

AQS110 – Introduction to Quality and Metrology – Fall 2016
LABORATORY EXERCISE #6

SAMPLING AND ANALYSIS

Purpose

The purpose of this lab is to gather data and then display results.

Format

- Data collection will be recorded using the check sheets provided.
- The results shall be depicted using a histogram. The histogram can be constructed manually using the charts provided or in Microsoft® Excel.

Due Date

November 2, 2016 for completed graphs and questions.

Laboratory Exercise

The mixed beads represent a product batch. The white (or black) beads are the product as desired by the Customer. The colored beads represent different imperfections that occurred during processing. The activity will be completed in teams, using the check sheets attached to record the data and generating histograms.

Background

This exercise will introduce the use of checklists and creation of histograms. The experiment introduces how variability occurs and how data is then used to accept/reject product.

A. Check Sheets

A check sheet is a structured, prepared form for collecting and analyzing data. This is a generic tool that can be adapted for a wide variety of purposes.

When to Use a Check Sheet

- When data can be observed and collected repeatedly by the same person or at the same location.
- When collecting data on the frequency or patterns of events, problems, defects, defect location, defect causes, etc.
- When collecting data from a production process.

Check Sheet Procedure

- Decide what event or problem will be observed. Develop operational definitions.
- Decide when data will be collected and for how long.
- Design the form. Set it up so that data can be recorded simply by making check marks or Xs or similar symbols and so that data do not have to be recopied for analysis.
- Label all spaces on the form.
- Test the check sheet for a short trial period to be sure it collects the appropriate data and is easy to use.
- Each time the targeted event or problem occurs, record data on the check sheet.

Check Sheet Example

The figure below shows a check sheet used to collect data on telephone interruptions. The tick marks were added as data was collected over several weeks.

Telephone Interruptions

Reason	Day					Total
	Mon	Tues	Wed	Thurs	Fri	
Wrong number						20
Info request						10
Boss						19
Total	12	6	10	8	13	49

B. Histogram

A frequency distribution shows how often each different value in a set of data occurs. A histogram is the most commonly used graph to depict frequency distributions. It looks very much like a bar chart, but there are important differences between them.

When to Use a Histogram

- When the data are numerical (not attribute data such as pass/fail)
- When you want to see the shape of the data's distribution, especially when determining whether the output of a process is distributed approximately normally.
- When analyzing whether a process can meet the customer's requirements.
- When analyzing what the output from a supplier's process looks like.
- When seeing whether a process change has occurred from one time period to another.
- When determining whether the outputs of two or more processes are different.
- When you wish to communicate the distribution of data quickly and easily to others.

Histogram Analysis

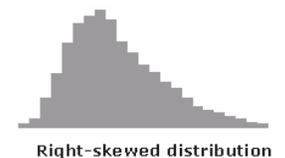
Before drawing any conclusions from your histogram, satisfy yourself that the process was operating normally during the time period being studied. If any unusual events affected the process during the time period of the histogram, your analysis of the histogram shape probably cannot be generalized to all time periods. Analyze the meaning of your histogram's shape:

Normal.

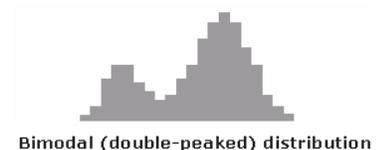
A common pattern is the bell-shaped curve known as the "normal distribution." In a normal distribution, points are as likely to occur on one side of the average as on the other. Be aware, however, that other distributions look similar to the normal distribution. Statistical calculations must be used to prove a normal distribution.

**Skewed.**

The skewed distribution is asymmetrical because a natural limit prevents outcomes on one side. The distribution's peak is off center toward the limit and a tail stretches away from it.



Double-peaked or bimodal. The bimodal distribution looks like the back of a two-humped camel. The outcomes of two processes with different distributions are combined in one set of data.



