

## What is a 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” [Ref. 5]. The chart gets its name from the Pareto Principle, which postulates that 80 percent of the trouble comes from 20 percent of the problems. Viewgraph 1 highlights the elements of this definition.

## Why should teams use Pareto Charts?

You can think of the benefits of using Pareto Charts in economic terms (Viewgraph 2). “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” [Ref. 1a].

## When should we use a Pareto Chart?

A Pareto Chart is a good tool to use when the process you are investigating produces data that are broken down into categories 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” [Ref. 5].

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. Some examples are:

- Process improvement efforts for increased unit readiness
- Skills you want your division to have
- Customer needs
- Suppliers
- Investment opportunities

## What Is a 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 "trivial many" (Pareto Principle)

PARETO CHART

VIEWGRAPH 1

## Why Use a Pareto Chart?

- Breaks big problem into smaller pieces
- Identifies most significant factors
- Shows where to focus efforts
- Allows better use of limited resources

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VIEWGRAPH 2

## How is a Pareto Chart constructed?

To construct a Pareto Chart, you need to start with meaningful data which you have collected and categorized. You may want to turn to the Data Collection module at this point to review the process of collecting and categorizing data that you can chart. Now you're ready to follow the steps for constructing a Pareto Chart (Viewgraphs 3 and 4). The steps below have been adapted from Joiner [Ref. 1b].

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

Step 2 - Order the data. Prepare an analysis sheet, putting the categories in order and placing the one with the largest count first.

Step 3 - Label the left-hand 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 - Find the cumulative counts. Each category's cumulative count is the count for that category added to the counts for all larger categories.

Step 7 - Add a cumulative line. This is optional. 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.

## Constructing a Pareto Chart

Step 1 - Record the data

Step 2 - Order the data

Step 3 - Label the vertical axis

Step 4 - Label the horizontal axis

Step 5 - Plot the bars

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VIEWGRAPH 3

## Constructing a Pareto Chart

Step 6 - Add up the counts

Step 7 - Add a cumulative line

Step 8 - Add title, legend, and date

Step 9 - Analyze the diagram

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VIEWGRAPH 4

Step 8 - Add title, legend, and date.

Step 9 - Analyze the diagram. Look for the break point on the cumulative percent graph. It can be identified by a marked change in the slope of the graph (see Viewgraph 11). This separates the significant few from the trivial many.

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 diagram. 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.

Now let's look at an example to illustrate the Pareto Chart construction process:

You recently inherited \$10,000 and would like to apply it to some of your outstanding bills. Here is what you owe:

Home improvement loan balance	\$1,956
Visa	\$2,007
Mastercard	\$1,983
Church building fund pledge (monthly installments of \$83.33 for two years)	\$2,000
Balance of car loan	\$1,971
School tuition (monthly installments of \$169.17 for one year)	\$2,030

Viewgraphs 5 and 6 show how this would look when recorded on an analysis sheet and plotted on a Pareto Chart.

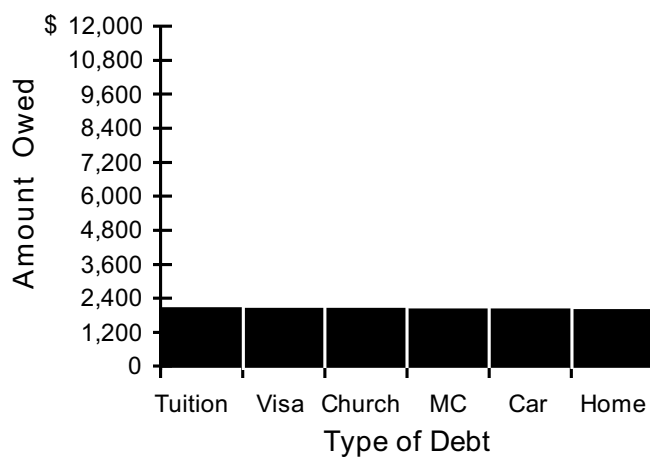
## Analysis Sheet Example Outstanding Debts

Category	Amount (\$)
School tuition (monthly installments)	2,030
Visa	2,007
Church pledge (monthly installments)	2,000
Mastercard	1,983
Balance of car loan	1,971
Home improvement loan balance	1,956
Total	11,947

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VIEWGRAPH 5

## Pareto Chart Example Outstanding Debts



LEGEND: AMOUNT OWED ON OUTSTANDING DEBTS AS OF 12 FEB 95.

