The Generation of Carpet Plots

by

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What is a carpet plot? A carpet plot is a means of displaying data dependent upon two variables in a format that makes interpolation and interpretation much easier than when using normal multiple curve plots.

For example, Table 1 is a set of data defining the surface area of ellipsoids as a function of two of the three semi-axes lengths.

Table 1 - Surface Area of Ellipsoids, S/b^2

		c / b				
		1.00	2.00	3.00	4.00	5.00
a / b	1.00	6.28314	10.73916	15.44678	20.24863	25.09610
	2.00	10.73911	17.34360	24.44084	31.73801	39.13673
	3.00	15.44668	24.44077	34.14764	44.15271	54.31268
	4.00	20.24849	31.73786	44.15261	56.95960	69.97266
	5.00	25.09590	39.13649	54.31245	69.97252	85.88845

Figure 1 is a typical representation of these data using multiple curves on a single plot. In this case the individual data curves are clearly separated from each other. This is often not the cases in normal applications.

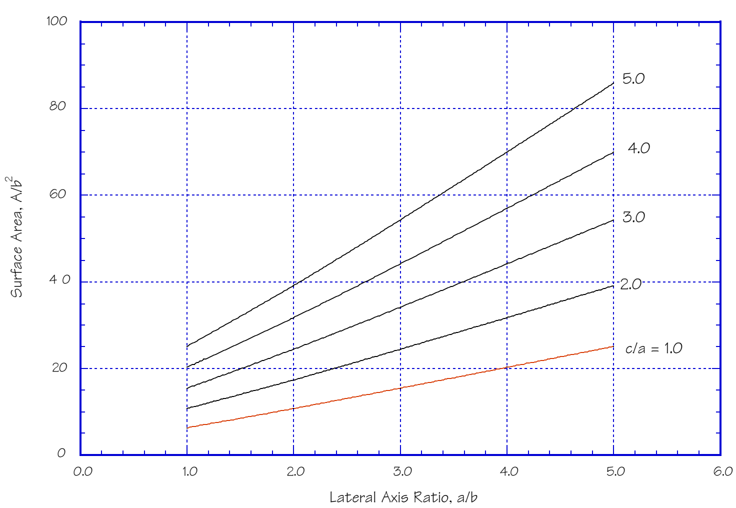

Figure 1 - Traditional Plot of Two Dimensional Data

If we now take the same data and plot it as a carpet plot we have Figure 2. Here we now have a two dimensional surface which provides clear indications of the interactions of the two independent variables.

The scale for each curve on this plot is defined by the crossing of the other family members. Note that each intersection takes place at one of the grid ordinates. Thus, it is easy to interpolate data from curves of either family.

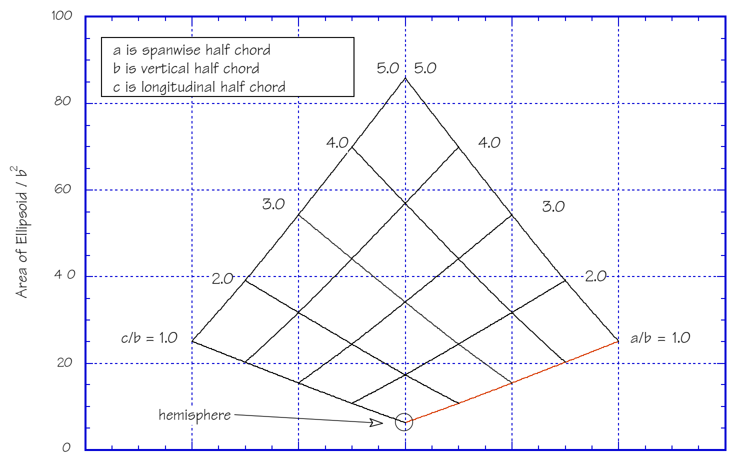

Figure 2 - Carpet Plot of Two Dimensional Data

Similarly, when some limitations are imposed upon the basic data, such limitations can be plotted as contours on these plots. Figure 3 shows this type of analysis using the constant value of the circumference of the base of the ellipsoid at an example. The superimposed curved line on Figure 3 shows the locus of all bodies have a base perimeter of 20 b units. Other values can be easily added.

