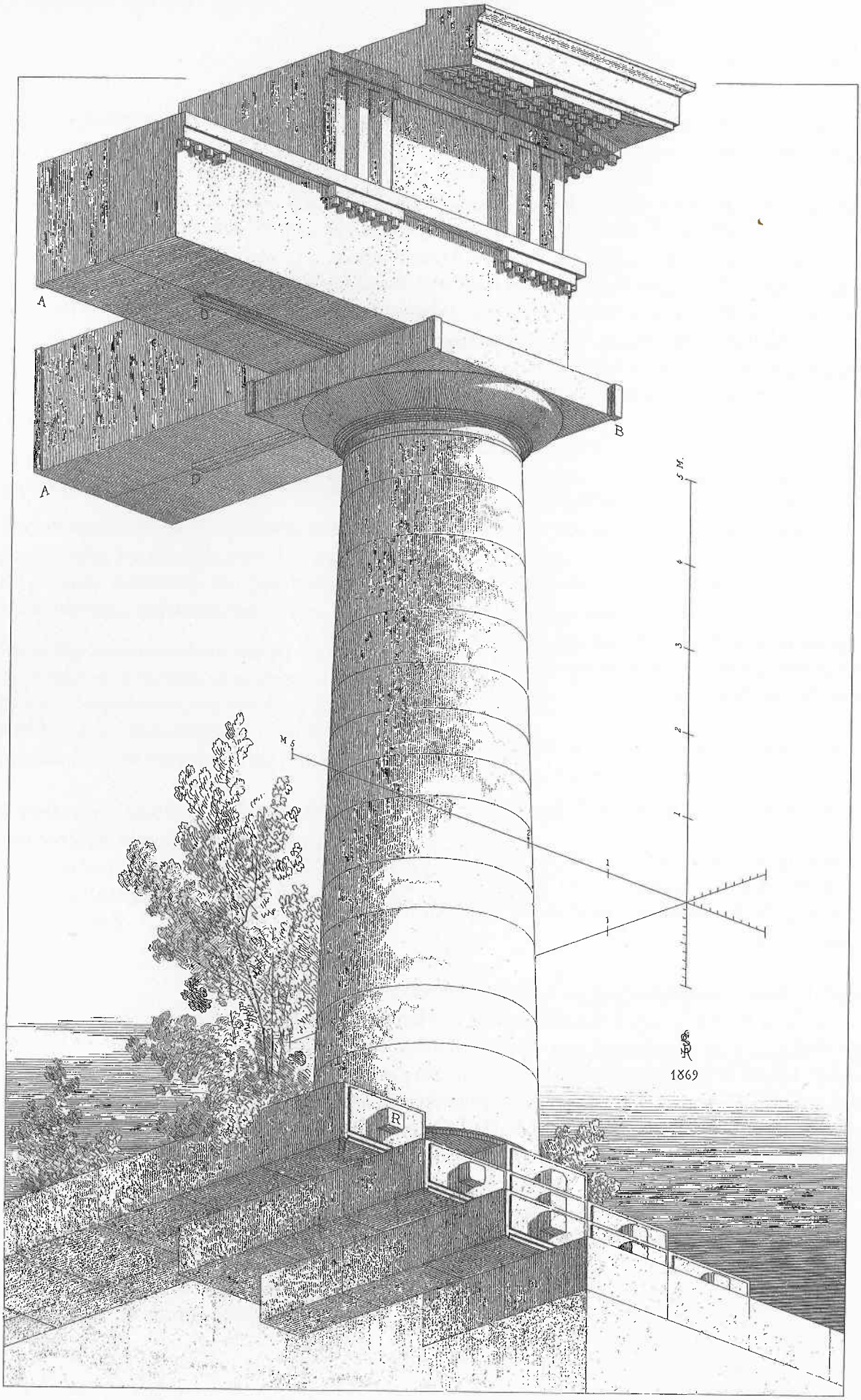