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VIEWGRAPH 6

You probably noticed that no single bar is dramatically different from the others. Looking at your outstanding debts in this way isn't much help. Is there a different way the data could be categorized to make it more meaningful? What if you were to consider the interest rates on your outstanding debts?

Viewgraphs 7 and 8 show what that would look like. A much clearer picture of your outstanding debts now emerges, and you are able to make a better decision on how to manage your money.

NOTE: In this example, we opted not to show a cumulative line (Step 7) on the right side of the Pareto Chart because it might be confusing to create a percentage of percentages.

## How do we interpret a Pareto Chart?

When you look at a Pareto Chart, you can see break points in the heights of the bars which indicate the most important categories. This information is useful when you are establishing priorities.

As you can see in the example we've just looked at, you can detect two big breaks in the heights of the bars when you categorize the data in a different way:

- The first break point is between the second and third bars. The difference between these two bars is much more noticeable than the other differences. This shows the relative importance of the first two bars in relation to the others.
- The other break point occurs after the fourth bar. Addressing the third and fourth bars will give a higher payoff than addressing the last two bars.

You will have an opportunity to develop your interpretation skills when you do the practice exercises that follow.

## Analysis Sheet Example

### Interest Rates on Outstanding Debts

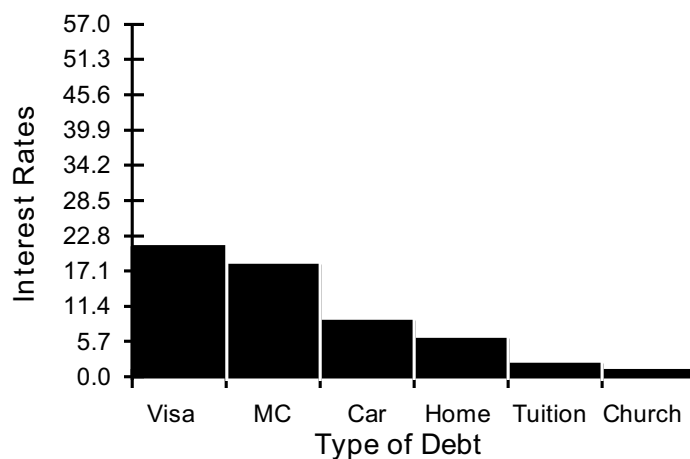
Category	Int. Rate (%)
Visa	21
Mastercard	18
Balance of car loan	9
Home improvement loan balance	6
School tuition (monthly installments)	2
Church pledge (monthly installments)	1

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VIEWGRAPH 7

## Pareto Chart Example

### Interest Rates on Outstanding Debts



LEGEND: INTEREST RATES CHARGED ON OUTSTANDING DEBTS AS OF 12 FEB 95.

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VIEWGRAPH 8



## How can we practice what we've learned?

Now let's practice constructing and interpreting Pareto Charts using the data provided for the scenario in each exercise. Analysis sheets and Pareto Charts are provided as answer keys.

EXERCISE 1: You are part of a team responsible for the quality of the BEQ/BOQ. You want to improve the service you provide but are not sure where to begin or where to concentrate your efforts. You decide to keep track of the complaints received over a three-month period. Viewgraph 9 records this data.

Rank order your data in an analysis sheet and draw a Pareto Chart.

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?

## Data on 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

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VIEWGRAPH 9

Now let's compare the analysis sheet and Pareto Chart you prepared for this exercise with Viewgraphs 10 and 11.

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.

