GRAPHMANSHIP AND GRAPHING GRAMMAR: THE ART AND SCIENCE OF GOOD GRAPHING
Graphing guidelines for the Walla Walla College School of Engineering

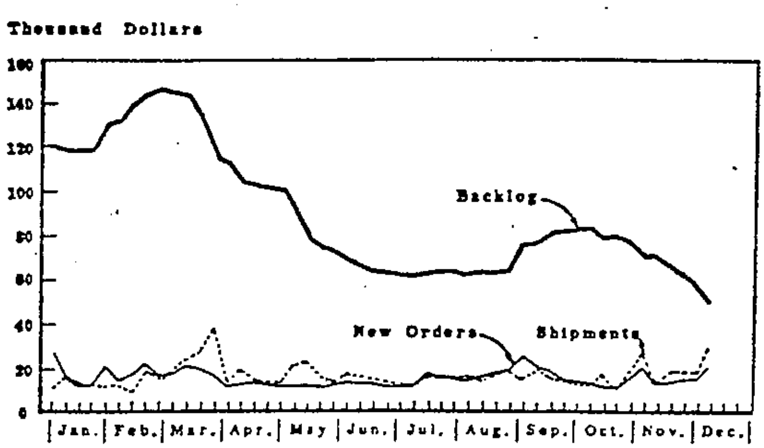
FOREWORD

A graph, like a picutre, is worth a thousand words. A good graph is like a well written editorial in that it is designed to communicate an idea (or at most a few ideas) to the reader with the least effort required by the reader to get the idea (or ideas). These guidelines will provide information to aid in the production of good graphs.

I. THE EFFICIENCY OF A GRAPH TO COMMUNICATE IDEAS

The table below and the graph contain the same information. After comparing the two it is very clear that the information is communicated much more efficiently by the graph!

Weeks	New Orders	Shipments	Backlog
1	$34,319	$11,415	$120,845
2	12,960	14,203	119,830
3	12,100	12,402	119,318
4	12,230	12,073	119,773
5	21,100	10,779	130,714
6	12,963	11,905	131,774
7	17,914	9,642	140,146
8	22,212	18,080	144,278
9	16,126	13,782	146,642
10	17,130	18,372	145,200
11	21,224	23,063	143,442
12	19,134	26,436	134,340
13	16,001	37,343	115,076
14	11,213	13,619	112,670
15	11,962	19,947	104,633
16	12,402	14,696	103,341
17	13,111	12,390	102,063
18	10,329	12,143	100,317
19	10,721	30,736	90,302
20	11,420	23,580	78,042
21	11,306	15,046	74,302
22	11,904	13,225	72,981
23	13,416	17,731	68,666
24	13,333	15,738	66,261
25	12,470	14,791	64,100
26	11,220	12,270	63,050
27	11,338	12,309	62,100
28	11,441	11,561	61,980
29	14,688	15,643	62,025
30	13,843	14,678	63,990
31	14,400	14,328	64,062
32	12,926	13,946	63,042
33	14,447	13,062	63,647
34	14,440	14,391	63,716
35	12,897	18,417	64,196
36	21,334	14,368	73,372
37	20,002	18,349	77,843
38	18,389	14,736	80,616
39	14,443	14,023	81,038
40	12,212	11,063	82,197
41	12,196	13,057	83,336
42	11,778	14,198	78,916
43	11,442	16,478	82,108
44	13,923	18,261	77,772
45	20,449	27,400	71,026
46	12,336	13,431	70,217
47	12,312	18,030	63,499
48	14,121	18,303	61,117
49	14,365	17,426	58,061
50	30,338	38,160	48,317



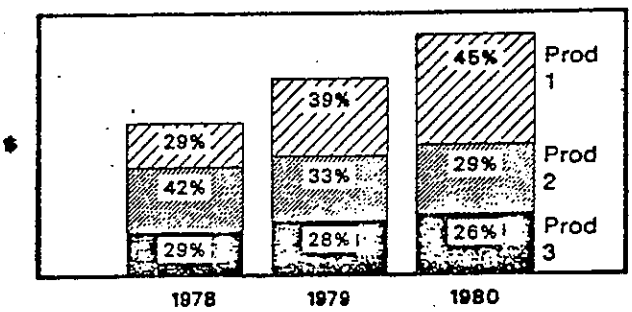
II. TYPES OF GRAPHS

The graph presented in the last section is a line graph which is the most common type of graph used in scientific and technical communication. The line graph shows the functional relationship of one variable to another. The independent variable is plotted on the horizontal axis and the dependent variable is plotted on the vertical axis. The graph may contain mulitple curves where each curve is some function of the same independent variable.

