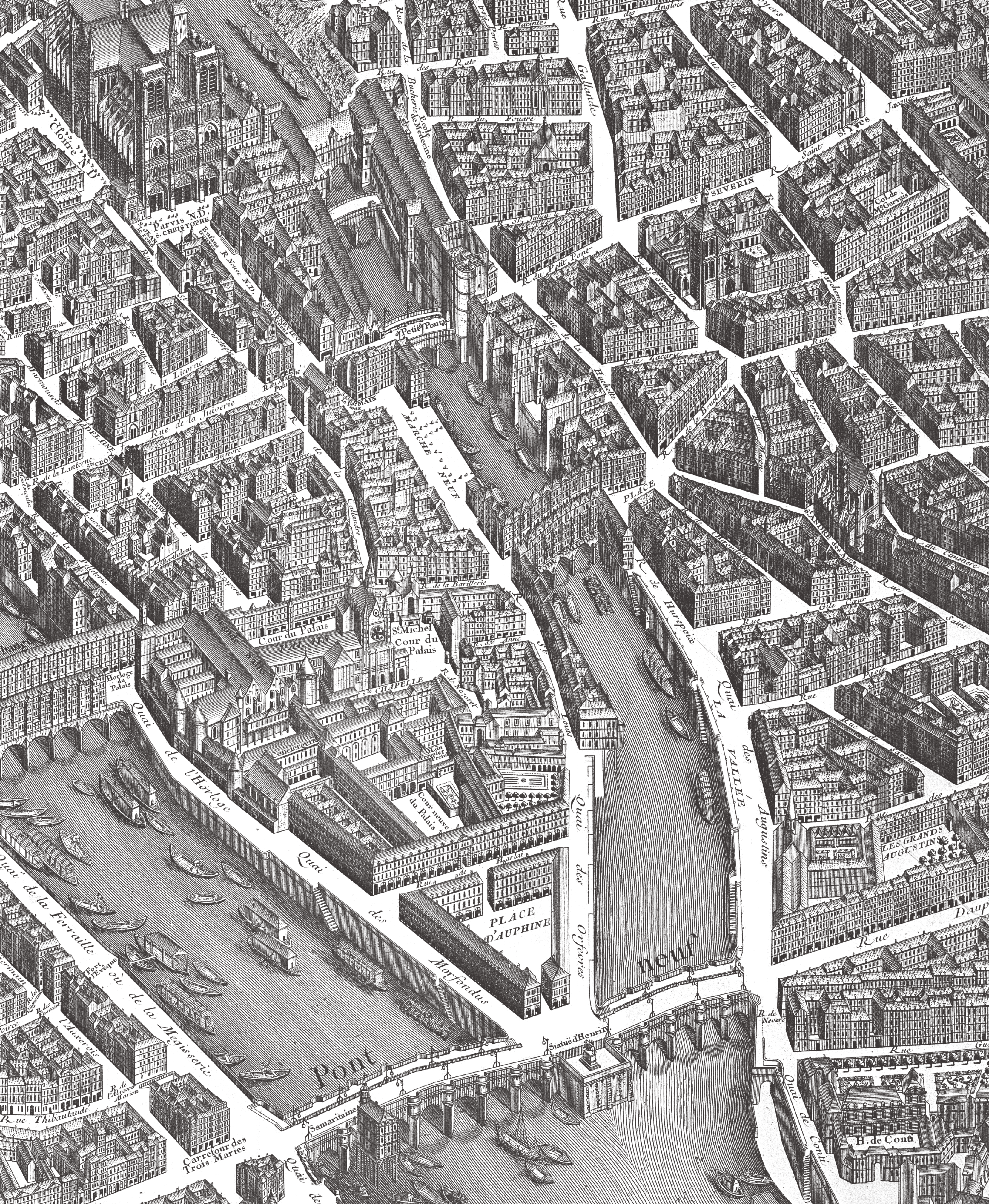
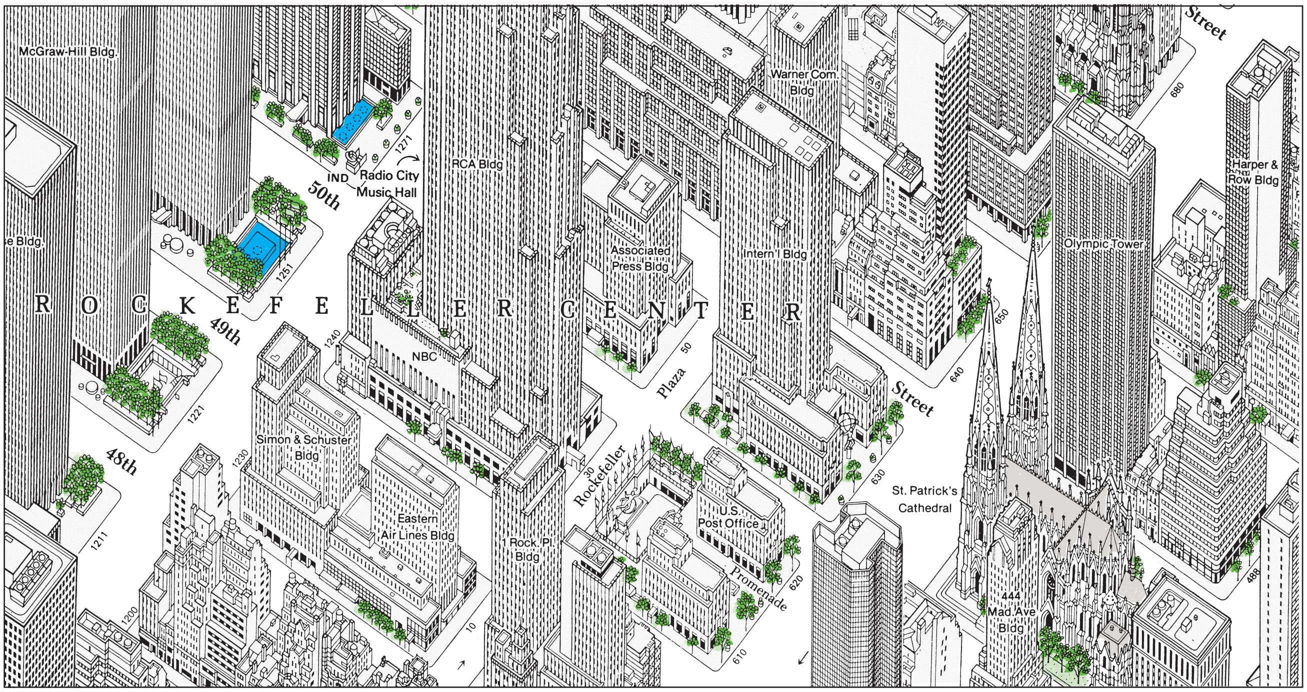

NOTRE DAME
Cloître N.D.
Parvis N.D.
S. CHRISTOPHE
Petit Pont
MARCHÉ NEUF
Rue de la Juiverie
R. de la Barillerie
Cour du Palais
St Michel
Cour du Palais
PALAIS
Conciergerie
Cour neuve du Palais
S. SEVERIN
PLACE
R. de Hurepoix
Quai des Augustins
LA VALLÉE
LES GRANDS AUGUSTINS
Rue Dauphine
Quai de l'Horloge
Quai des Morfondus
Quai des Orfévres
PLACE DAUPHINE
Pont neuf
Statue d'Henri IV
Samaritaine
Quai de la Ferraille
Quai de la Megisserie
Rue Thibautaude
Carrefour des Trois Maries
R. de Nevers
H. de Conti
Quai de Conti

# 2 *Micro/Macro Readings*






Michel Etienne Turgot and Louis Bretez, *Plan de Paris* (Paris, 1739), plate 11. Above, *The Isometric Map of Midtown Manhattan*, © 1989 The Manhattan Map Company. All rights reserved.