## EXERCISE 1 ANALYSIS SHEET ANSWER KEY BEQ / BOQ Complaints

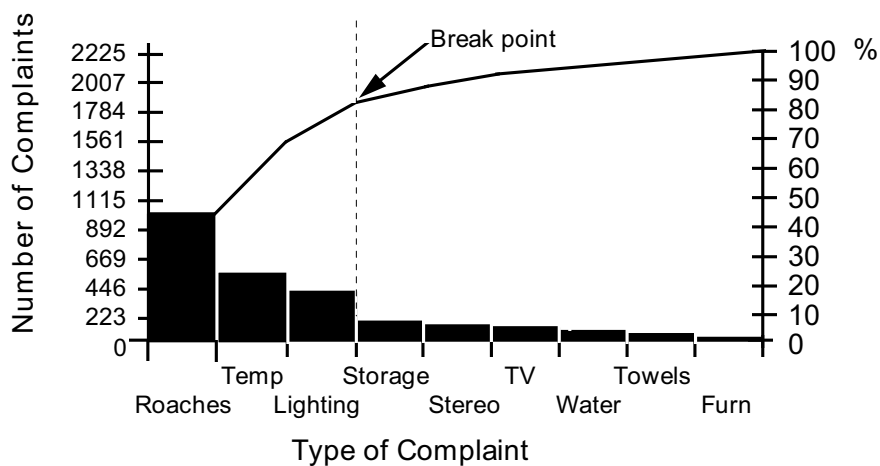
Category	Amount	Percent	Cum. % *
Cockroaches	962	43.2	43.2
Rooms too warm or cold	505	22.7	65.9
Inadequate lighting	350	15.7	81.6
Insufficient storage space	127	5.7	87.3
Loud stereo noise after 2300	97	4.4	91.7
Poor quality TV reception	83	3.7	95.4
Insufficient hot water	54	2.4	97.8
Towels too small and/or thin	32	1.4	99.2
Worn-out furniture	15	0.7	99.9
Total	2225		

\* Cumulative percent column does not equal 100% because of rounding.

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VIEWGRAPH 10

## EXERCISE 1 PARETO CHART ANSWER KEY BEQ / BOQ Complaints



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

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VIEWGRAPH 11

EXERCISE 2 - PART A: You are trying to improve safety in your unit. Lately, there seems to be a rash of injuries in the Maintenance Department. You decide to check out this perception by recording data by department for three months. Examining the matrix in Viewgraph 12, it appears that your perception is correct.

Order your data in an analysis sheet and draw a Pareto Chart for total unit injuries by department.

Now 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?

You can compare your analysis sheet and Pareto Chart with Viewgraphs 14 and 15.

Looking at your Pareto Chart, it appears that your suspicions are confirmed. Maintenance has the most injuries. You're ready to focus on the safety problems in that department. But wait a minute! What about that all-important sanity check?

EXERCISE 2 - PART B: What if you looked at the number of personnel assigned to each department? Here are those numbers:

Maintenance	200
Operations	10
Administration	10
Safety	5
Training	5

Dividing injuries by personnel assigned, your matrix now looks like Viewgraph 13.

Prepare a new analysis sheet and draw a Pareto Chart using this new information.

When you've completed it, see how it compares with Viewgraphs 16 and 17.

When the number of personnel in the various departments is considered, we can now see that Maintenance has the lowest injury rates. Perhaps we should look at our data from a different perspective. Any ideas?

## Data on 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

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VIEWGRAPH 12

## Data on 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

PARETO CHART

VIEWGRAPH 13

EXERCISE 2A ANALYSIS SHEET ANSWER KEY

Injuries by Department

Category	No. Injuries	Percent	Cum. % *
Maintenance	40	70.2	70.2
Operations	5	8.8	79.0
Admin	5	8.8	87.8
Training	4	7.0	94.8
Safety	3	5.3	100.1
Total	57		

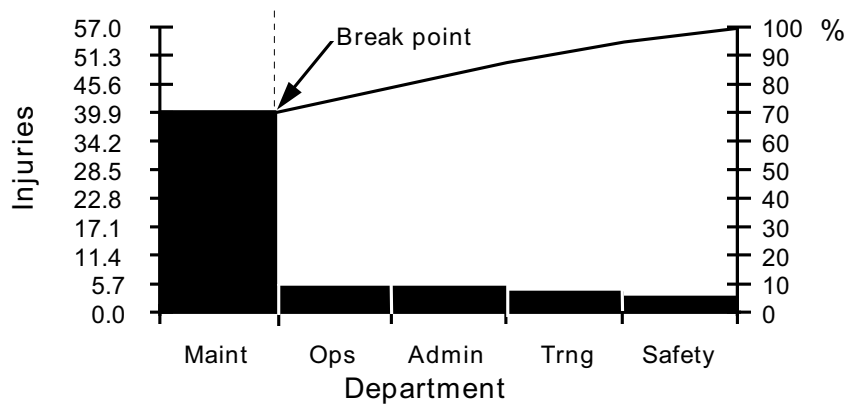
\* Cumulative percent column does not equal 100% because of rounding.