Other basic graph types are named and shown below. While these basic types are most common, actually the types and styles of graphs are seemingly unlimited. The basic forms can also be combined in many different ways to best suit the needs of the particular communication to be achieved.

To produce a good graph one must choose the graph type that best suits the nature of the data and the ideas to be communicated.

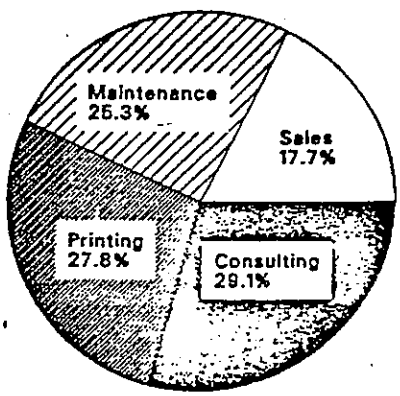
Bar Graph



Bar graph comparing growth and distribution of a product over time. Note that product 1 provided the most growth but all products grew.

Bar graphs are used to compare a group of "somethings" with respect to some independent variable which is usually discrete like the year in the example.

Pie Chart



Pie chart showing how the costs of a printing company are distributed.

Pie charts are ideal to show the "part of a whole" relationship of several items. All items making up the whole must be shown.

graph and should be placed near the graph title. The second type of annotation contains information giving test conditions of otherwise variable quantities which were held constant while the data determining the curves were obtained. This information should be placed on the graph page in an open space near the curves so the reader will know that this data is applicable to these specific curves. Often simple diagrams (such as circuits, test specimen shape, etc.) may be placed on the graph to help identify the data and clarify the information presented by the graph.

Coordinate axes

The coordinate axes consists of two mutually perpendicular lines graduated with tic marks which permit a given point on the graph page to be located by means of coordinate data. The horizontal axes, known as the abscissa, is parallel to the bottom of the page when it is placed in the normal position for reading. It is customary to plot the coordinate of the independent variable along the abscissa axis. There are exceptions to this rule, for example, in stress-strain curves strain which is depenedent on stress is always plotted on the abscissa axis. The ordinate axis is parallel to the left edge of the page and is used to plot one or more dependent variables.

The origin (coordinates are 0,0) is formed by the intersection of the coordinate axes and normally should be shown on the graph. If it is omitted the reader cannot see the lengths represented by each variable and hence important graphical information is lost. If it is desired to expand the scale to enlarge a section of the graph a portion of the scale may be omitted providing it is clearly indicated by a break mark and/or a note to that effect.

Scale graduations and labeling

The scales should be chosen so as to best represent the nature of the data. For example, if a quantity is essentially constant, this should be evident from inspection of the curve. It is misleading to expand the scale so that small variations from one point to another are exaggerated. The scale graduations (using tic marks) should be chosen so that the scale is easily read for quick determination of decimal values. Each major tic interval should be easily divided into ten. Hence use tic intervals that are multiples of 1, 2, 5 or 10. Mark scale numbers at major tic intervals which in general should be about one inch apart. Minor tic marks may be used to subdivide the scale to make it easier to read coordinates. The minor tic marks should divide the major tic intervals into either 2 or 5 subintervals.

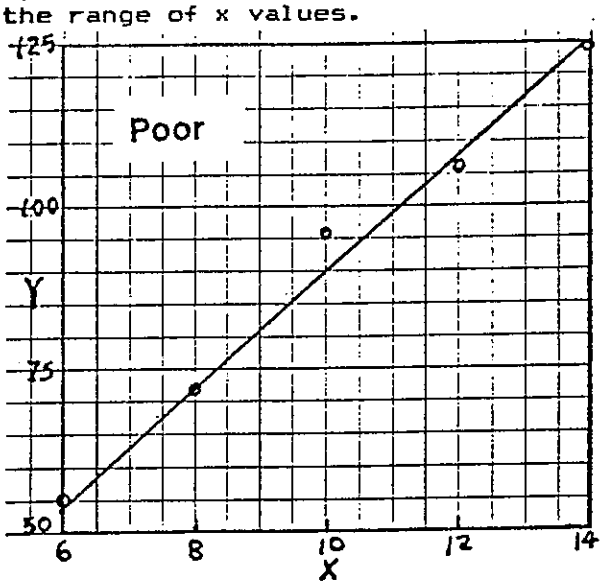
Each axis is to be identified with a label which is descriptive of the variable plotted on that axis. The label may be a caption describing the variable or it may be a symbol representing the variable. In either case units are to be included unless the variable is dimensionless.