For 20 years Constantine Anderson refined this precise axonometric projection of midtown New York (shown here are Rockefeller Center environs), following the tradition of the classic 1739 Bretez-Turgot *Plan de Paris* (at left, the area around Pont Neuf and Notre Dame, from the 11th of 20 sheets). The Manhattan map embraces such fine points as individual windows, subway stations and bus shelters, telephone booths, building canopies, trees, and sidewalk planters. And the typography is persistently thorough; the entire map (60 by 92 centimeters, or 24 by 36 inches) reports 1,686 names of buildings, stores, and parks along with 657 specific street addresses—for a map, an abundant typographic density of 3 characters per square centimeter (20 per square inch). The only major concession to paper flatland is widening of the map's streets to reduce masking of some buildings by others.

This fine texture of exquisite detail leads to personal micro-readings, individual stories about the data: shops visited, hotels stayed at, walks taken, office windows at a floor worked on—all in the extended context of an entire building, street, and neighborhood.[1] Detail cumulates into larger coherent structures; those thousands of tiny windows, when seen at a distance, gray into surfaces to form a whole building. Simplicity of reading derives from the context of detailed and complex information, properly arranged. A most unconventional design strategy is revealed: *to clarify, add detail.*

[1] Italo Calvino's *Invisible Cities* (San Diego, 1974) records this texture of storied detail: cities are "relationships between the measurements of its space and the events of its past: the height of a lamp-post and the distance from the ground of a hanged usurper's swaying feet; the line strung from the lamp-post to the railing opposite and the festoons that decorate the course of the queen's nuptial procession; the height of that railing and the leap of the adulterer who climbed over it at dawn; the tilt of a guttering cat's progress along it as he slips into the same window; the firing range of a gunboat which has suddenly appeared beyond the cape and the bomb that destroys the guttering; the rips in the fishnet and the three old men seated on the dock mending nets and telling each other for the hundredth time the story of the gunboat of the usurper, who some say was the queen's illegitimate son, abandoned in his swaddling clothes there on the dock." On Calvino and maps, see a fine essay by Marc Treib, "Mapping Experience," *Design Quarterly*, 115 (1980).

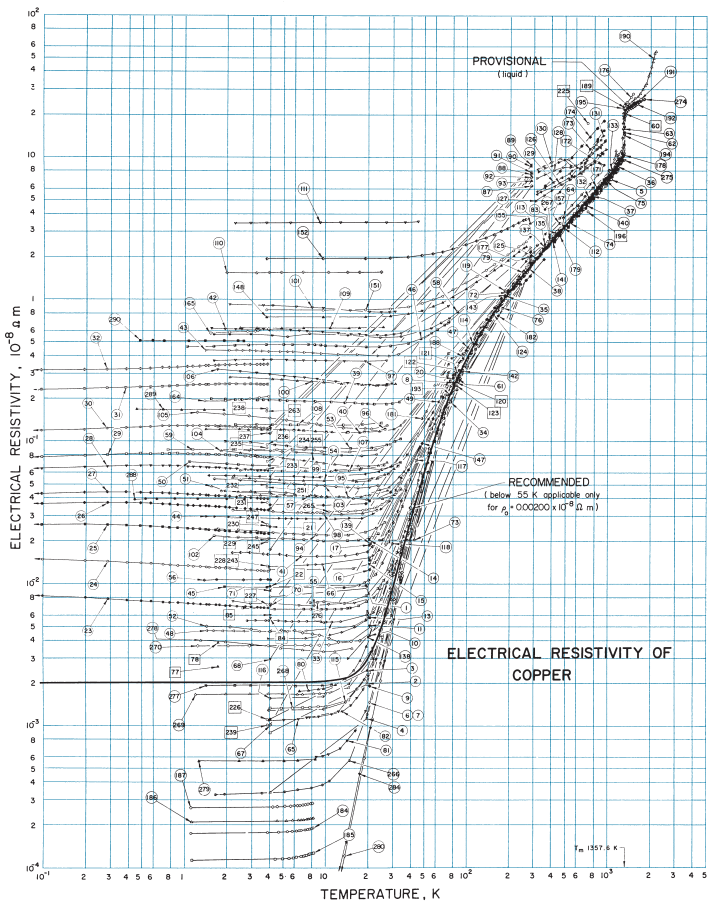
Robert Cameron, *Above Paris* (San Francisco, 1984), 146–147.

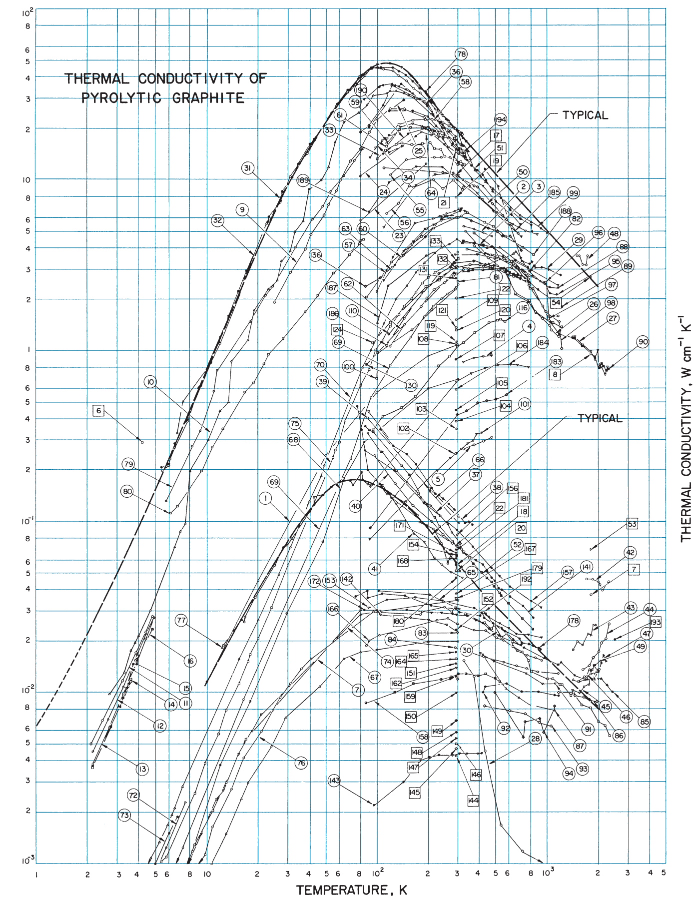
A high-resolution aerial photograph of Senlis, one of the oldest cities in France (construction started on this Notre Dame cathedral in 1153), arrays micro-details mixing into overall pattern. Encircling Senlis was once a broad strip of Gallo-Roman fortification, now replaced by houses, arranged by the memory of the old town's plan. Such intensity of detail is routinely reported in photographs, so much data that digitizing these images for computers requires $10^6$ to $10^8$ bits.

Micro/macro composition also oversees this celebrated 1930 poster composed by the Soviet graphic artist Gustav Klutsis. The design and political point correspond—as the poster shows and also writes out, from collaborative work of many hands, one great plan will be fulfilled.

At work here is a critical and effective principle of information design. Panorama, vista, and prospect deliver to viewers the freedom of choice that derives from an overview, a capacity to compare and sort through detail. And that micro-information, like smaller texture in landscape perception, provides a credible refuge where the pace of visualization is condensed, slowed, and personalized.[2] These visual experiences are universal, rooted in human information-processing capacities and in the abundance and intricacy of everyday perceptions. Thus the power of micro/macro designs holds for every type of data display as well as for topographic views and landscape panoramas. Such designs can report immense detail, organizing complexity through multiple and (often) hierarchical layers of contextual reading.

[2] Jay Appleton, *The Experience of Landscape* (Chichester, 1975); John A. Jakle, *The Visual Elements of Landscape* (Amherst, 1987).