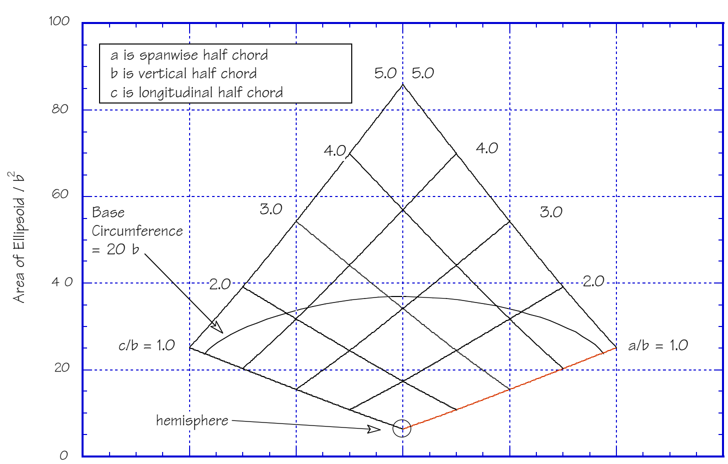

Figure 3 - The Locus of Ellipsoids Having a Circumference of 20 b

Several features of a carpet plot need to be recognized. First, there is no abscissa scale. Note that each of the nodes of this plot is located on one of the grid/tic points on the bottom scale. (Note that not all of the vertical grid lines were drawn in this example.) Thus if one is interested in the variation of area with c/b, the a/b intersections provide the appropriate scale, and vice versa. This makes interpolation much easier.

Given this type of plot, and its griding, the interpolation for values of the independent variables for a given value of the dependent variable is much easier. For example, trace the horizontal line of 40 b^2 across and you can easily define the relationship between c/b and a/b required to generate this value of surface area.

The generation of carpet plots is really an exercise in manipulating the basic data. We start with the basic data given above. We strip off the c/a and a/b definitions. Columns 1 through 5 of Table 2 now contain the basic data. (Note that Column Numbers have been added to clarify the steps to follow.)

Table 2 - Basic Data

Column Number				
1	2	3	4	5
6.28314	10.73916	15.44678	20.24863	25.09610
10.73911	17.34360	24.44084	31.73801	39.13673
15.44668	24.44077	34.14764	44.15271	54.31268
20.24849	31.73786	44.15261	56.95960	69.97266
25.09590	39.13649	54.31245	69.97252	85.88845

Next, we stagger the columns vertical, by one row. How we stagger makes a difference. This will be discussed below. With reference to column 5, column 4 is dropped one line, column 3 two lines, and so forth. See Table 3.

Table 3 - Staggered Basic Data

Column Number				
1	2	3	4	5
				25.09610
			20.24863	39.13673
		15.44678	31.73801	54.31268
	10.73916	24.44084	44.15271	69.97266
6.28314	17.34360	34.14764	56.95960	85.88845
10.73911	24.44077	44.15261	69.97252	
15.44668	31.73786	54.31245		
20.24849	39.13649			
25.09590				

We now add an initial column of sequential numbers. This column will be used as the independent for plotting the initial carpet plot. The actual values in column 1 are not significant, other than they must be sequential.. Here we have chosen to increment the variable data by 1. They could have been increments by 2, 4, 6 and so forth.

In the final carpet plot, the abscissa defining these Column 1 values will be dropped. With some experience involving the user and the actual plotting program, an appropriate selection of this "independent" variable will allow the plotting program to locate each node on a major grid line. While this is not absolutely necessary, it makes for neater plots. Table 4 shows the result of adding the abscissa data.

