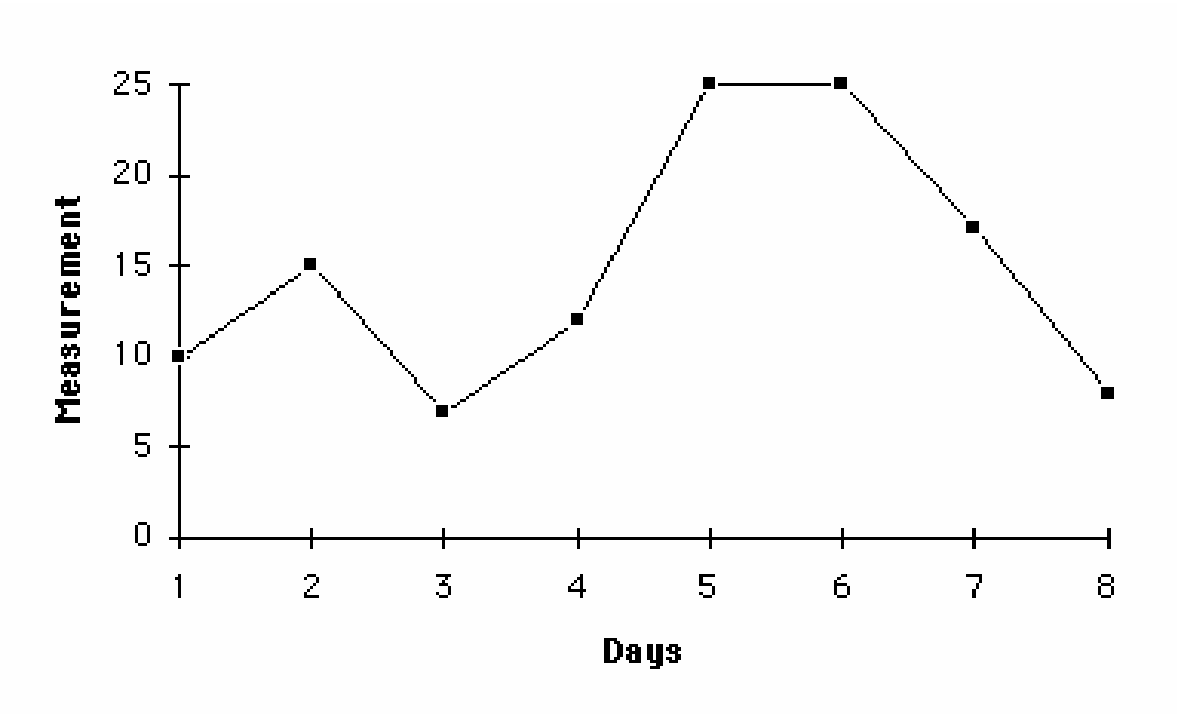
Some points to keep in mind:

- Focus attention on truly vital changes in the process. Some variation is expectable; look for the *significant* patterns.
- Don't confuse "control limits" with "specification limits". "Control limits" are computed values reflecting the data displayed in the chart; "specification limits" are arbitrary values specified by the process maintainers (they are the "goals" for the process).

Example

Data used:

```
Time    Measurement
----    -----------
 1          10
 2          15
 3           7
 4          12
 5          25
 6          25
 7          17
 8           8       AVG: 14.875
```


25
20
15
10
5
0
Measurement
1
2
3
4
5
6
7
8
Days

Checksheet

Usage

Use a Checksheet to:

- Facilitate gathering data on sample observations in order to detect patterns
- help answer the questions:
- What events are happening?
- When/how often are events happening?
- Where are events happening?
- Are events of concern happening together with other changes/events?
- Did we forget anything?
- Start the process of translating opinions into facts
- Prepare data for a Pareto Chart

Instructions

To construct a Checksheet, follow these instructions:

1. As a starting point, brainstorm about the categories of information you might want to collect data for. Determine the categories by asking such questions as:

- What happens?
- Who does it, who receives it, or who is responsible for it?
- When/how often does it happen?
- Where does it happen?
- How does it happen?

2. Once you have decided what categories of information you want to collect data for, mock-up a checksheet by laying out these categories onto a standardized form or grid.
3. Include places to record:

- who collected the data
- when the data was collected
- where the data was collected
- how the data was collected

4. Review and revise the proposed Checksheet until you have a final version.
5. Use the final Checksheet to collect data.

Tips

Some points to keep in mind:

- Consider gathering a little data prior to setting up the Checksheet, to help you determine what aspects of the process might be useful to measure, and what's involved in taking the measurements.
- In exploring possible categories, use all the jounalistic questions *except* "Why?" (Asking "Why?" typically lead to a search for causes, whereas a Checksheet is oriented to gathering data.)
- Agree on what is to be observed and why it is to be observed.
- Decide on the length of time for observation.
- Design an easy to use form, clearly labelled, with enough space to note the data -- and test the form before you use it in the field.
- It can be especially useful to include a visual element in the checksheet (e.g., auto rental companies often use a "checksheet" which shows an outline of the car, on which you are to record where scratches or dents occur on your rental vehicle).
- Collect the data consistently and accurately.