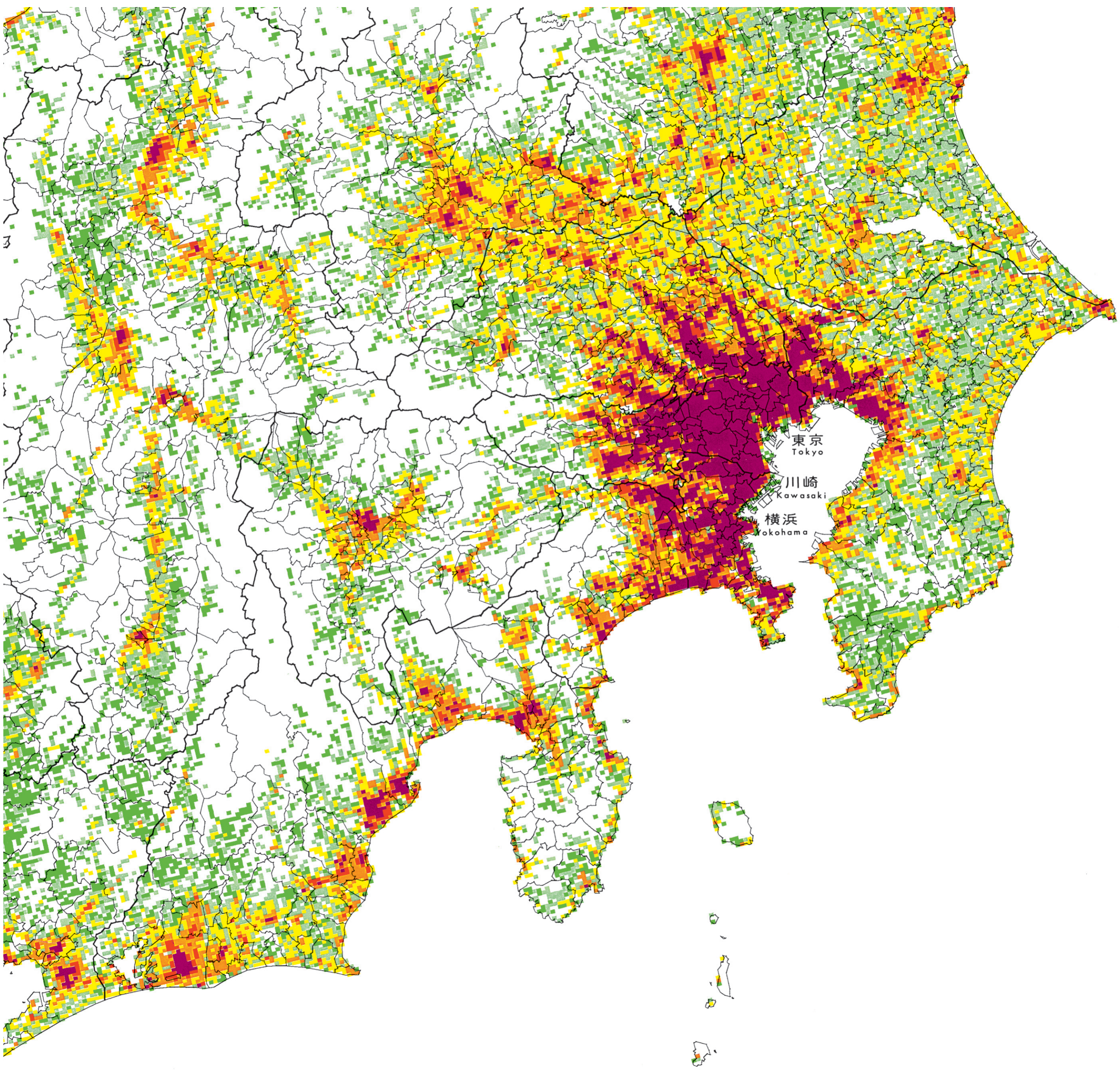

R. A. Matula, "Electrical Resistivity of Copper, Gold, Palladium, and Silver," *Journal of Physical and Chemical Reference Data*, 8 (1979), 1162; C. Y. Ho, R. W. Powell, and P. E. Liley, *Thermal Conductivity of the Elements. Journal of Physical and Chemical Reference Data*, 3 (1974), 1–151, 1–244.

These multi-layered graphs report a clouded relationship between temperature and conductivity for various elements, as measured by many different laboratories. Each set of connected points comes from a single publication, cited by an identification number. Note how easily these displays organize the material, recording observations from several hundred studies and also enforcing comparisons among quite divergent results (this is science?) scattered around the correct curve, a solid line labeled RECOMMENDED . Since both scales are logarithmic, cycling through 3.5 to 6 orders of magnitude, deviations from the recommended curve are often quite substantial. In this micro/macro arrangement, 4 layers of data are placed in evidence—individual points measured within each study, connected curves formed by those results, and, finally, an overall conglomeration of curves (which are compared with the standard).

Still another slice of data can be added. A number, linked to an *alphabetical* list ordered by author's name, now identifies each published paper. A better method is to order the list by the *date* of publication; then the numerical codes correspond to the sequence of findings—for example, 61c indicates the third paper published in 1961. This graphical indexing depicts which study first had the right answer, and movement toward the correct curve can be tracked over the years.

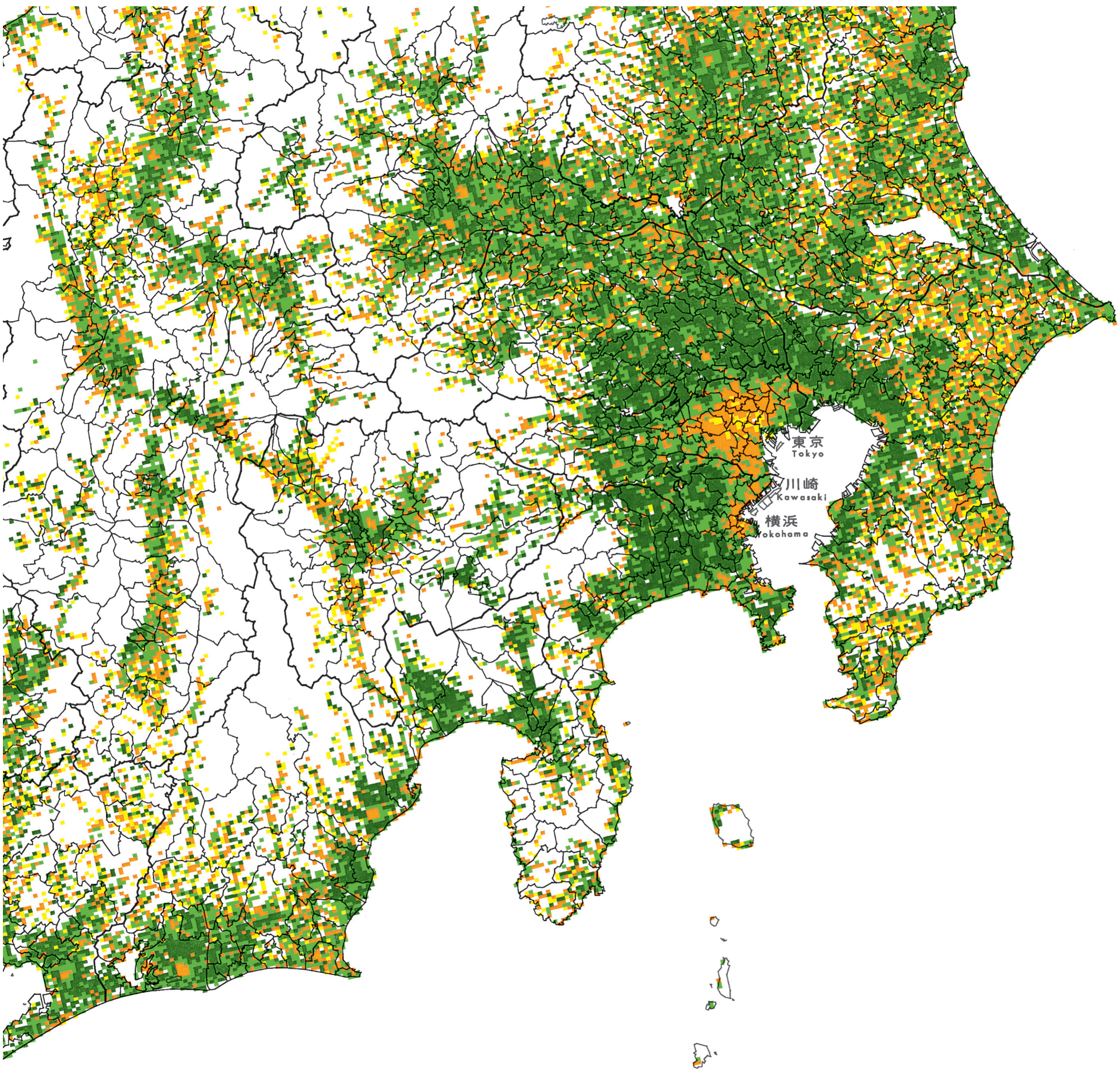
These extraordinary statistical maps report data for thousands of tiny grid squares (1 km on a side). Below, a map of Tokyo shows population density; note smaller concentrations dotting the tracks radiating from the city, as people cluster along rail lines and station stops. At this level of detail, residents can find their own particular square and also see it in a broader context. The map at right records the proportion of children living at each location, with a systematic pattern of lower percentages in central Tokyo (where space is limited and costly) and a suburban ring teeming—relatively—with children. A bright idea lies behind these grid-square or mesh maps. Conventional blot maps (choropleth maps,