Table 4 - Data with Plotting Sequence Numbers

Column Number					
1	**2**	**3**	**4**	**5**	**6**
1					25.09610
2				20.24863	39.13673
3			15.44678	31.73801	54.31268
4		10.73916	24.44084	44.15271	69.97266
5	6.28314	17.34360	34.14764	56.95960	85.88845
6	10.73911	24.44077	44.15261	69.97252	
7	15.44668	31.73786	54.31245		
8	20.24849	39.13649			
9	25.09590				

Now we copy the first value in column 6, the right-most column, into the first value in column 7 of Table 5. We copy the second entry in column 6 to the second entry in column 8, and so forth. These entries are now the initial values of new columns of data.

Table 5 - Tops of New Columns Defined

Column Number										
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1					25.09610	25.09610				
2				20.24863	39.13673	→	39.13673			
3			15.44678	31.73801	54.31268	→	→	54.31268		
4		10.73916	24.44084	44.15271	69.97266	→	→	→	69.97266	
5	6.28314	17.34360	34.14764	56.95960	85.88845	→	→	→	→	85.88845
6	10.73911	24.44077	44.15261	69.97252						
7	15.44668	31.73786	54.31245							
8	20.24849	39.13649								
9	25.09590									

We now copy values from column 5 and place them under the values from column 6 so as to become the second item in each of the new columns. In this manner we build up a new set of data to be plotted. See Table 6.

The easiest way to do this is through the use of a spreadsheet. By using a spreadsheet, the copy and pasting of the data is a purely mechanical process and quickly carried out. For larger data sets, the spreadsheet can be easily programmed to do this relocation process.

Table 6 - Data from Second Column Added										
Column Number										
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1 0**	**1 1**
1					25.09610	25.09610				
2				20.24863	~~39.13673~~ →	20.24863	39.13673			
3			15.44678	31.73801	~~54.31268~~ →		31.73801	54.31268		
4		10.73916	24.44084	44.15271	~~69.97266~~ →			44.15271	69.97266	
5	6.28314	17.34360	34.14764	56.95960	~~85.88845~~ →				56.95960	85.88845
6	10.73911	24.44077	44.15261	69.97252	→					69.97252
7	15.44668	31.73786	54.31245							
8	20.24849	39.13649								
9	25.09590									

Table 7 shows the competed result. Where as we started with five sets of data with five entries each, we now have 5x2 = 10 sets of data each with five values each. In the general case, the added columns of data may not have the same number of points as the first if the number of columns is not the same as the number of rows of data. The limitations of the specific plotting program must be consulted to prevent overloading the data input list.

Table 7 - All Data Added										
Column Number										
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1 0**	**1 1**
1					25.09610	25.09610				
2				20.24863	39.13673	20.24863	39.13673			
3			15.44678	31.73801	54.31268	15.44678	31.73801	54.31268		
4		10.73916	24.44084	44.15271	69.97266	10.73916	24.44084	44.15271	69.97266	
5	6.28314	17.34360	34.14764	56.95960	85.88845	6.28314	17.34360	34.14764	56.95960	85.88845
6	10.73911	24.44077	44.15261	69.97252			10.73911	24.44077	44.15261	69.97252
7	15.44668	31.73786	54.31245					15.44668	31.73786	54.31245
8	20.24849	39.13649							20.24849	39.13649
9	25.09590									25.09590

This now is the data set from which we plot the carpet plot. Note that the data in columns 2 through 6 define the variation of area with the variable a/b. The data in columns 7 through 11 now define the variation with the other variable, c/b.

If there are missing data in the original data set, this must be accounted for in the development of the new data columns. Each blank space must be copied over just as though it were a numerical data. If all the data for a given value of the "independent" variable are missing, the result will be a blank column on the right side. That is perfectly acceptable.

The resulting plot is shown in Figure 4. This figure shows the plotting data from column 1 along the abscissa. Note that, as desired, the intersections of the two sets of curves occur on the values of the "independent" variable.

