Chapter 1 : Nomography: Suggested Reading

The design of diagrams for engineering formulas and the theory of nomography The design of diagrams for engineering formulas and the theory of nomography.

A and B are entered on the horizontal and vertical scales, and the result is read from the diagonal scale. Being proportional to the harmonic mean of A and B, this formula has several applications. For example, it is the parallel-resistance formula in electronics , and the thin-lens equation in optics. This nomogram demonstrates the use of curved scales with unevenly spaced graduations. The relevant expression is The scale along the top is shared among five different ranges of observed values: The observed value is found in one of these ranges, and the tick mark used on that scale is found immediately above it. Then the curved scale used for the expected value is selected based on the range. For example, an observed value of 9 would use the tick mark above the 9 in range A, and curved scale A would be used for the expected value. An observed value of 81 would use the tick mark above 81 in range E, and curved scale E would be used for the expected value. This allows five different nomograms to be incorporated into a single diagram. Food risk assessment[edit] Food risk assessment nomogram Although nomograms represent mathematical relationships, not all are mathematically derived. The following one was developed graphically to achieve appropriate end results that could readily be defined by the product of their relationships in subjective units rather than numerically. The use of non-parallel axes enabled the non-linear relationships to be incorporated into the model. The numbers in square boxes denote the axes requiring input after appropriate assessment. The pair of nomograms at the top of the image determine the probability of occurrence and the availability, which are then incorporated into the bottom multistage nomogram. The example uses a three-year minimum frequency for each, though with the high risk end of the scales different for the two aspects, giving different frequencies for the two, but both subject to an overall minimum sampling of every food for all aspects at least once every three years. This risk assessment nomogram was developed by the UK Public Analyst Service with funding from the UK Food Standards Agency for use as a tool to guide the appropriate frequency of sampling and analysis of food for official food control purposes, intended to be used to assess all potential problems with all foods, although not yet adopted. Sample size estimation[edit] Nomograph for Sample Size Estimation This nomograph can be used to estimate the sample size requirements for statistical analyses. It uses four parameters: Cohen [2] recommends using power equal to 0.

Chapter 2 : Nomogram - Wikipedia

Excerpt from The Design of Diagrams for Engineering Formulas: And the Theory of Nomography It is intended in this volume to present in a prae tical way the principles of the design of diagrams or nomograms for the solution of engineering and other formulas.

These graphs are variously called nomograms the term used here , nomographs, alignment charts, and abacs. Along with the mathematics involved, a great deal of ingenuity went into the design of these nomograms to increase their utility as well as their precision. Many books were written on nomography and then driven out of print with the spread of computers and calculators, and it can be difficult to find these books today even in libraries. Every once in a while a nomogram appears in a modern setting, and it seems odd and strangely old-fashionedâ€"the multi-faceted Smith Chart for transmission line calculations is still sometimes observed in the wild. This essay is an overview of how nomograms work and how they are constructed from scratch. The simplest form of nomogram is a scale such as a Fahrenheit vs. Celsius scale seen on an analog thermometer or a conversion chart. Linear spacing can be replaced with logarithmic spacing to handle conversions involving powers. Slide rules also technically qualify as nomograms but are not considered here. A slide rule is designed to provide basic arithmetic operations so it can solve a wide variety of equations with a sequence of steps, while the traditional nomogram is designed to solve a specific equation in one step. Most of the nomograms presented here are the classic forms consisting of three or more straight or curved scales, each representing a function of a single variable appearing in an equation. A straightedge, called an index line or isopleth, is placed across these scales at known values of these variables, and the value of an unknown variable is found at the point crossed on that scale. This provides an analog means of calculating the solution of an equation involving one unknown, and for finding one variable in terms of two others it is much easier than trying to read a 3-D surface plot. We will see later that it is sometimes possible to overlay scales so the number of scale lines can be reduced. The Geometry of Nomograms We can design nomograms composed of straight scales by analyzing their geometric properties, and a variety of interesting nomograms can be constructed from these derivations. Certainly these seem to be the most prevalent types of nomograms. The figure on the right shows the basic parallel scale nomogram for calculating a value f3 w as the sum of two functions f1 u and f2 v: The spacing of the lines is shown here as a and b. This can be rearranged as: The left half of this relationship provides the relative scaling of the two outer scales and the outer parts provide the scaling of the middle scale: For a smaller range and greater accuracy of an outer scale, we can change its scale m and move the middle line away from it and toward the other outer scale. In fact, if the unknown scale w has a very small range it can be moved outside the two other scales to widen the scale. Additions to u, v or w simply shift the scale values up or down. Multipliers of u, v and w multiply the value when drawing the scales they are not included in the values of m in the above calculations. So this looks like a lot of work to solve a simple linear equation. But in fact plotting logarithmic rather than linear scales expands the use of parallel scale nomograms to very complicated equations! The use of logarithms allows multiplications to be represented by additions and powers to be represented by multiplications according to the following rules: And note that there is actually no need to solve symbolically for the variable we just plot these logs on the scales , a significant advantage when we come to more complicated equations. We assume that the engineering ranges we are interested in are 1. To find the scaling factors we divide the final desired height of the u and v scales say, 6 inches for both by the ranges maximum â€" minimum of u and v: To do this we mark a baseline value of 1. Then 3 inches to the right of it we draw the v-scale with a baseline value of 1. And we arrive at the nomogram on the right, where a straightedge connecting values of u and v crosses the middle scale at the correct solution for w, and in fact any two of the variables will generate the third. Flexibility in arranging terms of the equation into different scales provides a means of optimizing the ranges and accuracies of the nomogram. A larger scale and finer tick marks can produce a quite accurate parallel scale nomogram that is deceptively simple in appearance, and one