PROCEDURE**A. Data Collection**

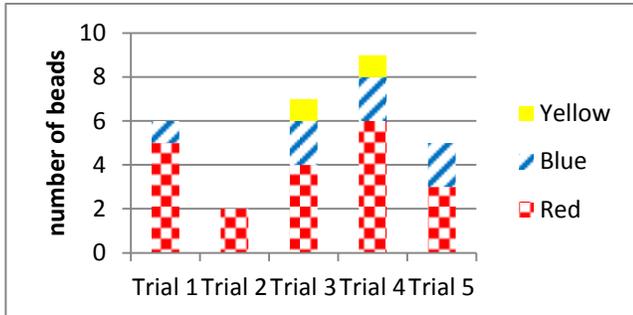
1. Each team will be provided two pans containing a mixture of colored beads, simulating a finished product batch. The percentage of each color is the same in all trays.
2. Each team will be provided with two paddles, one containing 20 holes and the other 50 holes.
3. Each student on the team will sample the product batch using each of the paddle(s) five times, with another student recording the results. When the first team member has completed the sampling operation, the second shall proceed, with another recording, until all team members have performed the sampling method.
4. **Sampling Method**
 - a. Begin by mixing the product batch. Slowly stir the beads using the paddle.
 - b. Select one of the paddles and dip it into the bead mixture, be sure to go deep enough to ensure all beads have a chance to be sampled.
 - c. Lift the paddle out of the beads and allow the extras (those not trapped in a hole) to flow back into the tray.
Note: prior to counting the results, all holes must be filled. If necessary, re-dip the paddle into the bead mixture.
 - d. Record the color combination as indicated on the check sheet (page 6)
 - i. Count and record number of white/black
 - ii. Count and record number of red
 - iii. Count and record number of blue
 - iv. Count and record number of yellow
 - e. Return sample to the batch and stir with paddle.
 - f. Select second paddle and repeat steps c through f.
 - g. Next team member then repeats the sampling process beginning with mixing step “a” and continuing through h.
 - h. Repeat until all team members have performed the sampling process once.
 - i. Each student then takes a second, third, fourth and fifth sample, repeating a through h.
5. Once the sampling has been completed, verify that each team member has a completed check sheet with data.

B. Data Analysis

1. Complete the check sheet (page 6)
 - a. total the red/blue/yellow beads for each trial
 - b. calculate the percentage of white beads (record to 1 decimal place, i.e. 91.5%)
 - c. draw a circle around the smallest percentage of white beads (this is the minimum)
Note: if the minimum value appears more than once, circle it only once.
 - d. draw a square around the largest percentage of white beads (this is the maximum)
Note: if the maximum value appears more than once, draw a square around only one.
 - e. calculate the range by subtracting the minimum from the maximum, record this value in the space provided.
2. Two graphs per sample paddle will be created and these have been included on pages 7 & 8. You can also choose to create the graphs in Excel[®]. The instructions below describe manual creation of the graphs.
 - a. First will be a stacked bar graph depicting the number of red/blue/yellow beads counted in each trial
3. Second will be a histogram showing the distribution of % white beads.
4. Constructing the stacked bar graph (page 7)
 - a. The x-axis will be the individual trial (1, 2, 3, 4, 5)
 - b. The y-axis will be the bead count. Be sure to label the axis “bead count”
 - c. First, using a red pencil, draw a bar up to the number recorded.
 - d. Second, using a blue pencil and starting at the top of the red bar, add the number of blue recorded.

- e. Third, using a yellow pencil and starting at the top of the blue bar, add the number yellow recorded.
- f. The stacked bar should end at the number corresponding to the “total red/blue/yellow” recorded on the data sheet.