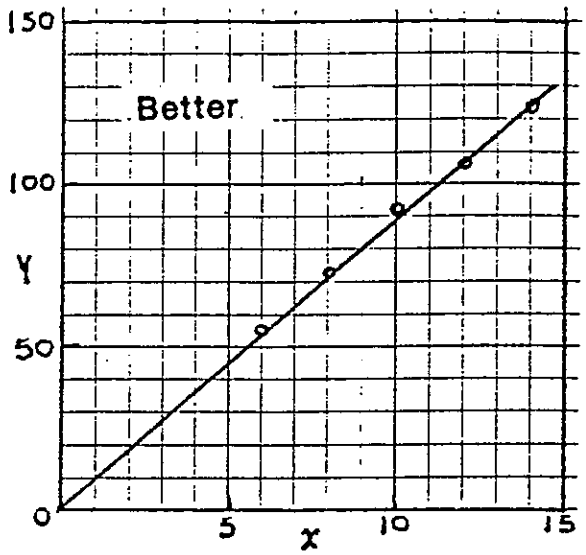
When mulitiple curves are plotted on the graph the vertical scale may represent several variables. In the case of hand drawn graphs the right

Guiding Rules for the Production of Good Line Graphs

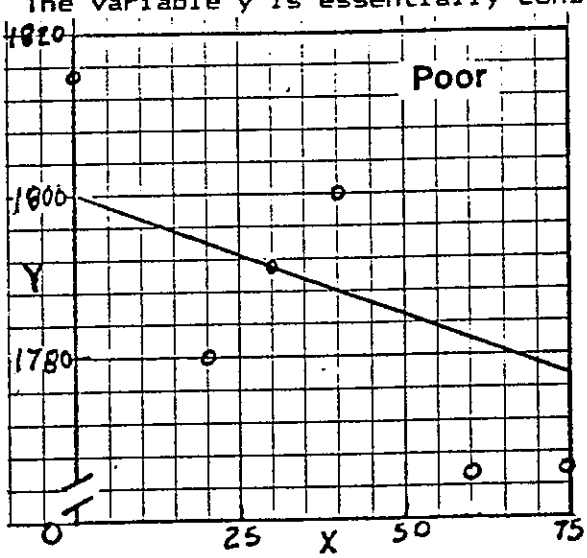
1. Select the origin and the ranges on each axes to emphasize the ideas to be communicated.

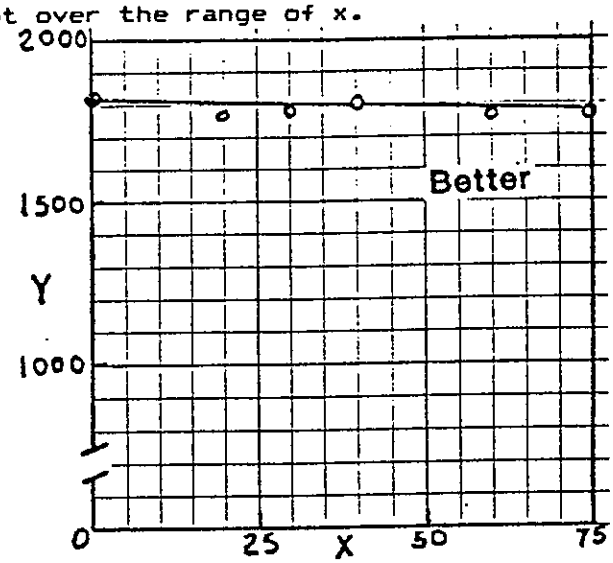
Example 1 - Ideas to communicate: A set of measured data is modeled by a function of the form $y = ax$ with an error of less than 2% over the range of x values.