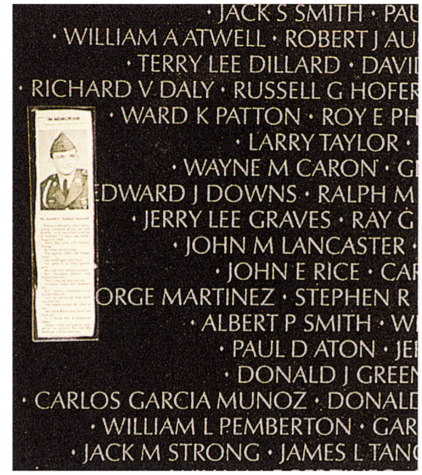
Statistics Bureau, Prime Minister's Office, *Statistical Maps on Grid Square Basis: The 1980 Population Census Results* (Tokyo, 1985). See Hidenori Kimura, "Grid Square Statistics for the Distribution and Mobility of Population in Japan," Statistics Bureau (Tokyo, no date), manuscript.



in the jargon) paint over areas formed by *given* geographic or political boundaries. The consequences are (1) sizes of areas are non-uniform, (2) colored-in areas are proportional to (often nearly empty) land areas instead of the activities depicted, with large unpopulated areas often receiving greatest visual emphasis, and (3) historical changes in political boundaries disrupt continuity of statistical comparisons.[3] Mesh maps finesse these problems. For these maps, the whole country of Japan was divided up in 379,000 equal-sized units and then, in a heroic endeavor, census data and addresses were collated to match the new grid squares. Arbitrary but statistically wise boundaries now cradle the micro-data.

[3] J. C. Müller, "Wahrheit und Lüge in Thematischen Karten—Zur Problematik der Darstellung Statistischer Sachverhalte," *Kartographische Nachrichten*, 35-2 (1985), 44-52. Other uses of mesh maps include describing flows; see Waldo R. Tobler, "A Model of Geographic Movement," *Geographical Analysis*, 13 (January 1981), 1-19.






The Vietnam Veterans Memorial in Washington, DC achieves its visual and emotional strength by means of micro/macro design. From a distance the entire collection of names of 58,000 dead soldiers arrayed on the black granite yields a visual measure of what 58,000 means, as the letters of each name blur into a gray shape, cumulating to the final toll. When a viewer approaches, these shapes resolve into individual names. Some of the living seek the name of one particular soldier in a personal micro-reading; more than a few visitors here touch the etched, textured names. We focus on the tragic information; absent are the big porticoes, steps and stairs, and other marble paraphernalia usually attached to grand official monuments. Walking on a slight grade downward (approaching from either side), our first close reading is of panels no higher than a few names. But looking forward, the visitor sees names of the dead rising higher and higher, a statistical blur of marks in the distance with micro-detail at hand. The context is enlarged by calm reflections off polished black granite, reflections of the living and of trees, and, at a distance, of the Lincoln and Washington memorials toward which the walls angle.

An additional data dimension comes from the *ordering* of names. The memorial's designer, Maya Ying Lin, proposed that names be listed by date of death rather than alphabetically:

> . . . chronological listing was essential to her design. War veterans would find their story told, and their friends remembered, in the panel that corresponded with their tour of duty in Vietnam. Locating specific names with the aid of a directory would be like finding bodies on a battlefield. . . . Some initially disagreed. If 58,000 names were scattered along the wall, anyone looking for a specific name would wander around for hours and then leave in frustration. One solution seemed obvious: list everyone in alphabetical order. . . . But when a two-inch-thick Defense Department listing of Vietnam casualties was examined, thinking changed. There were over 600 Smiths; 16 people named James Jones had died in Vietnam. Alphabetical listing would make the Memorial look like a telephone book engraved in granite, destroying the sense of unique loss that each name carried. . . . [4]

[4] Jan C. Scruggs and Joel L. Swerdlow, *To Heal A Nation: The Vietnam Veterans Memorial* (New York, 1985), 78–79. See Jeffrey Karl Ochsner, "A Space of Loss: The Vietnam Veterans Memorial," *Journal of Architectural Education*, 50 (February 1997), 156–171; and Maya Lin, "Making the Memorial," *The New York Review of Books*, 47 (November 2, 2000), 33–35.

Vietnam Veterans Memorial, *Directory of Names* (Washington, DC, 1985). Shown here is an excerpt from the finder, a large book recording the name, rank, service, birthdate, deathdate, home town, and panel and line number locating each name on the stone memorial.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SMITH ROBERT GEORGE | PFC | AR | 11 JUN 45 | 02 JAN 66 | CLEVELAND | OH | 4E | 52 |
| SMITH ROBERT HAROLD | SP4 | AR | 27 OCT 46 | 24 JAN 67 | WARMINSTER | PA | 14E | 73 |
| SMITH ROBERT JAMES | SSGT | AR | 16 DEC 45 | 18 APR 68 | ALBANY | NY | 50E | 41 |
| SMITH ROBERT JEREMIAH | CPL | AR | 16 MAY 47 | 29 SEP 67 | BUFFALO | NY | 27E | 32 |
| SMITH ROBERT JOE | SP4 | AR | 04 JUL 44 | 21 MAR 67 | JACKSONVILLE | FL | 17E | 14 |
| SMITH ROBERT JOHN | A1C | AF | 15 OCT 42 | 25 JUN 65 | SCARBORO | ME | 2E | 19 |
| SMITH ROBERT JOSEPH | PFC | MC | 04 AUG 48 | 26 AUG 68 | COLUMBUS | GA | 46W | 34 |
| SMITH ROBERT JR | PFC | AR | 20 MAR 45 | 26 MAY 66 | PHILADELPHIA | PA | 7E | 111 |
| SMITH ROBERT L | SGT | AR | 30 JUN 37 | 25 AUG 66 | MILLINGTON | TN | 10E | 44 |
| SMITH ROBERT LEE | SP4 | AR | 06 NOV 43 | 29 JAN 66 | WELCH | WV | 4E | 115 |
| SMITH ROBERT LEE | SSGT | AR | 22 AUG 32 | 25 MAY 68 | CHILLICOTHE | OH | 67W | 6 |
| SMITH ROBERT LEE | LCPL | MC | 09 JAN 46 | 31 MAY 68 | MONROE | MI | 62W | 17 |
| SMITH ROBERT LEE | PFC | MC | 28 MAR 46 | 02 SEP 68 | CINCINNATI | OH | 45W | 28 |
| SMITH ROBERT LEE | PFC | AR | 06 OCT 43 | 30 DEC 69 | CHICAGO | IL | 15W | 111 |
| SMITH ROBERT LEE JR | LCPL | MC | 31 JUL 45 | 04 MAR 66 | NEWPORT NEWS | VA | 5E | 110 |
| SMITH ROBERT LEWIS | PFC | AR | 05 APR 48 | 06 JUN 68 | SMITHLAND | KY | 59W | 15 |
| SMITH ROBERT LINDO | PFC | AR | 22 JAN 40 | 17 FEB 66 | SANFORD | NC | 5E | 43 |
| SMITH ROBERT LOUIS | CPL | AR | 27 MAY 47 | 08 MAR 67 | ANGIER | NC | 16E | 42 |
| SMITH ROBERT MICHAEL | SGT | AR | 11 NOV 48 | 10 MAR 70 | PEORIA | IL | 13W | 108 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SMITH ROBERT NORMAN | COL | MC | 20 SEP 26 | 19 AUG 69 | TRUCKSVILLE | PA | 19W | 74 |
| SMITH ROBERT SR | SGT | AR | 28 MAY 32 | 21 OCT 66 | ALEXANDRIA | LA | 11E | 96 |
| SMITH ROBERT T | SGT | AR | 01 AUG 44 | 12 APR 69 | INDIANAPOLIS | IN | 27W | 67 |
| SMITH ROBERT WALTER | SGT | AR | 27 APR 47 | 20 JAN 69 | LAKE CORMORANT | MS | 34W | 45 |
| SMITH ROBERT WILBUR | CAPT | AF | 02 JUL 44 | 17 APR 70 | WASHINGTON | DC | 11W | 19 |
| SMITH ROBERT WILLIAM | PFC | AR | 02 AUG 47 | 12 NOV 66 | WENTZVILLE | MO | 12E | 64 |
| SMITH RODNEY HOWE | LTC | AR | 02 AUG 31 | 03 JUN 67 | ARLINGTON | VA | 21E | 53 |
| SMITH ROGER LEE | SP4 | AR | 14 MAR 47 | 03 OCT 68 | SOUTH POINT | OH | 41W | 2 |
| SMITH RONALD C | SP4 | AR | 21 APR 46 | 03 MAR 67 | DEARBORN | MI | 16E | 14 |
| SMITH RONALD CARLTON | SP4 | AR | 18 SEP 44 | 14 APR 68 | HATBORO | PA | 50E | 1 |
| SMITH RONALD EUGENE | SFC | AR | 29 MAR 40 | 28 NOV 70 | COVINGTON | IN | 6W | 89 |
| SMITH RONALD ORDON | SP4 | AR | 03 JUN 47 | 21 NOV 67 | COVINGTON | TN | 30E | 60 |
| SMITH RONALD LARRY | 1LT | MC | 02 MAR 36 | 23 FEB 69 | HOGANSVILLE | GA | 31W | 24 |
| SMITH RONALD LEE | PFC | AR | 20 DEC 47 | 26 MAY 68 | BEECH GROVE | IN | 65W | 1 |
| SMITH RONNIE WAYNE | PFC | MC | 28 SEP 48 | 28 MAY 68 | HUNTSVILLE | AL | 64W | 16 |
| SMITH RONNY | PFC | MC | 04 FEB 49 | 10 MAY 69 | LENA | MS | 25W | 43 |
| SMITH ROY | CPL | MC | 11 MAY 46 | 20 MAY 67 | BIRMINGHAM | AL | 20E | 65 |
| SMITH ROY MILTON | SP4 | AR | 31 MAR 50 | 19 FEB 71 | HOUSTON | TX | 5W | 122 |