EXAMPLE:

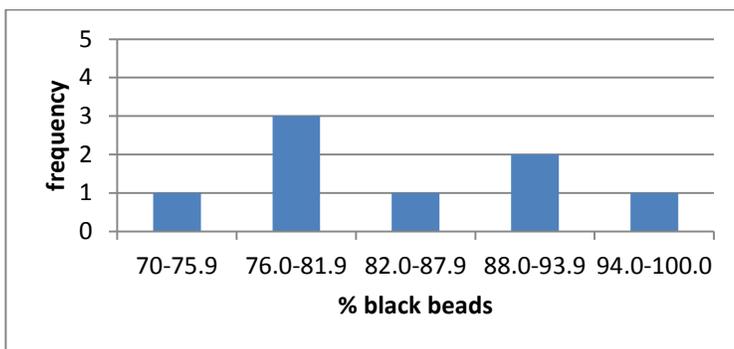


5. Constructing the histogram (page 8)
 - a. To determine the x-axis divisions
 - i. Calculate the range of “% black (or white) beads” recorded.
 - ii. The lowest and highest percentages will be the starting and ending number for your graph.
 - iii. Next divide the axis into 5 equally spaced “buckets”, by dividing the range calculated in step a by 5.
 - b. The y-axis will be from 0 to 5, in whole numbers
 - c. Draw x- and y-axes on graph paper
 - d. Mark and label the y-axis for counting data values. Label this axis “frequency”
 - e. Mark and label the x-axis with the values calculated in step 4.a. Label this axis “% black / white beads”
 - f. For each data point mark off one count above the appropriate “bucket” with an X or by shading that portion of the bar.

EXAMPLE: % black beads ranged from 70% to 100%

Range = 30%, divided by 5 each bucket would then be 6%

the x-axis “buckets” would be: 70.0-75.9% 76.0-81.9% 82.0-87.9% 88.0-93.9% 94.0-100.0%



Post Lab Questions

- Compare the minimum/maximum and range of % white/black beads among team members
 - Were they similar? Describe.

- What was the smallest minimum and largest maximum % for the team

- For the 20 paddle: _____
- For the 50 paddle: _____

- Additional sources of information

<http://asq.org/learn-about-quality/data-collection-analysis-tools/overview/histogram.html>
<http://asq.org/learn-about-quality/data-collection-analysis-tools/overview/check-sheet.html>

Google these topics (histogram and checklist) and bring two examples to class that show the use of these tools. Share with the class your examples and explain what the information you gather from these examples.

- The sampling method could be improved. How? [what worked, what didn't] Utilize the principles discussed in class regarding measurement fundamentals, inspection criteria and sampling logistics.

- Did the percentage of white/black change depending on the paddle size? Why? Or Why not?

- The sample paddles represent “normal” and “reduced” sampling, per the ANSI ASQ Z1.9 Attribute Sampling Plan. For each trial compare your results to the specification, discuss Consumer and Producer risk.

Name _____

PROCESS VARIABILITY – DATA COLLECTION SHEET

Inspector _____ Date Inspection Conducted _____
Print name and initial

Specification: Yellow – 0 Blue - 2 maximum Red – 5 maximum

Color	Sampling Paddle - 50 holes (normal)				
	Paddle ID# _____				
	Trial 1	Trail 2	Trial 3	Trial 4	Trial 5
White / Black					
Red					
Blue					
Yellow					
% White / Black <small>(number of white(black) / 50) * 100%</small>					