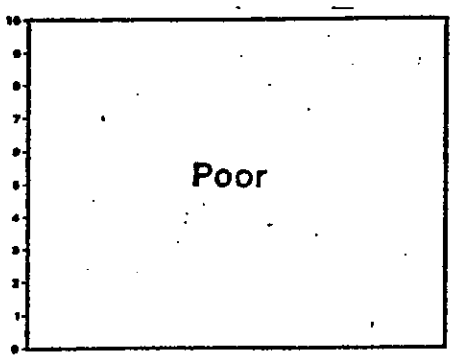


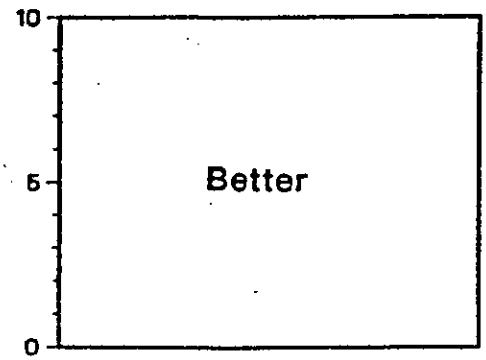
Example 2 - Ideas to communicate: A set of measured data is modeled by a function of the form $y = a + bx$ with an error of less than 1%. The variable y is essentially constnt over the range of x.





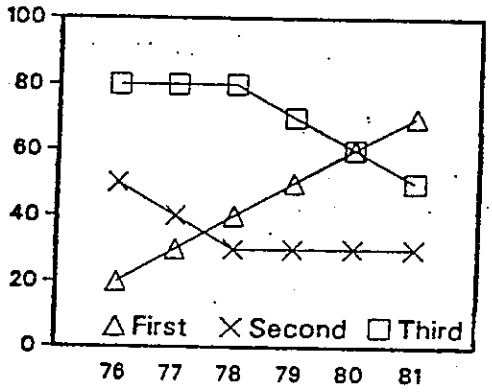
2. Label axes scales with numbers that are large enough to read and not too densly distributed (too many numbers gives a cluttered appearance). Label the axes with numbers every inch (or every 2 cm) is a good spacing for axes numbers.



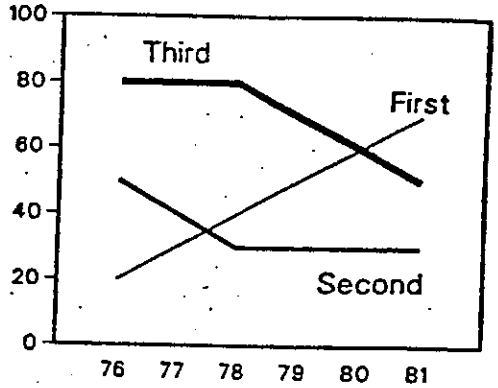


6. Label the curves providing there is room on the graph.

Poor

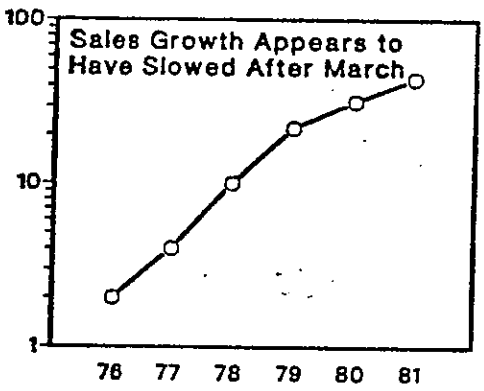


Better

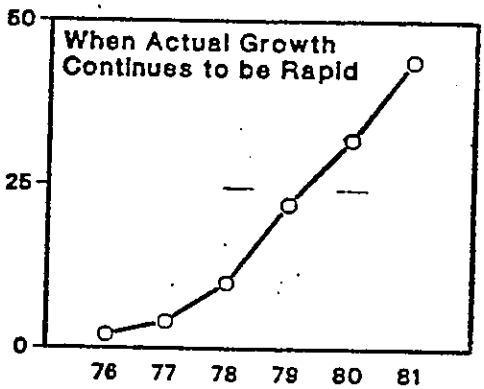


7. Be careful in choosing logarithmic axis scales (avoid this scale type for readers who may not understand the logarithmic scale).