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VIEWGRAPH 14

EXERCISE 2A PARETO CHART ANSWER KEY

Injuries by Department



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

PARETO CHART

VIEWGRAPH 15

EXERCISE 2B ANALYSIS SHEET ANSWER KEY

Injuries by Personnel Assigned

Category	Injury Rate	Percent	Cum. % *
Safety	0.80	28.6	28.6
Training	0.80	28.6	57.2
Admin	0.50	17.9	75.1
Operations	0.50	17.9	93.0
Maintenance	0.20	7.1	100.1
Total	2.80		

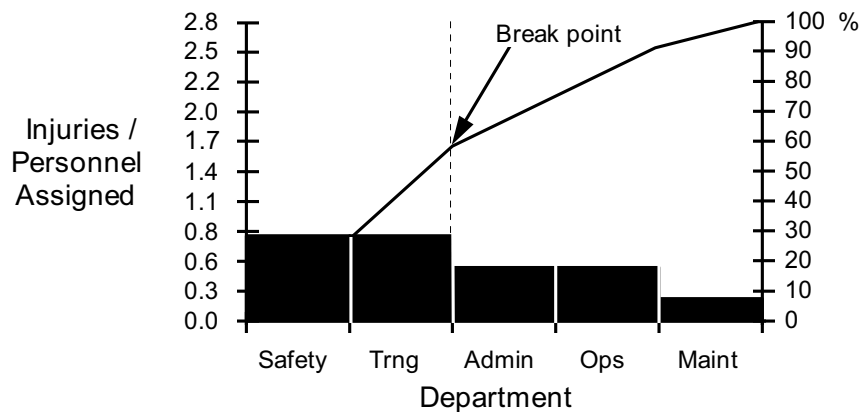
\* Cumulative percent column does not equal 100% because of rounding.

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VIEWGRAPH 16

EXERCISE 2B PARETO CHART ANSWER KEY

Injuries by Personnel Assigned



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

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VIEWGRAPH 17



EXERCISE 2 - PART C: One possibility is to explore the types of injuries.

Let's look at our first matrix again (Viewgraph 18).

Would the Pareto Principle apply if we analyzed our data based on the vertical columns?

Prepare an analysis sheet and draw a Pareto Chart.

Does this chart tell you anything?

## Data on 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

PARETO CHART

VIEWGRAPH 18

Compare your analysis sheet and Pareto Chart with Viewgraphs 19 and 20.

What you've probably noticed from the analysis is the impact of sports injuries on the unit. This would be a good place to focus your efforts to improve safety.

The Pareto Principle allows you to pursue your search for the best application of your time, energy, and dollars even further. For example, sports could be broken down into:

- > Types of sports
- > Types of injuries (back, ankle, head; fracture, sprain, bruise)
- > Age of persons injured
- > Use of protective equipment
- > Level of preparation (stretching)
- > Level of training for the sport

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.

EXERCISE 2C ANALYSIS SHEET ANSWER KEY

Injuries by Type

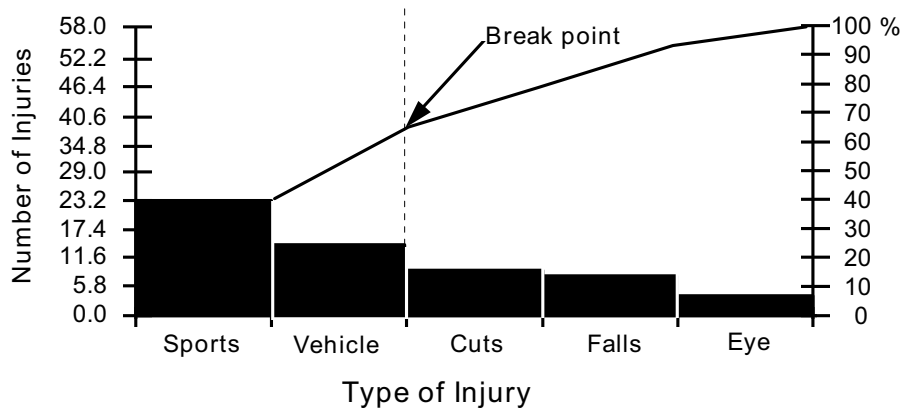
Category	No. Injuries	Percent	Cum. %
Sports	23	40.4	40.4
Motor vehicle	13	22.8	63.2
Cuts/abrasions	9	15.8	79.0
Falls	8	14.0	93.0
Eye injuries	4	7.0	100.0
Total	57		

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VIEWGRAPH 19

EXERCISE 2C PARETO CHART ANSWER KEY

Injuries by Type



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

PARETO CHART

VIEWGRAPH 20

EXERCISE 3: During your off-duty hours, you coach a little league team composed of eleven- and twelve-year-olds. The team has lost a couple of close ball games recently. You decide to look at the statistics from the games you have already played and see whether you notice any areas that require attention in your next few practices. Viewgraph 21 shows this data.