Thus the names on stone triple-function: to memorialize each person who died, to make a mark adding up the total, and to indicate sequence and approximate date of death. A directory-book alphabetically lists all the names and serves as a finder, pointing viewers to the location of a single engraved name.

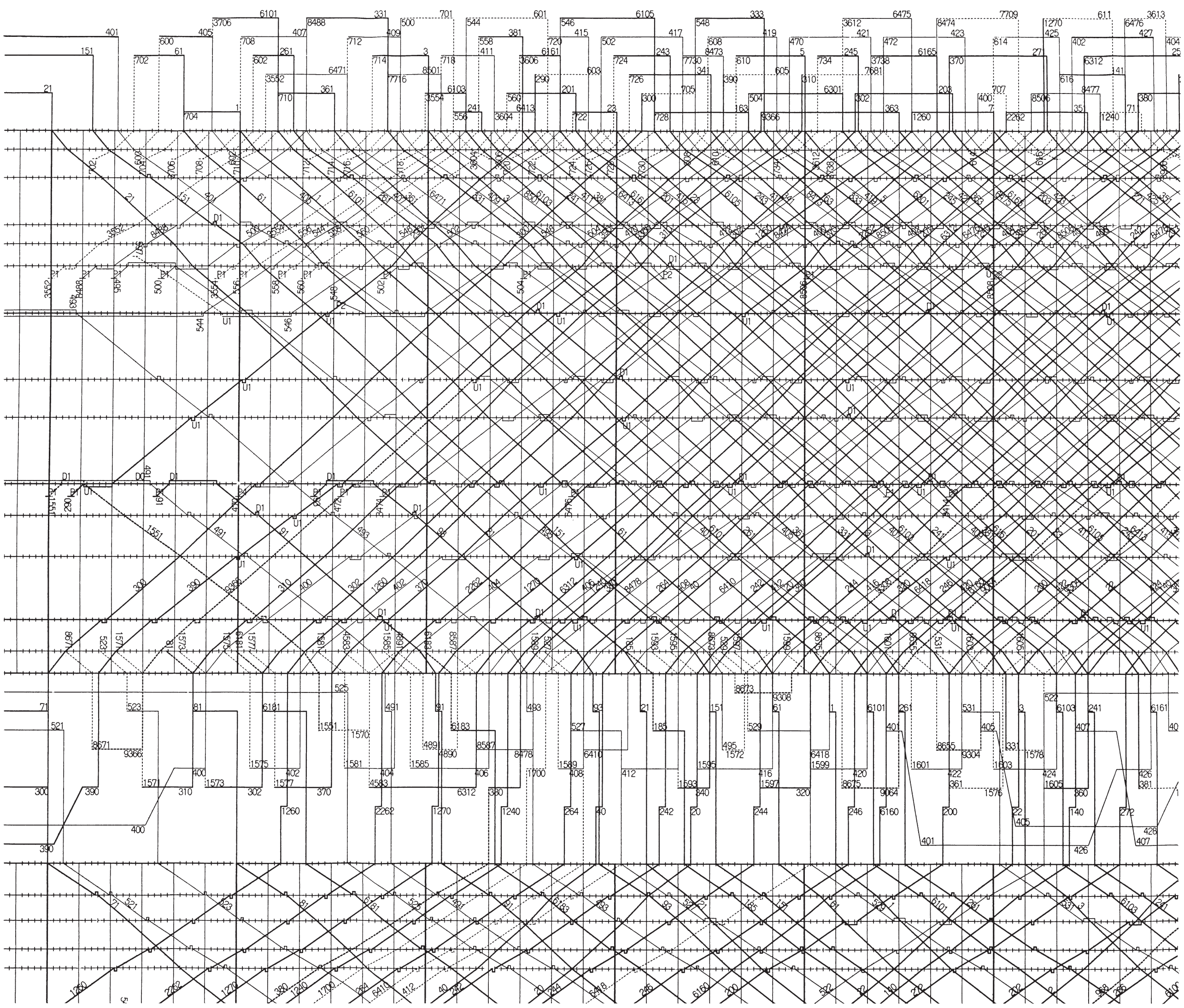
The spirit of the *individual* created by the wall—both of each death and of each viewer personally editing—decisively affects how we see other visitors. The busloads of tourists appear not so much as crowds but rather as many separate individual faces, not as interruptions at an architectural performance but rather as our colleagues.[5]

[5] Since installation in 1982, the Vietnam Memorial has become one of the most visited monuments in Washington. Some four million people saw it in 1988, according to "Maya Lin's Unwavering Vision," *The Washington Post*, February 13, 1989, B1, B6. In 1991, the sculptor Chris Burden created "The Other Vietnam Memorial," an attempt to list the three million Vietnamese killed during the war. See Robert Storr, *Dislocations* (Museum of Modern Art, New York, 1991), 42–47.

Graphical timetables also exemplify the multiplicity and wholeness of micro/macro design. Described here is the overall structure of a railroad system, as the individual lines aggregate into systematic patterns. This computer-graphical timetable shown here governs Japanese high-speed trains, or *Shinkansen*. Station stops are plotted down the side of the grid; time of day runs across the top; diagonal lines show the space-time path of each train. The Tokyo control room directing these high-speed trains is filled with these graphical timetables, long paper strips used to help oversee thousands of journeys each day—a task which makes clear the enormous advantages of *seeing* information rather than tabulating data. Similar charts are also used for planning new schedules, with different interest groups negotiating where a train should stop and the frequency of service as they design a graphical timetable.[6]

[6] Hiroaki Shigehara, *Ressha Daiya* [Train Diagram] (Tokyo, 1983). An enchanting story of graphical timetable design is told by Hideo Ohki, "Transportation of Professional Baseball Spectators by Seibu Railways," *Japanese Railway Engineering*, 19 (1979), 19–23, describing a small railway serving baseball spectators. Considerations include irregular length of games, and spectators leaving early in event of a runaway. Railway workers monitor the game on television in order to adjust dynamically the train graph (as it is called, in a logic so visual that the graph entirely replaces entabled times).