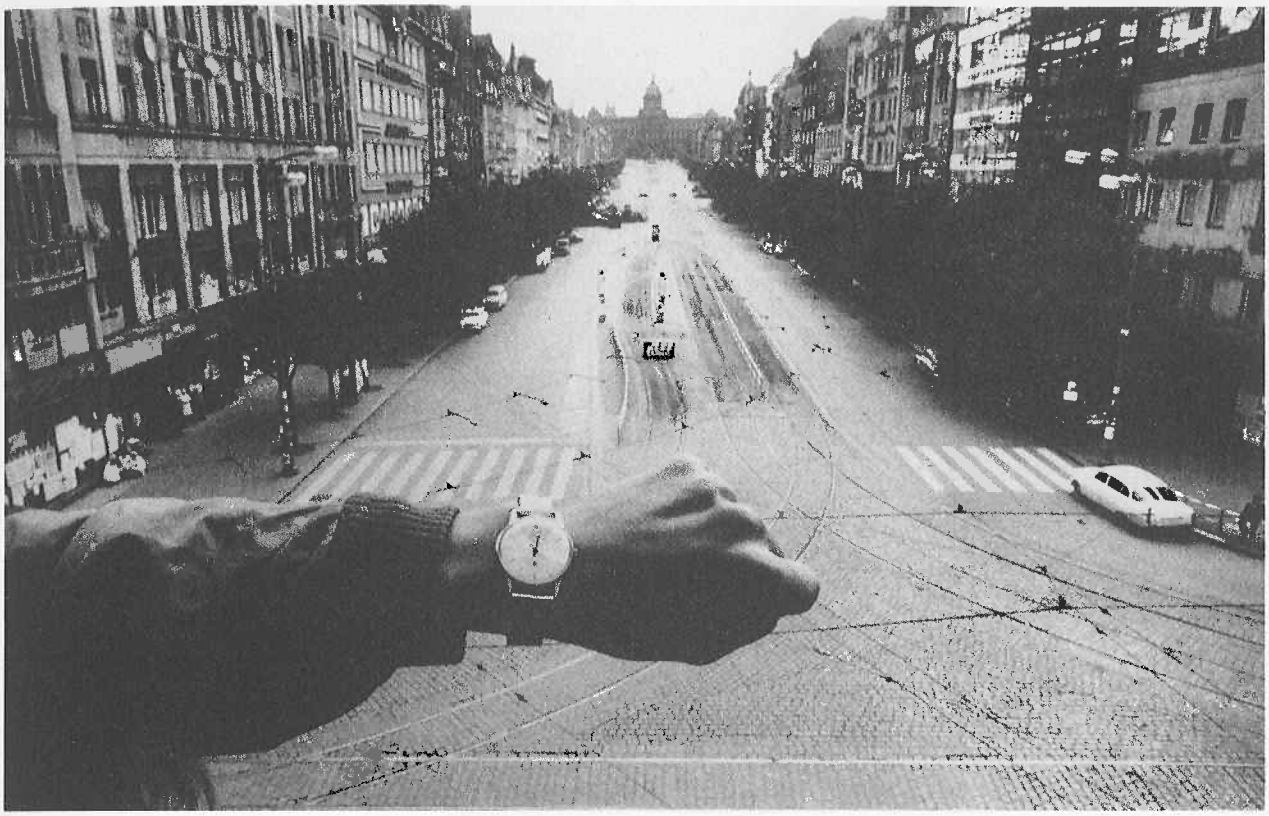