Example

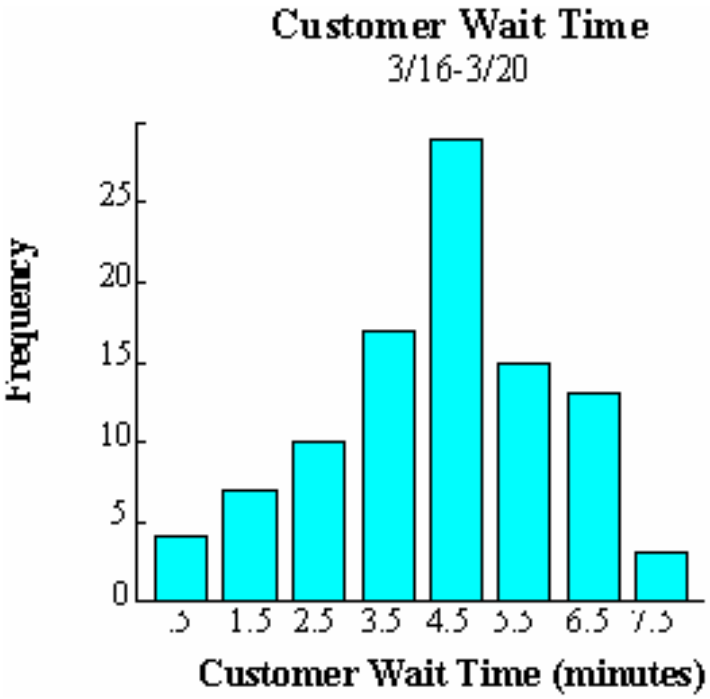
Shipping and Receiving Complaints	Time Period						
	Monday	Tuesday	Wednesday	Thursday	Friday	Total	Percentage
Late Delivery	5	8	6	7	5	31	39%
Damaged cartons	2	1	2	3	4	12	15%
Lost packages	3	4	2	5	2	16	20%
Staff responsiveness	1	2	1	6	1	11	14%
Other	2	0	3	2	2	9	11%
Total	13	15	14	23	14	79	100%

Histograms

Usage

A histogram takes measurement data, e.g. average waiting time or response time, and displays its distribution. A histogram reveals the amount of variation within any process.

A histogram is a vertical bar graph that shows the nature and distribution of data. The team can use histograms to identify problems and opportunities for improvements; to compare one process (or group, department, etc.) to another; and/or to measure if the process conforms to a certain standard. A histogram shows the information from a check sheet in visual form.



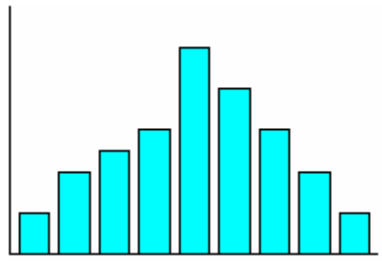
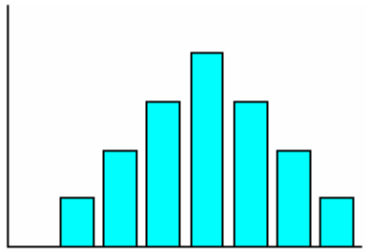
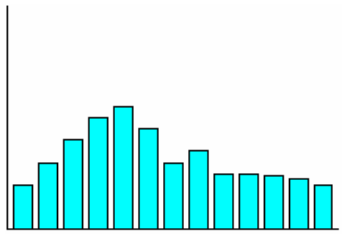
Instructions

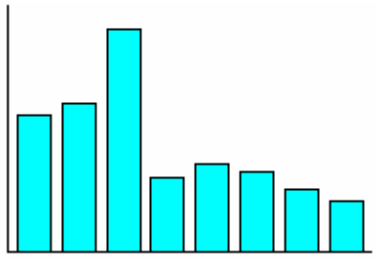
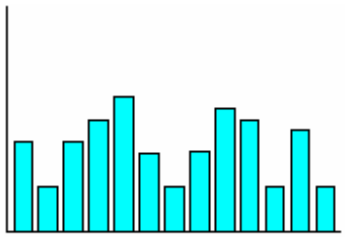
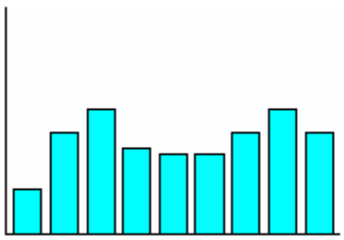
1. Decide if the categories on the check sheet need to be grouped. For example, if the team is counting number of days, the data might be grouped into 5-day increments (0-5 days, 6-10 days, etc.). Be careful about dividing the data into too few or too many groups.
2. Total the occurrences for the new groups.
3. Label the bottom of the histogram with the groups, starting on the left with zero or

least.