Operation diagram for 12:00 noon, July 25, 1985, Tokaido and Sanyo Shinkansen Lines (bullet train), Japanese National Railroad control room, Tokyo.



Stem-and-leaf plots of statistical analysis also rely on micro/macro design. Each data point simultaneously states its value and fills a space representing one counted unit, like the names on the Vietnam Veterans Memorial, with those spaces in turn assembling to form a profile of the overall univariate distribution. Envisioned here are the heights of 218 volcanoes; each individual number helps to build the histogram. Micro-

0|9 = 900 feet

Stem-and-leaf displays:
heights of 218 volcanoes, unit 100 feet.

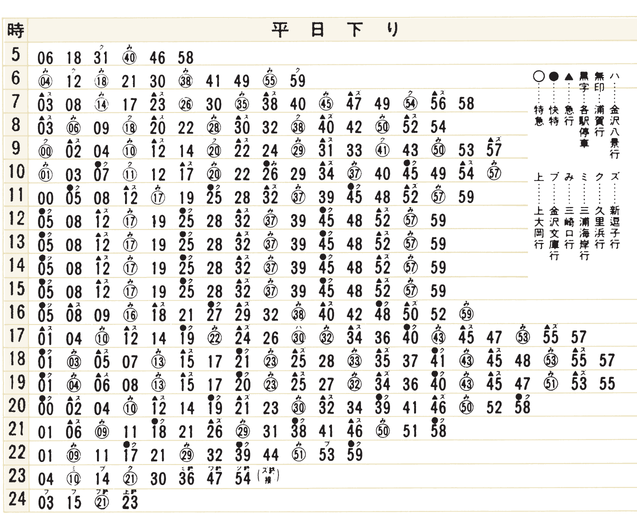
19|3 = 19,300 feet

| | |
|---|---|
| 0 | 98766562 |
| 1 | 97719630 |
| 2 | 69987766544422211009850 |
| 3 | 876655412099551426 |
| 4 | 99988443319294333361107 |
| 5 | 97666666554422210097731 |
| 6 | 898665441077761065 |
| 7 | 98855431100652108073 |
| 8 | 653322122937 |
| 9 | 377655421000493 |
| 10 | 0984433165212 |
| 11 | 4963201631 |
| 12 | 45421164 |
| 13 | 47830 |
| 14 | 00 |
| 15 | 676 |
| 16 | 52 |
| 17 | 92 |
| 18 | 5 |
| 19 | 39730 |

data has replaced the information-empty bars of a traditional barchart. This idea of making each graphical element *repeatedly* effective animated design of the stem-and-leaf plot. In describing his invention, John Tukey wrote: "If we are going to make a mark, it may as well be a meaningful one. The simplest—and most useful—meaningful mark is a digit."[7]

In a similar fashion, this train schedule below positions the individual departure times so that they add up to a frequency distribution. For trains that run often, leading hour-digits need not be repeated over and over, and, instead, minutes can be stacked:

[7] John W. Tukey, "Some Graphic and Semigraphic Displays," in T. A. Bancroft, ed., *Statistical Papers in Honor of George W. Snedecor* (Ames, Iowa, 1972), 296.



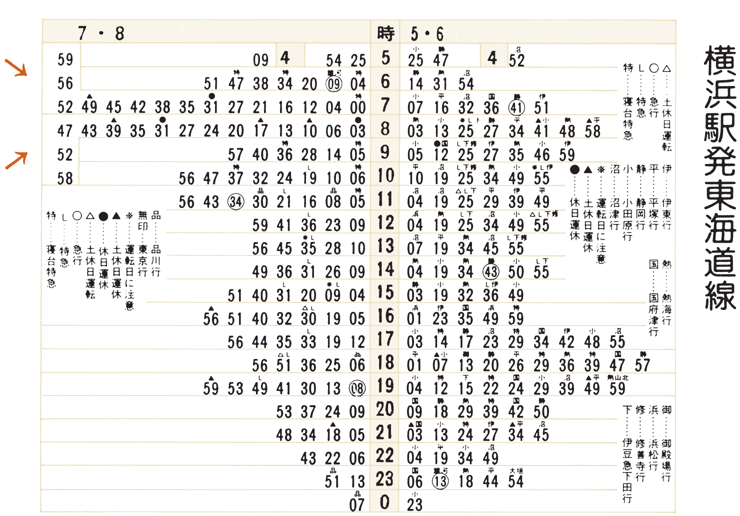

Keihin Express Line at Yokohama Station, Sagami Tetsudo Company, 1985 timetable, 76. Encodings indicate types of trains (super express, commuter, and so on) and various local stops.

Reported is the overall time distribution of 292 daily trains, with peaks during morning and evening rush hours. The shrewd design saves 777 characters, avoiding this typographical extravaganza below, which lacks the intensive annotation of the stem-and-leaf original and also fails to provide clear testimony about frequency of train service by hour.[8]

[8] The stem-and-leaf schedule contains 619 numbers; the typographic version 1,396 numbers and periods. Thus the stem-and-leaf schedule saves 777 characters, and, more importantly, gives a much a better sense of comparison of train times.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.06 | 7.17 | 8.28 | 9.31 | 10.40 | 11.57 | 13.12 | 14.28 | 15.45 | 16.52 | 17.53 | 18.45 | 19.40 | 20.39 | 21.51 | 23.36 |
| 5.18 | 7.23 | 8.30 | 9.33 | 10.45 | 11.59 | 13.17 | 14.32 | 15.48 | 16.59 | 17.55 | 18.48 | 19.43 | 20.41 | 21.58 | 23.47 |
| 5.31 | 7.26 | 8.32 | 9.41 | 10.49 | 12.05 | 13.19 | 14.37 | 15.52 | 17.01 | 17.57 | 18.53 | 19.45 | 20.46 | 22.01 | 23.54 |
| 5.40 | 7.30 | 8.38 | 9.43 | 10.54 | 12.08 | 13.25 | 14.39 | 15.57 | 17.04 | 18.01 | 18.55 | 19.47 | 20.50 | 22.09 | 24.03 |
| 5.46 | 7.35 | 8.40 | 9.50 | 10.57 | 12.12 | 13.28 | 14.45 | 15.59 | 17.10 | 18.03 | 18.57 | 19.51 | 20.52 | 22.11 | 24.15 |
| 5.58 | 7.38 | 8.42 | 9.53 | 11.00 | 12.17 | 13.32 | 14.48 | 16.05 | 17.12 | 18.05 | 19.01 | 19.53 | 20.58 | 22.17 | 24.21 |
| 6.04 | 7.40 | 8.50 | 9.57 | 11.05 | 12.19 | 13.37 | 14.52 | 16.08 | 17.14 | 18.07 | 19.04 | 19.55 | 21.01 | 22.21 | 24.23 |
| 6.12 | 7.45 | 8.52 | 10.01 | 11.08 | 12.25 | 13.39 | 14.57 | 16.09 | 17.19 | 18.13 | 19.06 | 20.00 | 21.06 | 22.29 | |
| 6.18 | 7.47 | 8.54 | 10.03 | 11.12 | 12.28 | 13.45 | 14.59 | 16.16 | 17.22 | 18.15 | 19.08 | 20.02 | 21.09 | 22.32 | |
| 6.21 | 7.49 | 9.00 | 10.07 | 11.17 | 12.32 | 13.48 | 15.05 | 16.18 | 17.24 | 18.17 | 19.13 | 20.04 | 21.11 | 22.39 | |
| 6.30 | 7.54 | 9.02 | 10.11 | 11.19 | 12.37 | 13.52 | 15.08 | 16.21 | 17.26 | 18.21 | 19.15 | 20.10 | 21.18 | 22.44 | |
| 6.38 | 7.56 | 9.04 | 10.12 | 11.25 | 12.39 | 13.57 | 15.12 | 16.27 | 17.30 | 18.23 | 19.17 | 20.12 | 21.21 | 22.51 | |
| 6.41 | 7.58 | 9.10 | 10.17 | 11.28 | 12.45 | 13.59 | 15.17 | 16.29 | 17.32 | 18.25 | 19.20 | 20.14 | 21.26 | 22.53 | |
| 6.49 | 8.03 | 9.12 | 10.20 | 11.32 | 12.48 | 14.05 | 15.19 | 16.32 | 17.34 | 18.28 | 19.23 | 20.19 | 21.29 | 22.59 | |
| 6.55 | 8.06 | 9.14 | 10.22 | 11.37 | 12.52 | 14.08 | 15.25 | 16.38 | 17.36 | 18.33 | 19.25 | 20.21 | 21.31 | 23.04 | |
| 6.59 | 8.09 | 9.20 | 10.26 | 11.39 | 12.57 | 14.12 | 15.28 | 16.40 | 17.40 | 18.35 | 19.27 | 20.23 | 21.38 | 23.10 | |
| 7.03 | 8.18 | 9.22 | 10.29 | 11.45 | 12.59 | 14.17 | 15.32 | 16.42 | 17.43 | 18.37 | 19.32 | 20.30 | 21.41 | 23.14 | |
| 7.08 | 8.20 | 9.24 | 10.34 | 11.48 | 13.05 | 14.19 | 15.37 | 16.48 | 17.45 | 18.41 | 19.34 | 20.32 | 21.46 | 23.21 | |
| 7.14 | 8.22 | 9.29 | 10.37 | 11.52 | 13.08 | 14.25 | 15.39 | 16.50 | 17.47 | 18.43 | 19.36 | 20.34 | 21.50 | 23.30 | |