DESSINE PAR A CHOISY

GRAVE PAR H·SAUVESTRE

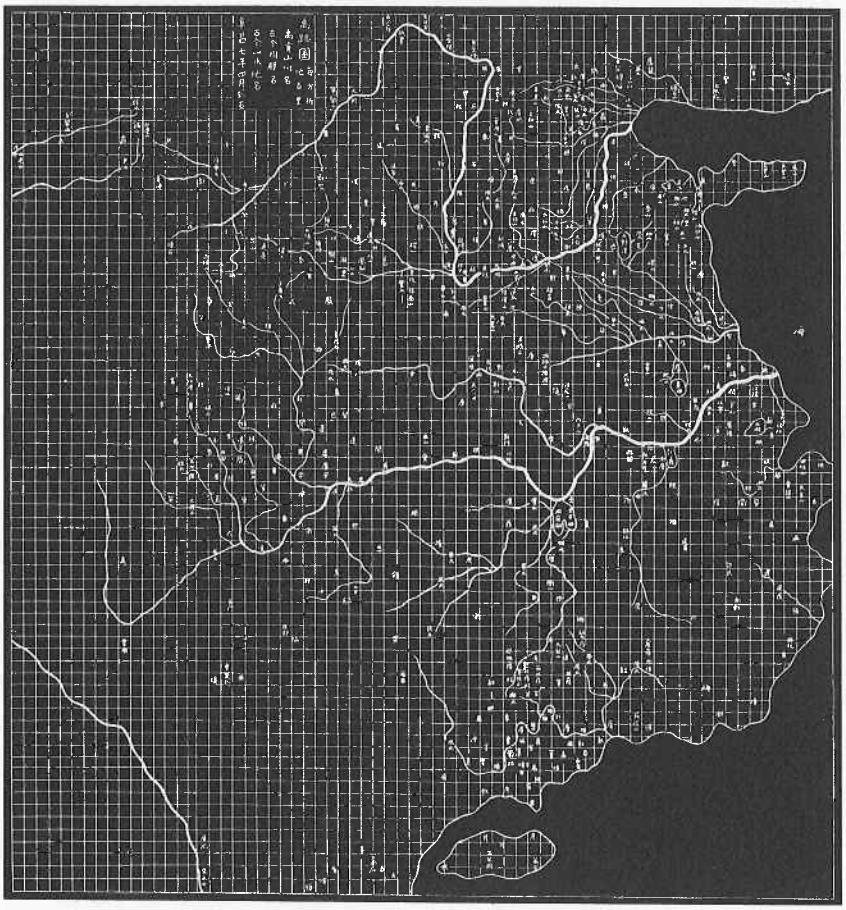


Josef Koudelka, *The Urge to See*, Prague, August 22, 1968.

OUR thinking is filled with assessments of quantity, an approximate or exact sense of number, amount, size, scale. In scientific work, both order-of-magnitude reasoning and precise measurements are pervasive. How are such quantities represented in visual expressions of ideas, experience, evidence? How are moving images, photographs, diagrams, maps, and charts to be scaled and labeled? And what makes images quantitatively eloquent?

VISUAL techniques for depicting quantities include *direct labels* (for example, the numerically labeled grids of statistical graphics, or, at left, dimensional tripods in architectural drawings); *encodings* (color scales); and *self-representing scales* (objects of known size appearing in an image). Using all these methods, Josef Koudelka's haunting and vehement photograph, *The Urge to See*, testifies to the empty streets during the 1968 Soviet invasion of Czechoslovakia that ended the Prague Spring of democratic reform. In the foreground, a watch documents the hour (*direct label*), as the shadows and gray light hint at the time of day (*encoding*), while in the distance Soviet tanks surround the national museum (*self-representing scales*, as many familiar objects in perspective demarcate the street and the photographer's location).

Auguste Choisy, *L'art de bâtir chez les romains* (Paris, 1873), plate XXIII, Segeste.



The original stone engraving is 32 by 31 in or 80 by 79 cm; redrawn from Edouard Chavannes, "Les Deux Plus Anciens Spécimens de la Cartographie Chinoise," *Bulletin de l'École Française de l'Extrême Orient*, 3 (1903), pp. 214–247, Carte B.

MAPS express quantities visually by location (two-dimensional addresses of latitude and longitude) and by areal extent (surface coverage). Some 900 years ago a fully scaled map was engraved in stone by precocious Chinese cartographers. The *Yu ji tu* or the Map of the Tracks of Yu is

> . . . the most remarkable cartographic work of its age in any culture, carved in stone in +1137 but probably dating from before +1100. . . . The coastal outline is relatively firm and the precision of the network of river systems extraordinary. . . . Anyone who compares this map with the contemporary productions of European religious cosmography cannot but be amazed at the extent to which Chinese geography was at that time ahead of the West. . . . There was nothing like it in Europe till the Escorial MS. map of about +1550.[1]

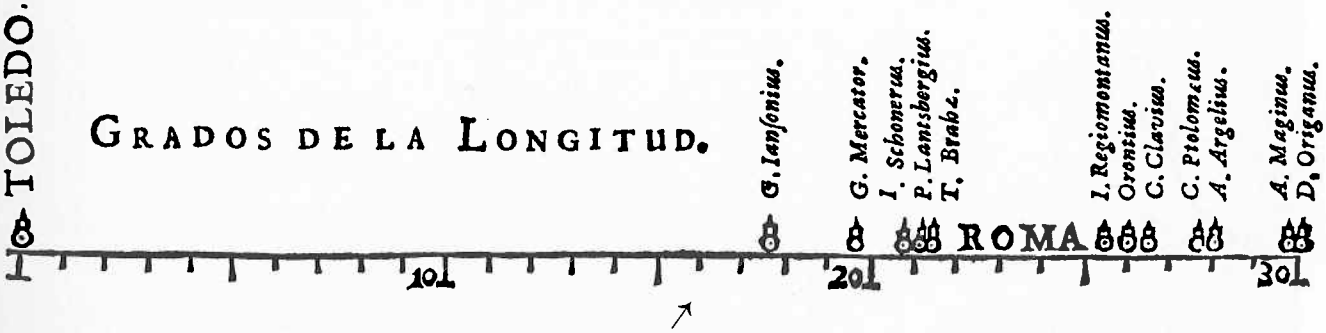
A note on the stone indicates that each grid square represents 100 *li*, a scale of map to world of approximately 1 to 4,500,000.