Poor

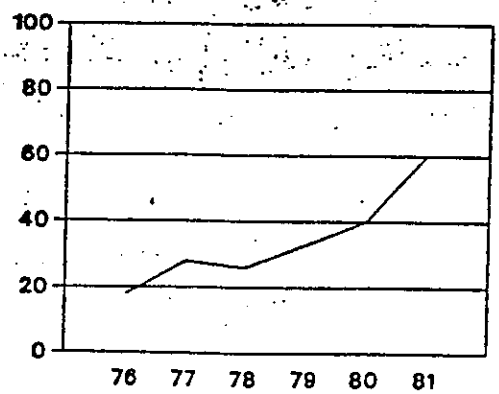


Better

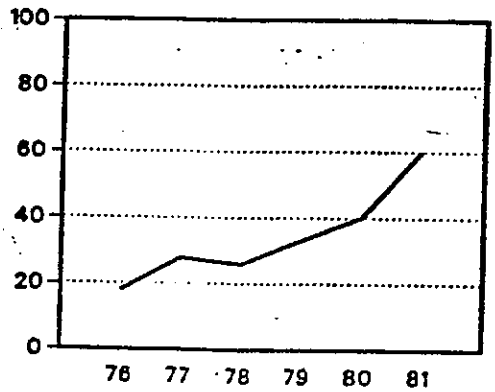


8. Do not use graticule (grid lines) that are as heavy (emphasized) as the lines representing the curves of the the graph.

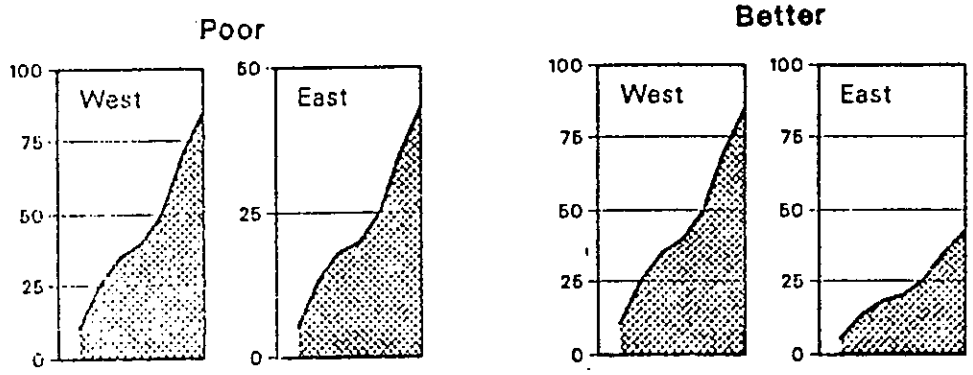
Poor



Better

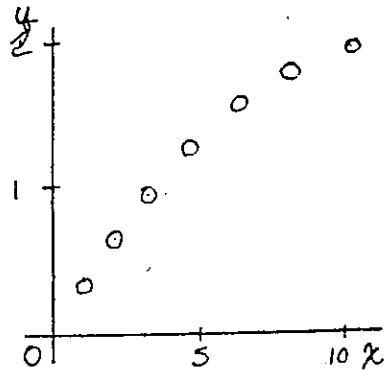


12. Use the same scales when you use multiple graphs to compare trends.

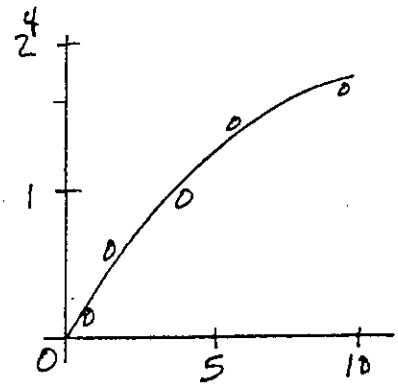


13. Draw best-fitting curves to depict variables that are inherently continuous. Point symbols represent sampled (or measured) data. Use a French curve or a ship curve if the graph is hand-drawn.