In all these micro/macro designs, the same ink serves more than one informational purpose; graphical elements are multifunctioning. This suggests a missed opportunity in the stem-and-leaf timetable—surely leaves of numbers can grow from *both* sides of a central stem. And so it is; the finely detailed timetable below records trains running in several directions from the station, with the platforms 7-8 at left and platforms 5-6 at right (at the arrows, note how numbers serpentine around a bend when times for the morning rush hour exceed the grid). Sometimes this arrangement is called a "back to back stem-and-leaf plot." Nonetheless, Japanese train passengers have managed to use the schedules for decades without ever knowing the fancy name.

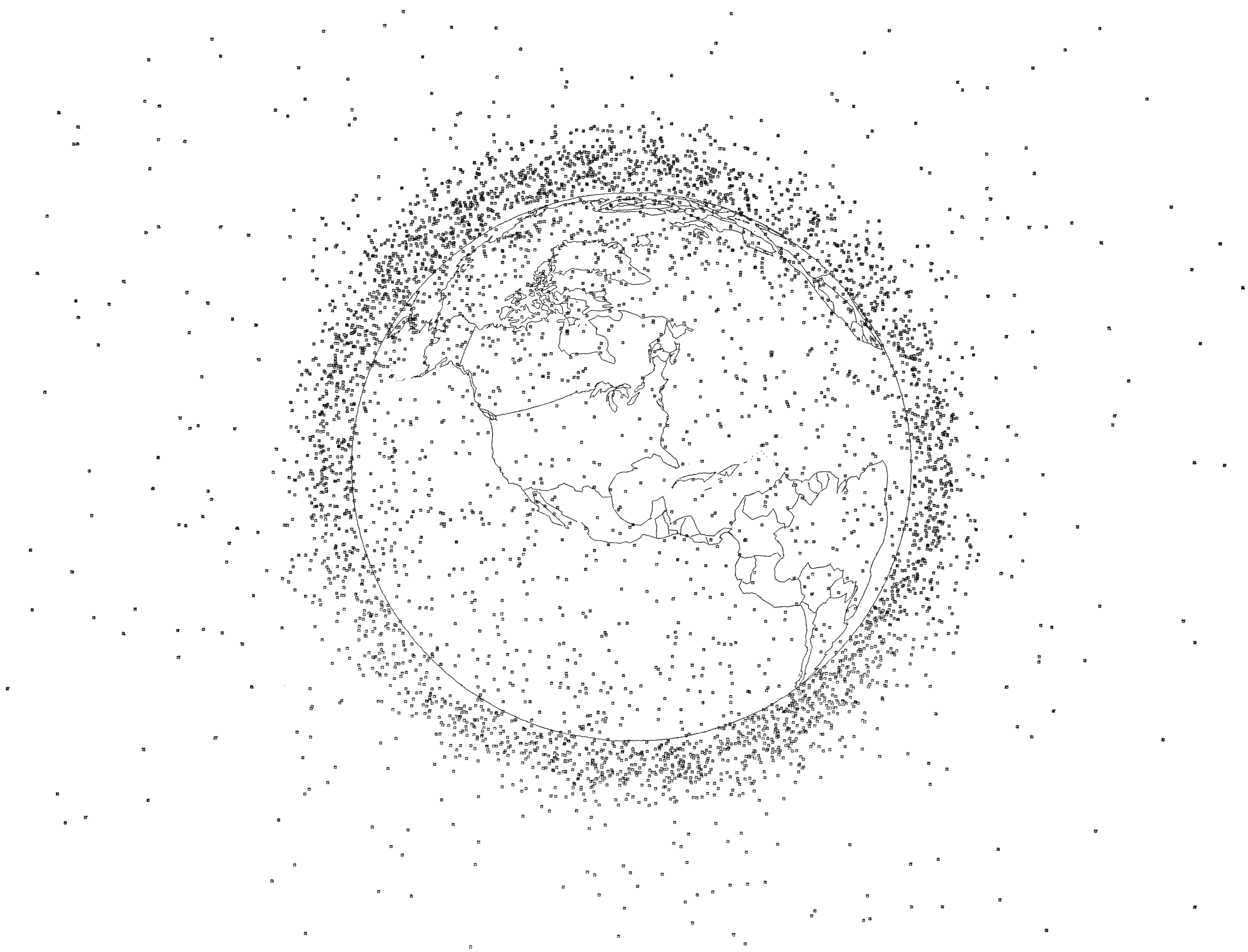

| 7・8 | 時 | 5・6 |
|---|---|---|
| 59 09 4 54 25 | 5 | 25 47 4 52 |
| 56 51 47 38 34 20 (09) 04 | 6 | 14 31 54 |
| 52 49 45 42 38 35 31 27 21 16 12 04 00 | 7 | 07 16 32 36 (41) 51 |
| 47 43 39 35 31 27 24 20 17 13 10 06 03 | 8 | 03 13 25 27 34 41 48 58 |
| 52 57 40 36 28 14 05 | 9 | 05 12 25 27 35 46 59 |
| 58 56 47 37 32 24 19 10 06 | 10 | 10 19 25 34 49 55 |
| 56 43 (34) 30 21 16 08 05 | 11 | 04 19 25 29 39 49 |
| 59 41 36 23 09 | 12 | 04 19 25 34 49 55 |
| 56 45 35 28 10 | 13 | 07 19 34 45 55 |
| 49 36 31 26 09 | 14 | 04 19 34 (43) 50 55 |
| 51 40 31 20 09 04 | 15 | 03 19 32 36 49 |
| 56 51 40 32 30 19 05 | 16 | 01 23 35 49 59 |
| 56 44 35 33 19 12 | 17 | 03 14 17 23 29 34 42 48 55 |
| 56 51 36 25 06 | 18 | 01 07 13 20 26 29 36 39 47 57 |
| 59 53 49 41 30 13 (08) | 19 | 04 12 15 22 24 29 39 49 59 |
| 53 37 24 09 | 20 | 09 18 29 39 42 50 |
| 48 34 18 05 | 21 | 03 13 24 27 34 45 |
| 43 22 06 | 22 | 04 19 34 49 |
| 51 13 | 23 | 06 (13) 18 44 54 |
| 07 | 0 | 23 |