Minimum % _____ Maximum % _____

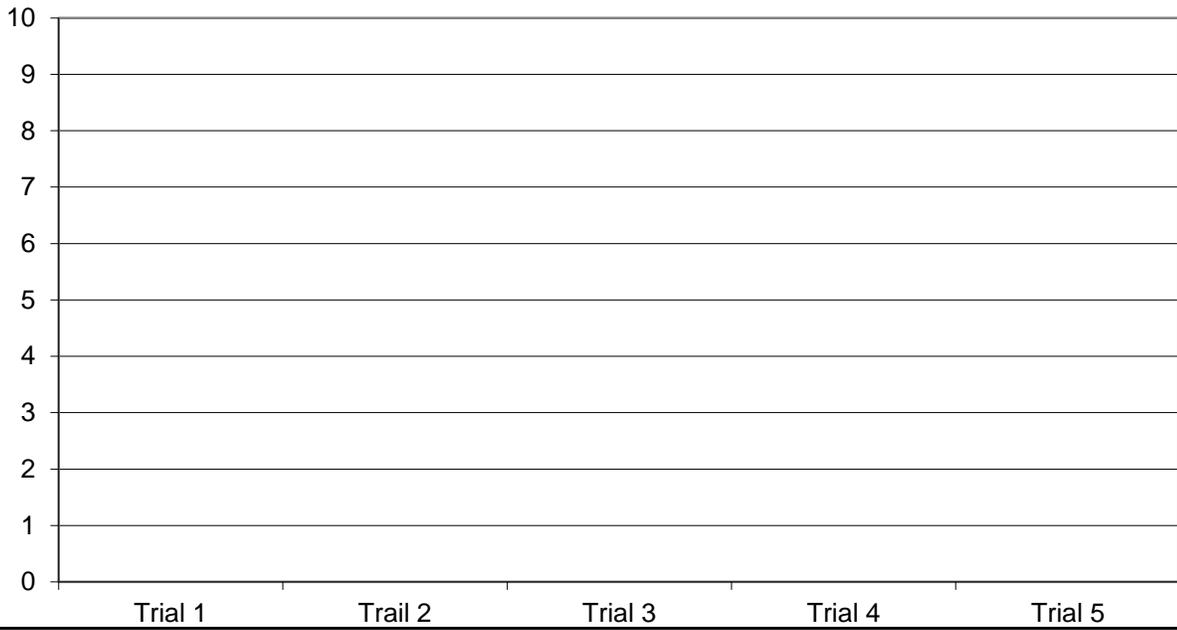
Range % White/Black – 50 hole paddle: _____

Color	Sampling Paddle - 20 holes (normal)				
	Paddle ID# _____				
	Trial 1	Trail 2	Trial 3	Trial 4	Trial 5
Black / White					
Red					
Blue					
Yellow					
% Black / White <small>(number of black (white) / 20) * 100%</small>					