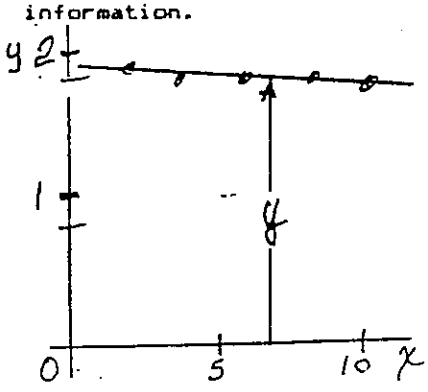
y is a discrete variable

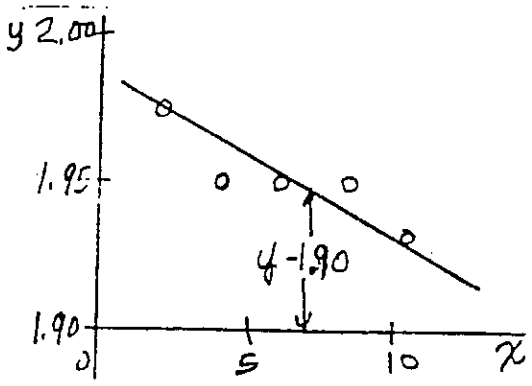


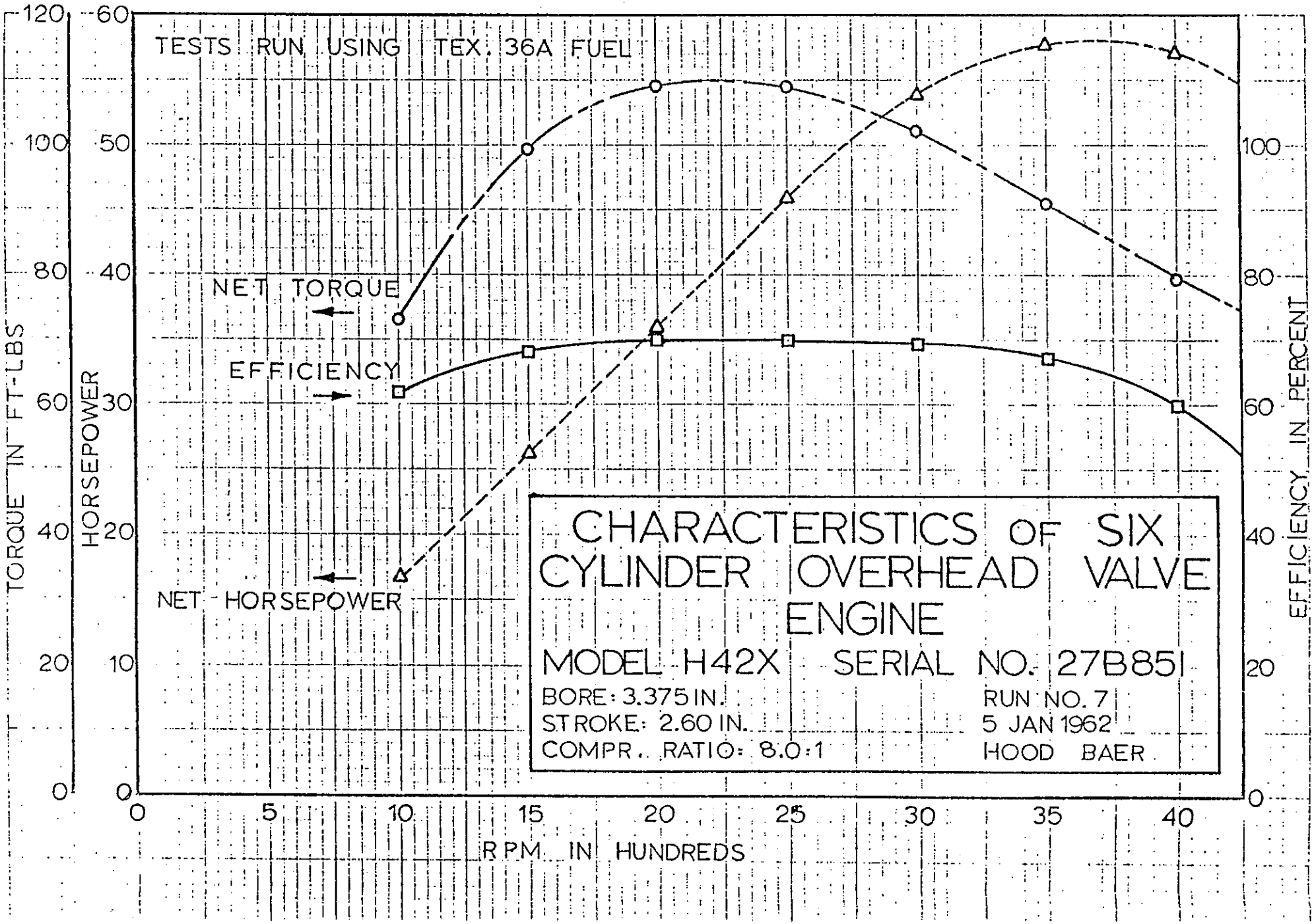
y is a continuous variable



14. Do not omit the origin unless you want to show how a change in a dependent variable varies with respect to the independent variable. The graph on the left below shows that y drops about 7% as x increases from 0 to 10. The graph on the right contains the same information. It does not show how y varies with x but rather how y-1.9 varies with x. It takes the reader extra interpretation to see from the second graph that y changes about 7% as x varies from 0 to 10. There are few cases when a portion of a scale should be deleted. Omitting the origin always throws away graphical information.