4. Label the left-hand axis numerically. Start with zero at the bottom. The top number must be at least as large as the highest group total.
5. For each group, draw a bar as tall as the number of occurrences in that group.
6. Label each axis. Add a title and a date.

Examples

This shape occurs most often. Most of the occurrences are in the center with about an equal number on each side. This shape is the result of a normal, in control process.	
A normal distribution with small variability suggests that the process is probably operating within specification limits. Measures are tightly grouped around the center.	
A normal distribution with large variability suggests that the process is probably operating outside of specification limits. Measures are spread out from the center.	

A skewed distribution indicates that the process is operating near an imposed limit.	 Skewed
The comb-like distribution may be the result of a measurement error (for example, if more than one person is recording the data or more than one instrument is used). Additional data collection may be necessary.	 Comb-like
The bimodal distribution may be the result of measuring two or more processes with different averages together. It may be necessary to separate the data and draw a histogram for each process. .	 Bimodal

Brainstorming

Brainstorming is a group technique for generating new, useful ideas and promoting creative thinking.

It can be used to help 1) define what project or problem to work on, 2) to diagnose problems , 3) remediate a project by coming up with possible solutions and to identify possible resistance to proposed solutions.

Roles

There are three roles for participants in a brainstorming session: leader, scribe and team member.

Leader

This person needs to be a good listener.
Before the session they need to refine a statement to help the others on the team focus on the reason for the brainstorming, and prepare the warm up activity.
During the session the leader will need to relay the ground rules of the session, and to orchestrate the session.

The Problem Statement

- needs to be specific enough to help participants focus on the intent of the session, but it must be open enough to allow innovative thinking.
- should not be bias so it favors a particular solution or excludes creative ideas.

Ground Rules for Brainstorming

1. All ideas are welcome. There are no wrong answers. During brainstorming, no judgments should be made of ideas.
2. Be creative in contributions. Change involves risk taking, it's important to be open to new, original ideas. Every point of view is valuable.
3. Attempt to contribute a high quantity of ideas is a short amount of time.
4. Participants should "hitch hike" on others' ideas.

Scribe

This person needs to write down EVERY idea - clearly and where everyone in the group can see them. Check to be sure the materials provided will allow you to write so everyone in the group can clearly see what you are writing. The scribe could be the same person as the leader.

Team Members

The number of participants should be no less than five, and no more than ten. The ideal group number is usually between six and seven. Sometimes it is helpful to include a person on the brainstorming team who has worked with the subject in the past.
Team members will follow this brainstorming procedure:

1. Team members will make contributions in turn.
2. Only one idea will be contributed each turn.
3. A member may decline to contribute during a particular round, but will be asked to contribute each round.
4. Participants should not provide explanations for ideas during brainstorming. Doing so would both slow the process down, and allow premature evaluation of ideas.

Set the Stage

- If possible the group should know what the brainstorming session is about before the session begins. This will allow them to think about the session.
- Provide appropriate places and ways to record ideas. This could include: flip charts, chalk or white boards, Post-Its, or large monitored computers.
- Provide a mental and physical environment which allows for creativity. Putting out thing such as magazines, clay, books, water colors, slates, a kaleidoscope, or jacks.

Steps for the Leader on How to Brainstorm

1. Introduce the Session.
   Review the reason for the brainstorming session, discuss the ground rules, and the team member procedure to be used.
2. Warm-Up.
   Provide a warm up activity (5 to 10 minutes) that helps the group get use to the excitement possible in a brainstorming session. This activity should be on a neutral subject that will encourage participants to be creative. The leader may want to end the warm up by having the members discuss what could be said about the ideas that would prevent brainstorming from being successful.
3. Brainstorming.
   This is the creative part! Set a time limit of 20 to 25 minutes. Sometimes it is effective to call time and then allow 5 more minutes. Stop when there is still excitement, do not force the group to work. Guide the group to generate as many ideas as possible. All suggestions made must be noted by the scribe. The scribe should use the speaker's own words. If the speaker's idea is long, the leader may need to summarize it and verify with the originator if the summary is correct.

4. Process the Ideas.
   Review ideas for clarification, making sure everyone understands each item. Similar ideas should be combined and grouped. At this point you can eliminate duplicate ideas and remove ideas. Next the group should agree on the criteria for evaluation. This could include: time allotments, talents and skills of the group, and more.

5. Establish a consensus if appropriate.
   Have the group vote on ten ideas to consider, then have the group vote on five of the ideas and tally the results to get a priority of feelings of the group.
   After refining ideas give each team member 100 points to allocate on the idea list. Team members can use their points however they wish.
   Have team members pick the five ideas they favor. Then ideas with the most picks can be prioritized.