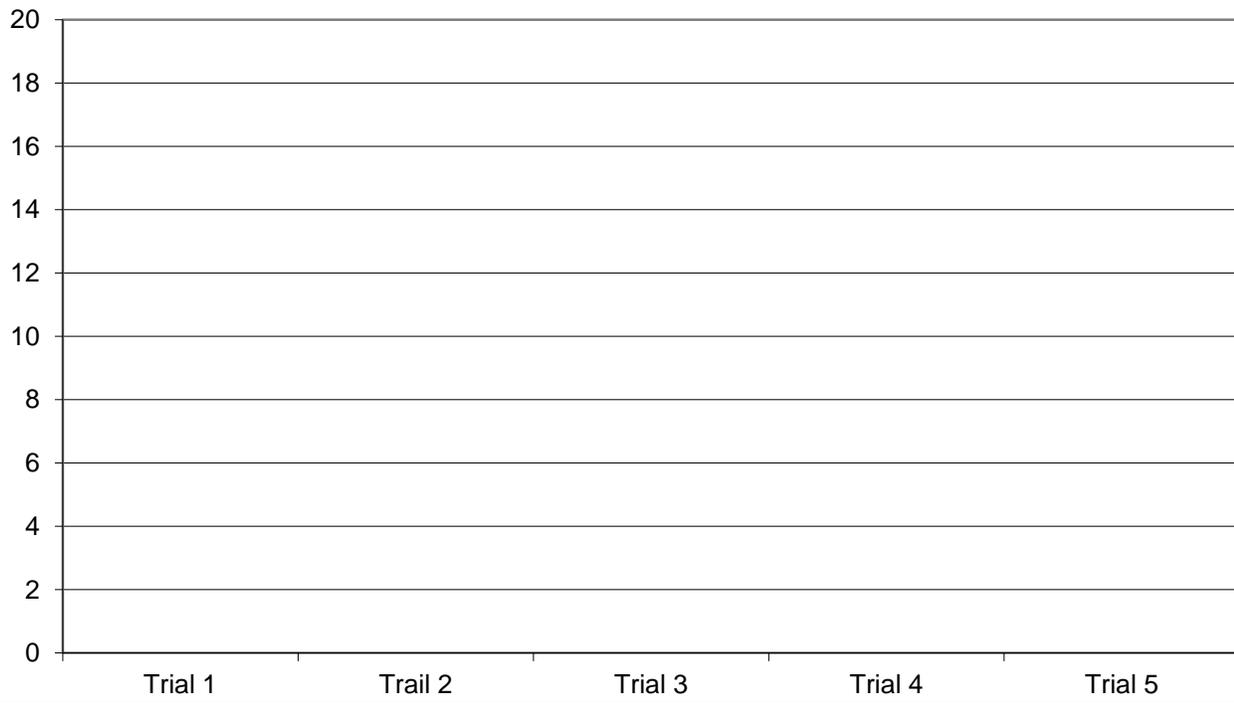
Minimum % _____ Maximum % _____

Range % Black (white) – 20 hole paddle: _____

Red/Blue/Yellow - 20 Hole paddle

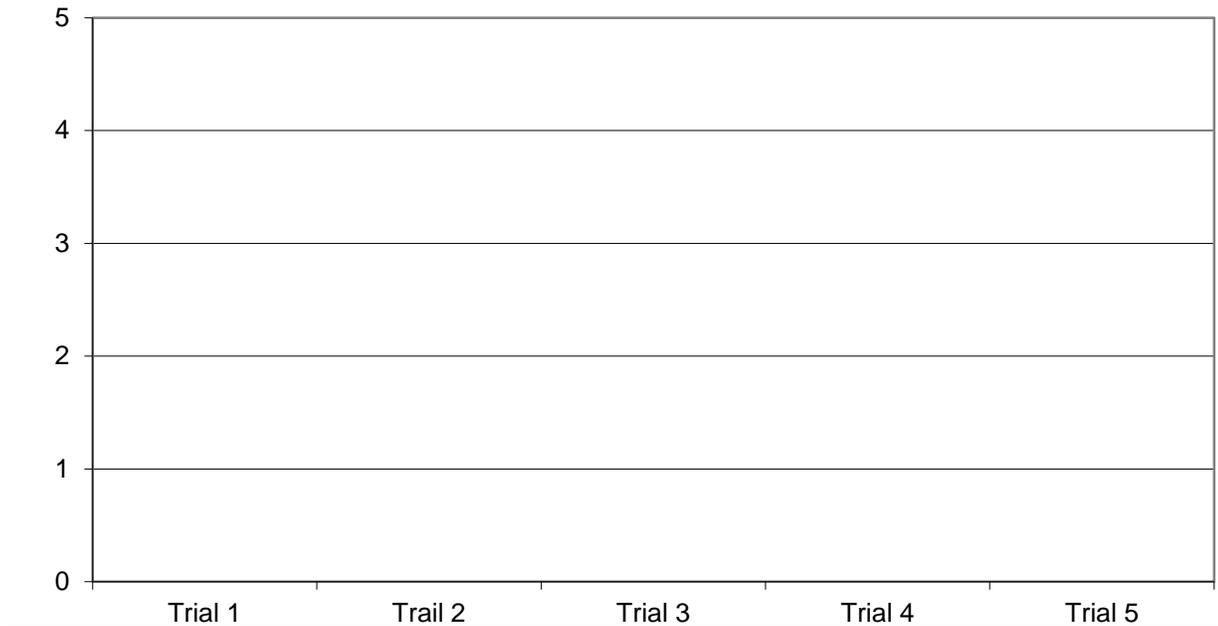


Red/Blue/Yellow - 50 Hole paddle

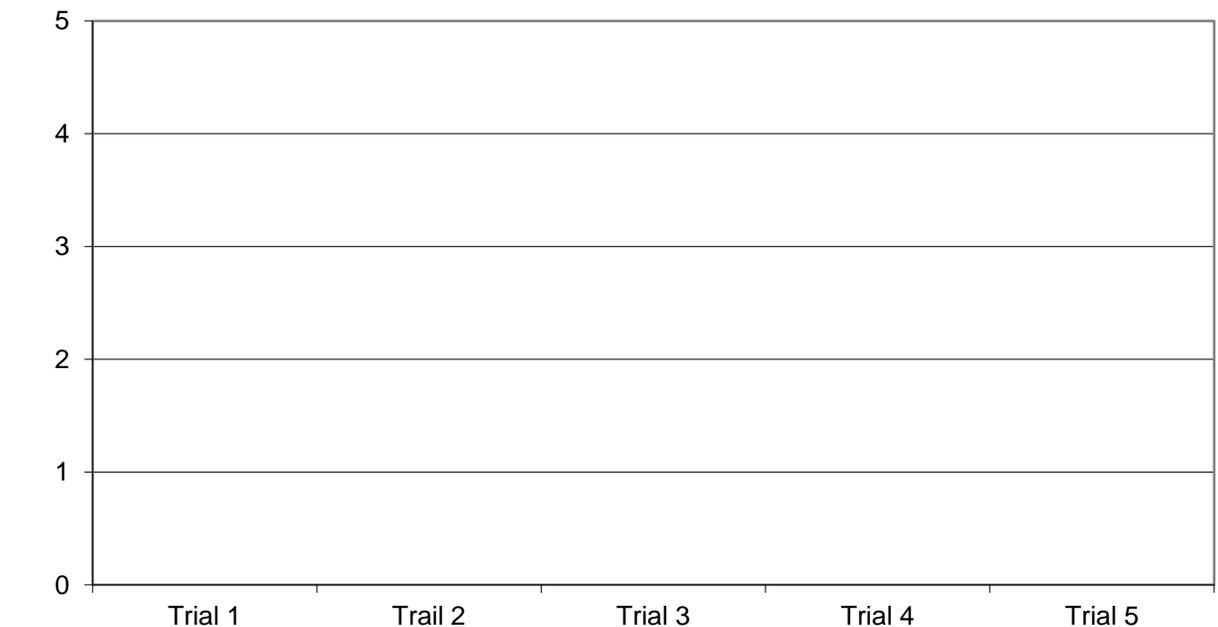


Histogram – 20 holes

(Note: when constructing your graph, cross out “Trial” and replace this with the “bucket ranges” determined based on the data, step 4 page 4)

Histogram – 50 holes

(Note: when constructing your graph, cross out “Trial” and replace this with the “bucket ranges” determined based on the data, step 4 page 4)



Insert Tab

EXCEL GRAPHING SCREEN SHOTS

The screenshot shows the Microsoft Excel interface with the 'Insert' tab selected. The 'Charts' group in the ribbon is highlighted with a blue box. A blue arrow points from a box labeled 'Chart Types' to this group. Below the ribbon is a data table with columns for Name, group, Paddle, count, trial, and various colored categories (red, blue, yellow, white, 2-red, 2-blue, 2-yellow, 2-white, 3-red, 3-blue, 3-yellow, 3-white, 4-red, 4-blue, 4-yellow, 4-white, 5-red, 3-blue, 3-yellow, 3-white). The table includes a 'Grand Tot' row at the bottom. The status bar at the bottom shows 'Ready', 'data', and '100%' zoom.