that can be manufactured and re-used indefinitely for this engineering equation. It is also possible to create a circular nomogram to solve a 3-variable equation. Details on doing this from geometrical derivations are given in Douglass. The slanting middle scale joins the baseline values of the two outer scales which are now plotted in opposition. A Z chart can be used to solve a 3-variable equation involving a division: We could have used a parallel scale chart with logarithmic scales to plot this division, but the Z chart performs this with linear scales for u and v and it was once a real chore to calculate logarithms. But further, the linear scales of the Z Chart are much more suitable for combining a division with an addition or subtraction than compound parallel scales with their logarithmic scales. And of course if the scale for the unknown variable is an outside one, we have a Z chart for multiplication. To create this, the desired height of the nomogram and the ranges of P and R provide their scaling factors m1 and m2 as done earlier. The tick marks for Q are located a distance from the end calculated from the formula for Z above, where f3 w is replaced with Q2. It is also possible to slide the outer scales up or down without changing the tick mark spacing of the Z-scale as it also rotates due to its endpoints because similar triangles still result , yielding in a nomogram with a perpendicular Z-scale as shown in an example in the second part of this essay. Another type of proportional chart uses crossed lines within a boxed area, as shown below. Actually, similar triangles still exist and the ratios still hold for any parallelogram, not just a rectangle. But there are other types of proportional charts as shown below. In the ones labeled Type 3 an isopleth is drawn between two scale variables, then moved parallel until it spans the third variable value and the fourth unknown variable. The flange rivet example done in this manner is shown here. The derivation is somewhat involved, but in the end the scaling factors m must meet the following conditions: The scaling factor m3 corresponds to the w-scale. The zeros of the scales must meet at the vertex. Then the two halves are set equal to an intermediate value f q. The first step is to break the equation into two parts in three variables that are equal to one another. The scaling for u, v and w and the position chosen for the k-scale can be optimized to minimize errors at the pivot point for small errors in the straightedge alignment. The figure on the right shows a compound parallel scale nomogram. Below are examples from Levens of compound nomograms of Z charts and concurrent and proportional charts. A key often provides instructions on the use of a compound nomogram as shown in the first figure. Of course, this concept can be extended to equations with additional variables, where color coding would be helpful. Curved Scale Charts It is possible to geometrically derive relationships for nomograms that have one or more curved scales, but the design of these more complicated nomograms is so much easier using determinants.

Chapter 3 : Graphical and Mechanical Computation

PREFACE It is intended in this volume to present in a prae tical way the principles of the design of diagrams or nomograms for the solution of engineering and other.

In addition to the mathematical theory, also has bios of the mathematicians that developed the theory. Falk, Columbia Graphs Alignment Charts Lester R. A good solid book. Interesting method for making three-dimensional nomograms. Hewes and Herbert L. The section on nomograms is lucid and comprehensive. It also has valuable information on creating custom slide rules. John Wiley and Sons Khavinson, American Mathematical Society It is easy to read for those with shaky mathematical backgrounds, and has some techniques I have not seen in other books. It also has many unique techniques from other books collected in one volume. Applied Nomography 3 volumes J. Kuong, Gulf Publishing Co. Levens, New York, N. John Wiley and Sons, Inc. Download it from Google Books Here. Be sure you do not get Part II by accident as it has nothing on nomograms. Fundamental Formulas of Physics, Vol. Very minimalist and terse. There are only four pages covering nomograms. Construction Of Nomographic Charts F. International Textbook Company Has some hints on creating determinants that I have not seen in any other books. This is the book to have if you can only have one book. However, be warned that it is not for beginners, it is quite heavy on the math. Instant Calculations for Designers Robert L. Unfortunately, I cannot read French. Amelin, New York, Pergamon Press Links NomoGraphics You can commision them to create custom nomograms and custom slide rules for you. Form factors are PDF documents and iPad apps. Modern Nomograms Sells posters of interesting nomograms. They help teach that the purpose of computing is insight, not numbers. Dead Reckonings lost art in the Mathematical Sciences. The blog of Ron Doerfler, it often has important details about nomograms. Do not miss the following posts: PyNomo for the Python programming language. A marvelous software library that will allow a Python programmer to easily create PDF files of your nomograms. The Nomography Discussion , second era of graphical computation. An online forum about nomography. Birds of Prey is a paper and cardboard wargame of air combat. The game makes extensive use of nomograms as game play aids.

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