Despite their quantifying scales and grids, maps resemble miniature pictorial representations of the physical world. To depict relations between *any* measured quantities, however, requires replacing the map's natural spatial scales with abstract scales of measurement not based on geographic analogy. To go from maps of existing scenery to graphs of newly measured and collated data was an enormous conceptual step. Embodied in the very first maps were all the ideas necessary for making

[1] Joseph Needham, *Science and Civilization in China, volume 3: Mathematics and the Sciences of the Heavens and the Earth* (Cambridge, 1959), pp. 547–549. See also Cao Wanru, *et al.*, eds., *Zhongguo gudai ditu ji* [*Atlas of Ancient Chinese Maps*] (Beijing, 1990); and Cordell D. K. Yee, "Reinterpreting Traditional Chinese Geographical Maps," in J. B. Harley and David Woodward, eds., *The History of Cartography, volume 2, book 2: Cartography in the Traditional East and Southeast Asian Societies* (Chicago, 1994), pp. 47–50.

statistical graphics—quantified measures of locations of nouns in two-dimensional space—and yet it took 5,000 years to change the name of the coordinates from *west-east* and *north-south* to empirically measured variables *X* and *Y*. The even longer history of art took a similar course: the naturalistic coordinate system of painted cave-wall and canvas was first dislocated by Cubism's fractured images from multiple viewpoints and then eventually abandoned altogether in 20th-century abstract painting, as the two dimensions of the canvas no longer referred to worldly scenery but only to themselves.

One of the earliest visual representations of statistical data was drawn in 1644 by Michael Florent van Langren, a Flemish astronomer to the Spanish court. Appropriately enough for statistics, this graph shows 12 diverse estimates of the distance between Toledo and Rome. Measured in degrees longitude, the scale locates Toledo, the historic Spanish city portrayed in El Greco's *View of Toledo*, at the prime meridian of 0°. All the longitudes are too large, perhaps a result of underestimating



Michael Florent van Langren, *La Verdadera Longitud por Mar y Tierra* (Antwerp, 1644), p. 3. The purpose of the graph was to advance Langren's own method for the determination of longitude because of ". . . the existence of such enormous errors, as can be seen from the line, which shows the different distances that the greatest astronomers and geographers put between Rome and Toledo . . ."

the earth's circumference. The correct distance is 16° 30′. Combining nouns with numbers, the chart cites the astronomers and cartographers making the estimates—Jansson, Mercator, Schoener, Lansberge, Brahe, Regiomontanus, Ptolemy, and others. On Langren's scale, the broadly inexact position of Rome, sprawled out 22° to 25° from Toledo, places it far east of its actual location and well across the Adriatic Sea into western Greece. A one-dimensional map of data, the chart is remarkably advanced for its time, spatially arranging (rather than merely recording in a table) various estimates of the same quantity. Furthermore, the data are distributed in relation to a putatively true value. Langren's chart appears to be the earliest display of a distribution of common measurements; and it is my candidate for the first statistical graphic ever.[2]

By 1765, two-dimensional space was liberated from pictorially-based scales. J. H. Lambert described a *general* graphical grid (no more analogies to maps) for depicting systematic relations between measured quantities:

> We have in general two variable quantities, x, y, which will be collated with one another by observation, so that we can determine for each value of x, which may be considered as an abscissa, the corresponding ordinate y. Were the experiments or observations completely accurate, these ordinates would give a number of points

[2] On the history of statistical graphics, see H. Gray Funkhouser, "Historical Development of the Graphical Representation of Statistical Data," *Osiris*, 3 (November 1937), 269–404; and James R. Beniger and Dorothy L. Robyn, "Quantitative Graphics in Statistics: A Brief History," *American Statistician*, 32 (February 1978), pp. 1–11.