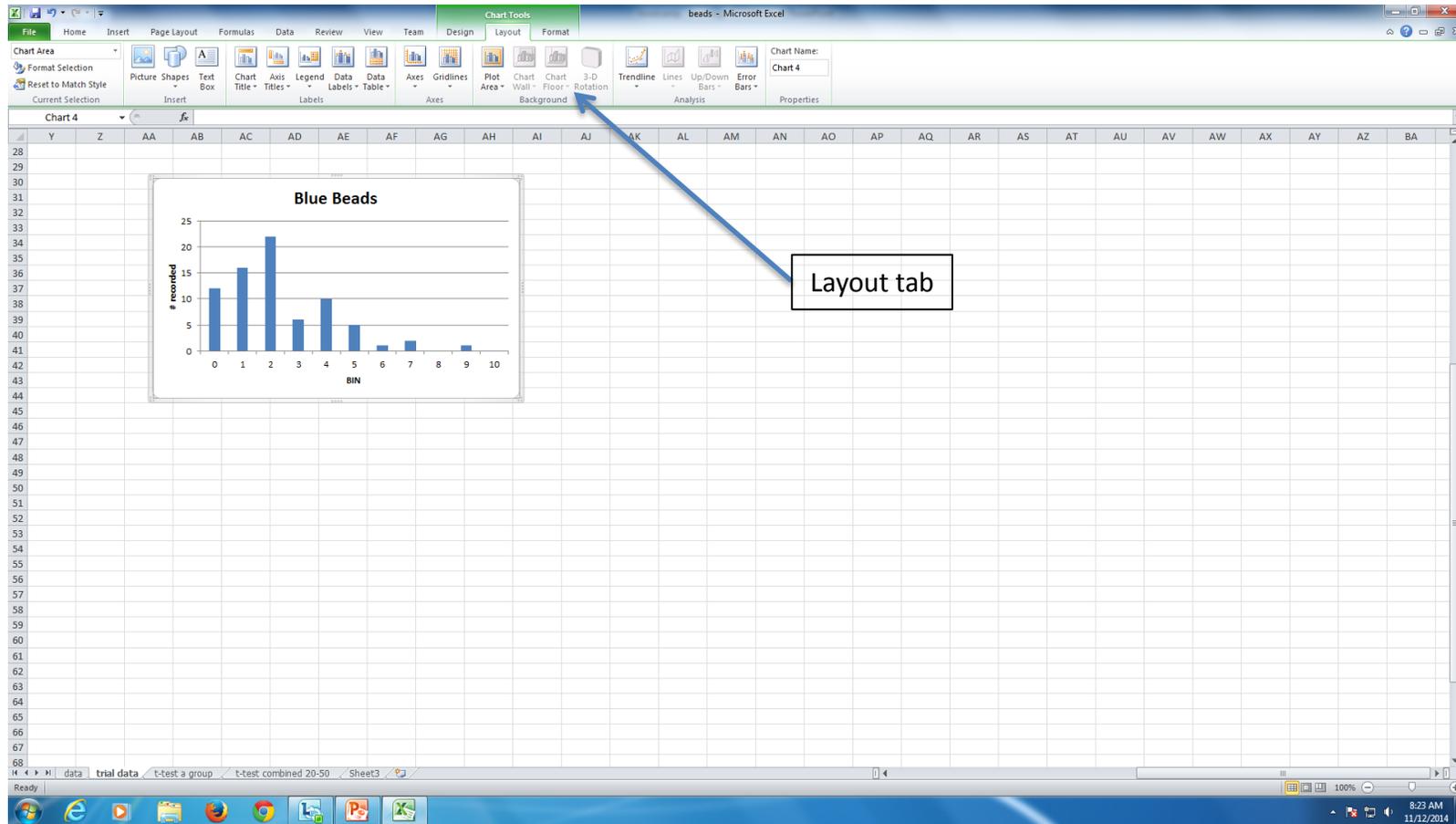
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	
1	Name	group	Paddle	count	trial	red	blue	yellow	white	2-red	2-blue	2-yellow	2-white	3-red	3-blue	3-yellow	3-white	4-red	4-blue	4-yellow	4-white	5-red	3-blue	3-yellow	3-white				
2	cindy	A		20	1	1	0	1	0	19	1	0	0	19	0	2	0	18	1	2	0	17	0	2	0	18		Sum of co Group	
3	Nydia	A		50	1	1	0	2	0	48	1	2	1	46	1	2	0	47	0	2	0	48	0	9	0	41		Paddle: A	
4	Nina	B		50	1	1	0	4	0	46	0	3	1	46	1	1	1	47	3	4	0	43	0	5	1	44		20	
5	cindy	B		50	1	1	1	2	0	47	0	4	0	46	1	4	1	44	0	2	1	47	1	5	0	44		50	
6	don	B		50	1	1	0	4	1	45	1	3	0	47	1	2	1	46	2	3	0	45	0	3	0	47		Grand Tot	
7	mixed	b		20	1	1	0	2	1	1	0	0	0	20	2	2	0	16	1	2	0	17	1	0	1	18			
8	amanda	a		50	1	1	1	3	2	44	1	4	0	45	0	5	0	45	0	7	0	43	0	5	0	45			
9	mariane	a		50	1	1	1	1	3	45	0	7	0	43	0	5	1	44	1	1	0	48	3	4	0	43			
10	ian	a		50	1	1	2	2	0	46	0	1	1	48	0	6	0	44	1	3	1	45	1	2	1	46			
11	dan	b		20	1	1	0	1	0	19	0	2	0	18	0	1	0	19	0	0	0	20	1	0	1	18			
12	th	b		20	1	1	1	1	1	17	1	1	0	18	0	4	1	15	0	1	1	18	0	2	0	18			
13	sa	b		20	1	1	0	0	0	20	0	2	0	18	0	0	0	20	0	0	0	20	3	1	1	1	16		
14	sam	a		20	1	1	1	0	0	19	2	0	0	18	0	2	0	18	2	4	0	14	1	1	0	18			
15	rosemary	a		20	1	1	0	2	0	18	0	1	0	19	0	2	0	18	0	0	0	20	0	4	0	16			
16	jessica	a		20	1	1	0	1	1	18	0	0	0	20	0	2	0	18	1	1	0	18	1	1	0	18			