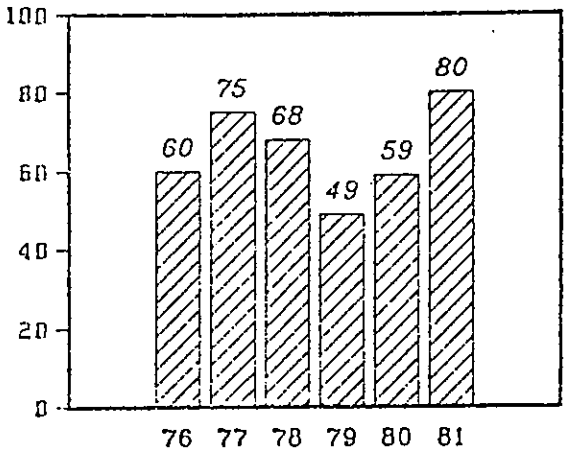




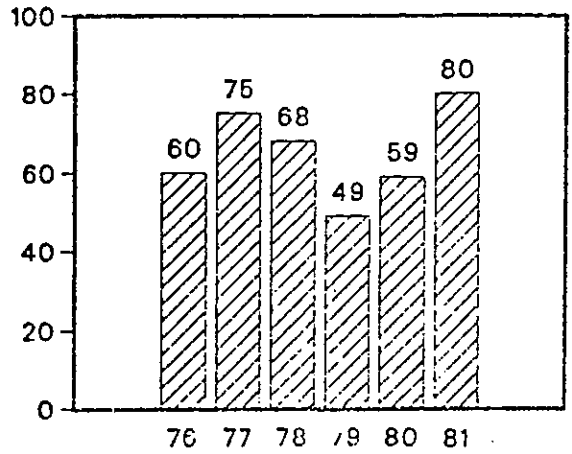

TESTS RUN USING TEX. 36A FUEL
NET TORQUE
EFFICIENCY
NET HORSEPOWER
CHARACTERISTICS OF SIX CYLINDER OVERHEAD VALVE ENGINE
MODEL H42X SERIAL NO. 27B851
BORE: 3.375 IN.
STROKE: 2.60 IN.
COMPR. RATIO: 8.0:1
RUN NO. 7
5 JAN 1962
HOOD BAER
TORQUE IN FT-LBS
HORSEPOWER
EFFICIENCY IN PERCENT
RPM IN HUNDREDS
0
10
20
30
40
50
60
80
100
120
5
15
25
35

4. Use a single family of type style on a chart; try to maintain consistency of type stiles from chrt to chart in a presentation. Simple sans-serif fonts are preferable.