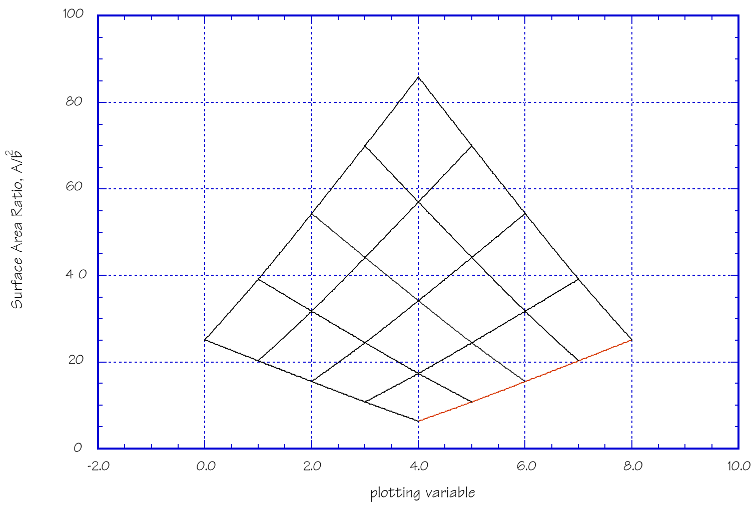

Figure 4 - Raw Plot of the Carpet Data

Now we move the values and identifier from the abscissa and add the text call outs, and we have Figure 2. Note that all that has been done is the manual movement of the initial data. This could easily be automated by a plotting program.

Our carpet plot is now completed.

Choosing the Correct Stagger: Starting the basic data, we have two choices as to the way to stagger the data. If we took the data in Table 2 and stagger them down rather than up, we have the data given in Table 8. In this case, the last element in column 6 was copied to the bottom of column 7. The second element from the bottom copied to the penultimate value of column 7 and so forth. Thus, the additional columns are thus built up from the bottom.

Table 8 - Alternative Stagger

Column Numbers										
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**7 0**	**1 1**
1	6.28314									6.28314
2	10.73911	10.73916							10.73911	10.73916
3	15.44668	17.34360	15.44678					15.44668	17.34360	15.44678
4	20.24849	24.44077	24.44084	20.24863			20.24849	24.44077	24.44084	20.24863
5	25.09590	31.73786	34.14764	31.73801	25.09610	25.09590	31.73786	34.14764	31.73801	25.09610
6		39.13649	44.15261	44.15271	39.13673	39.13649	44.15261	44.15271	39.13673	
7			54.31245	56.95960	54.31268	54.31245	56.95960	54.31268		
8				69.97252	69.97266	69.97252	69.97266			
9					85.88845	85.88845				

Plotting these data results in the poor carpet plot shown in Figure 5. Here the data curves are too closely packed to be useful. We actually have two curves plotted on top of each other due to the symmetry of the basic data. (This will not always be the case.) Thus, it is impossible to understand the effects of the interactions of the two independent variable. The user must resort to trial and error to pick the best one for his purposes.

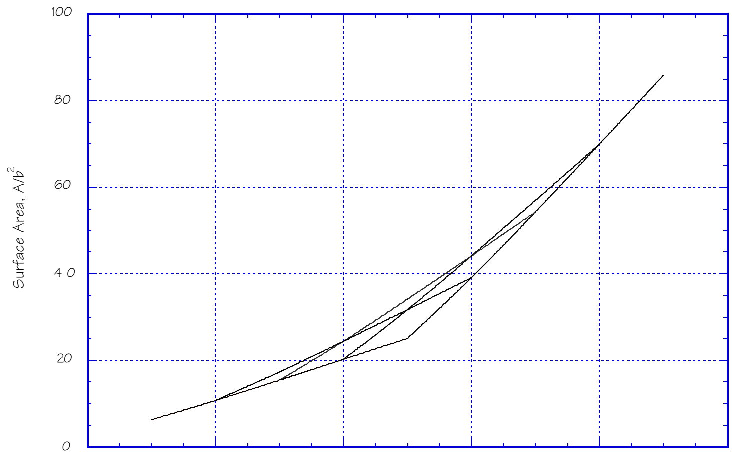

Figure 5 - The Result of a Poor Choice of Staggering the Original Data