Order your data in an analysis sheet and create a Pareto Chart.

Now 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?

## Little League Yankees Stats

Type of Error	Number
Wild pitch	5
Missed fly ball to the outfield	29
Missed grounder	7
Missed pop fly to the infield	4
Missed coaching signal	5
Taken third strike	42
Throw to wrong cutoff player	25
Failure to back up the play	6
Passed ball	3

PARETO CHART

VIEWGRAPH 21

Now let's compare the analysis sheet and Pareto Chart you prepared with Viewgraphs 22 and 23.

Did analyzing your Pareto Chart show you some practical applications for the information you gathered and ranked?

1. When you analyzed your Pareto Chart, you could easily see the break point after the three items on the left, indicating that the Pareto Principle applies.
2. As a Little League coach, you can see the practical applications of this information. You and your assistant coaches need to spend more time during batting practice working on aggressively protecting the plate when there are two strikes; hitting fly balls to the outfielders and coaching them on fielding techniques; and teaching the outfielders to throw to the proper cutoff player.
3. Your Pareto Chart has given you reasonable answers. Based on the data, emphasis on these three areas would be time well spent and could make the difference in any future close ball games.

## EXERCISE 3 ANALYSIS SHEET ANSWER KEY Stats for Little League Yankees

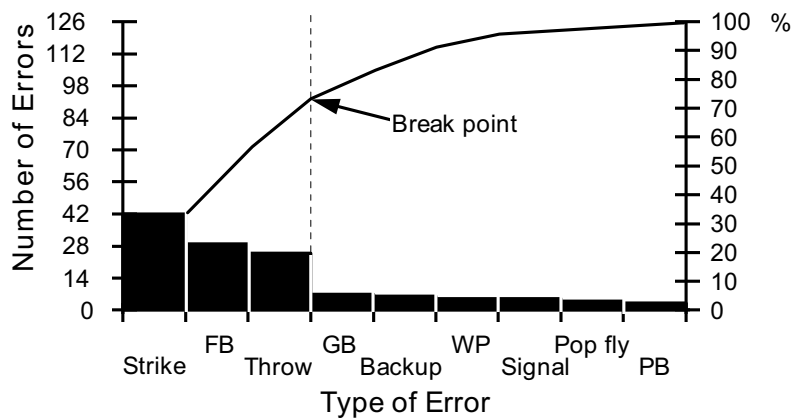
Type of Error	Number	Percent	Cum. % *
Taken third strikes	42	33.3	33.3
Missed fly balls	29	23.0	56.3
Throws to wrong cutoff player	25	19.8	76.1
Missed grounders	7	5.6	81.7
Failure to back up play	6	4.8	86.5
Wild pitches	5	4.0	90.5
Missed coaching signals	5	4.0	94.5
Missed pop flies	4	3.2	97.7
Passed balls	3	2.4	100.1
Total	126		

\* Cumulative percent column does not equal 100% because of rounding .

PARETO CHART

VIEWGRAPH 22

## EXERCISE 3 PARETO CHART ANSWER KEY Stats for Little League Yankees



LEGEND: ERRORS COMMITTED DURING FIRST FIVE GAMES OF SPRING SEASON 1995.

PARETO CHART

VIEWGRAPH 23



## REFERENCES:

1. Basic Improvement Tools. Madison, WI: Joiner Associates.
  - a. Instructor Guide, p. 13.
  - b. Workbook, p. 60.
2. Department of the Navy (November 1992). Fundamentals of Total Quality Leadership (Instructor Guide), pp. 6-35 - 6-42. San Diego, CA: Navy Personnel Research and Development Center.
3. Department of the Navy (November 1992). Introduction to Total Quality Leadership, pp. 6-18 - 6-19. Pensacola, FL: NET Program Management Support Activity.
4. Department of the Navy (September 1993). Systems Approach to Process Improvement (instructor Guide), pp. 4-26 - 4-39. San Diego, CA: OUSN Total Quality Leadership Office and Navy Personnel Research and Development Center.
5. Scholtes, P.R. et al (1988). The Team Handbook, p. 2-25. Madison, WI: Joiner Associates.