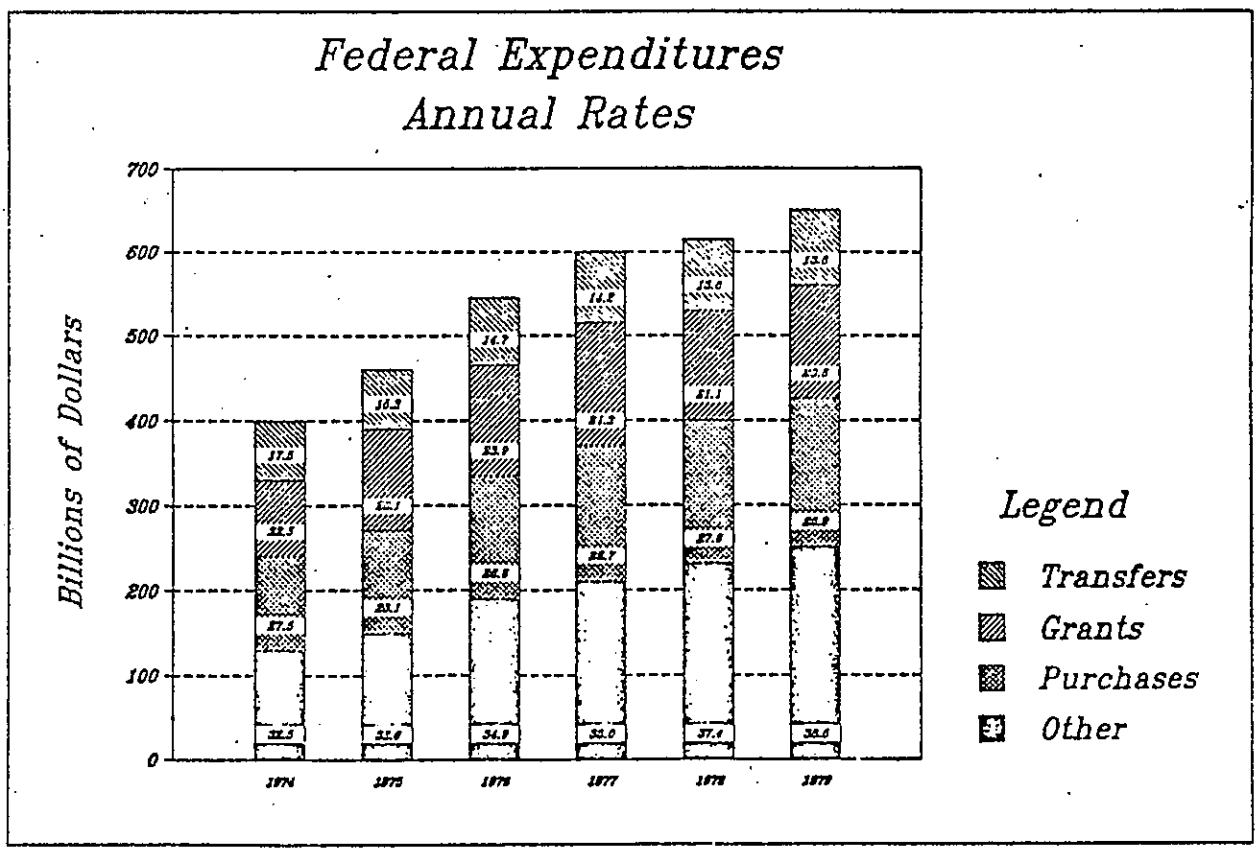
Poor



Better



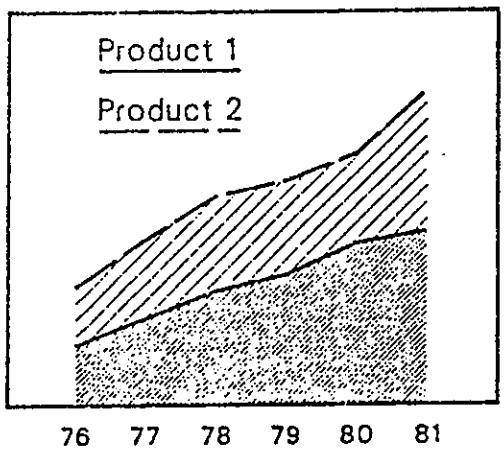
Complete Example



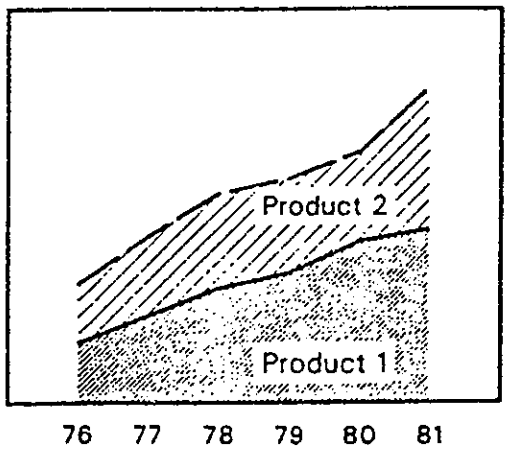
VI GUIDING RULES FOR COMPOSING SURFACE CHARTS

1. Put labels in shaded areas of surface charts when bands are side enough.

Poor

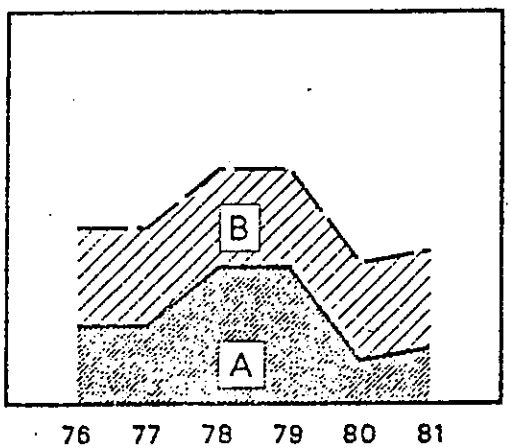


Better



2. Order data on surface charts so that irregular layers do not distort smoother upper layers.

Poor



Better