Chart Types

The screenshot shows the Microsoft Excel interface with a bar chart titled "Blue Beads". The chart displays the number of recorded beads for each bin (0-10). The y-axis is labeled "# recorded" and ranges from 0 to 25. The x-axis is labeled "BIN" and ranges from 0 to 10. The data points are approximately: (0, 12), (1, 16), (2, 22), (3, 6), (4, 10), (5, 5), (6, 1), (7, 2), (8, 0), (9, 1), (10, 0).

The Chart Tools ribbon is visible, with the Design, Layout, and Format tabs. A blue arrow points from the Format tab to a text box that defines the components of Chart Tools:

CHART TOOLS
Design – what type of graph
Layout – how to position text, etc.
Format – colors, fonts, ect.



The screenshot shows the Microsoft Excel interface with the 'Chart Tools' ribbon active. A bar chart titled 'Blue Beads' is displayed on the worksheet. The chart has a vertical axis labeled '# recorded' ranging from 0 to 25 and a horizontal axis labeled 'BIN' ranging from 0 to 9. A right-click context menu is open over the chart area, listing various actions. Two callout boxes with arrows point to specific menu items: 'Change Chart Type...' is labeled 'Same as design tab', and 'Format Chart Area...' is labeled 'Same as format tab'. The Excel ribbon shows the 'Design' and 'Format' tabs, and the status bar at the bottom indicates the current sheet is 'Sheet3'.

BIN	# recorded
0	12
1	16
2	22
3	6
4	10
5	5
6	1
7	2
8	0
9	1

Right mouse button display