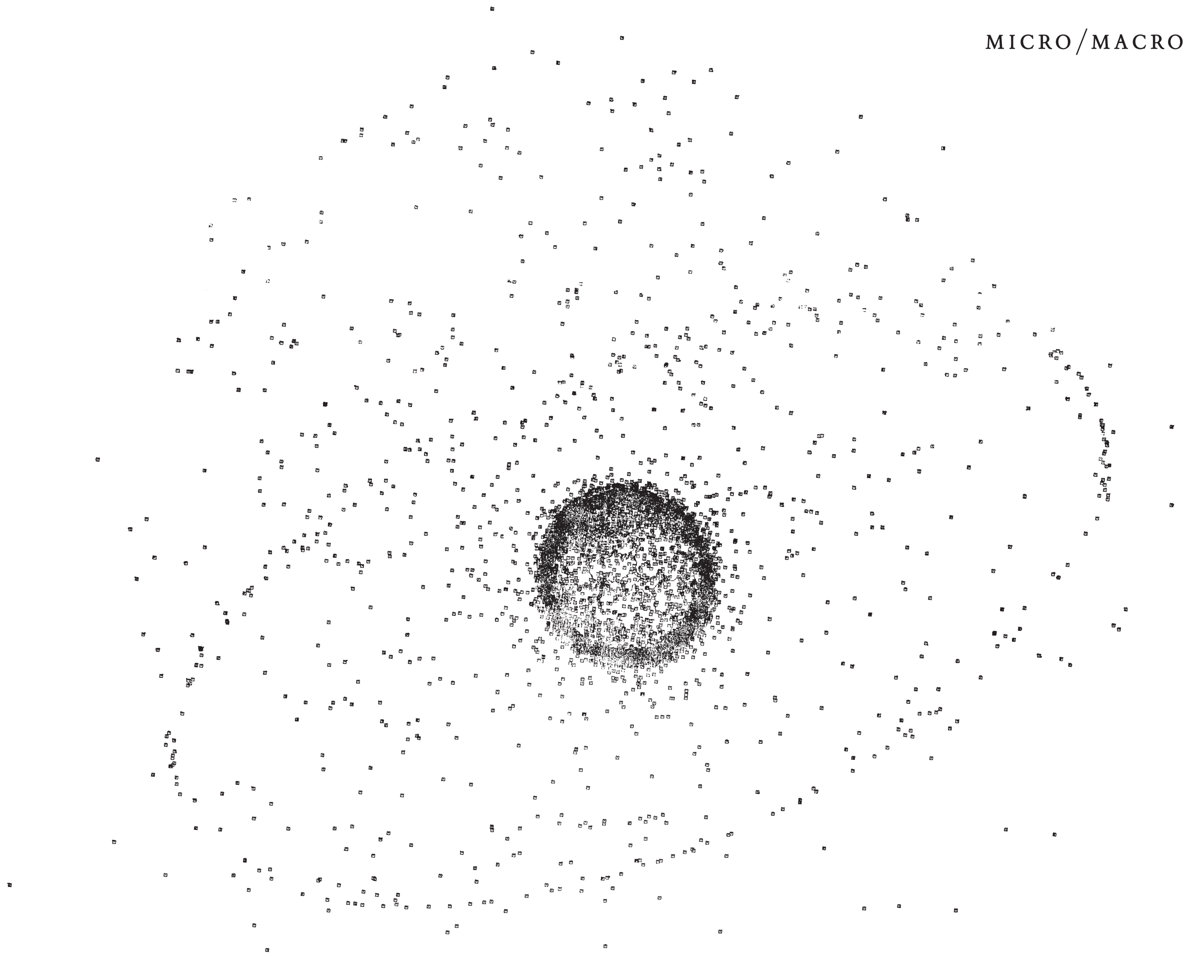


Tokaido Line at Yokohama Station, Sagami Tetsudo Company, 1985 timetable, 72.

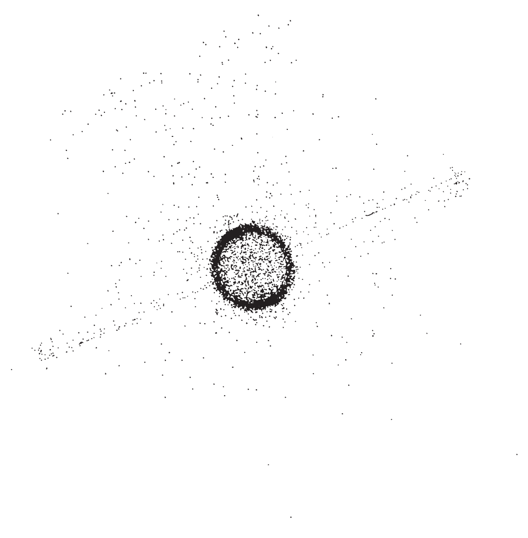
EACH at least as big as this drawing of the earth, some 7,000 pieces of space debris—operating and dead satellites, explosion fragments from rocket engines, garbage bags and frozen sewage dumped by astronauts, shrapnel from antisatellite weapons tests, 34 nuclear reactors and their fuel cores, an escaped wrench and a toothbrush—now orbit our world. Only about 5 percent are working satellites. By means of extraordinary data recording and analysis, military computers identify and then track *each* of these 7,000 objects (≥10 cm in diameter), in order to differentiate the debris from a missile attack, for which we may be thankful. Space is not totally self-cleaning; some of the stuff will be up there for centuries, endangering people and satellites working in space as well as inducing spurious astronomical observations. The risk of a damaging collision is perhaps 1 in 500 during several years in orbit. The volume of debris has doubled about every 5 years; future testing of space weapons will accelerate the trashing of space.[9]

[9] Donald J. Kessler and Burton G. Cour-Palais, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt," *Journal of Geophysical Research*, 83 (June 1, 1978), 2637–2646; Donald J. Kessler, "Earth Orbital Pollution," in Eugene C. Hargrove, ed., *Beyond Spaceship Earth* (San Francisco, 1986), 47–65; Nicholas L. Johnson, "History and Consequences of On-orbit Break-ups," in *Space Debris, Asteroids and Satellite Orbits*, D. J. Kessler, E. Grün, and L. Sehnal, eds., *Advances in Space Research*, 5 (Oxford, 1985), 11–19; Eliot Marshall, "Space Junk Grows with Weapons Tests," *Science*, 230 (October 25, 1985), 424–425; Joel R. Primack, "Gamma-Ray Observations of Orbiting Nuclear Reactors," *Science*, 244 (April 28, 1989), 407–408.





The consequences (as of 0:00 hours Universal time, July 1, 1987) are shown in these phenomenal and disheartening micro/macro images, as a multiplicity of 7,000 dots adds to the overall pattern of orbital pollution. Most of the debris is relatively close to earth; a more distant view shows a ring formed by geosynchronous satellites. Not shown are some 50,000 smaller objects (size between 1 cm and 10 cm), as well as 10 billion to 100 billion paint chips now in orbit.



Nearly all micro/macro designs of this chapter have portrayed large quantities of data at high densities, up to thousands of bits per square centimeter and 20 million bits per page, pushing the limits of printing technology. Such quantities are thoroughly familiar, although hardly noticed: the human eye registers 150 million bits, the 35 mm slide some 25 million bits, conventional large-scale topographic maps up to 150 million bits, the color screen of a small personal computer 8 million bits. Typographic densities are also substantial; a few reference books report 28,000 characters per page, books on non-fiction best-seller lists from 5,000 to 15,000 characters per page, and the world's telephone books run between 10,000 and 18,000 characters per page. Statistical graphics and other information displays should do so well.

Illustrations provided by Nicholas L. Johnson, Teledyne Brown Engineering, Colorado Springs, Colorado. Dots are not to scale of Earth.

We thrive in information-thick worlds because of our marvelous and everyday capacities to select, edit, single out, structure, highlight, group, pair, merge, harmonize, synthesize, focus, organize, condense, reduce, boil down, choose, categorize, catalog, classify, list, abstract, scan, look into, idealize, isolate, discriminate, distinguish, screen, pigeonhole, pick over, sort, integrate, blend, inspect, filter, lump, skip, smooth, chunk, average, approximate, cluster, aggregate, outline, summarize, itemize, review, dip into, flip through, browse, glance into, leaf through, skim, refine, enumerate, glean, synopsize, winnow the wheat from the chaff, and separate the sheep from the goats. And a lot of data are processed: recent evidence indicates that the optic nerve connecting eye's retina to brain operates at 10 Mb per second, equivalent to an Ethernet.[10]

Visual displays rich with data are not only an appropriate and proper complement to human capabilities, but also such designs are frequently optimal. If the visual task is contrast, comparison, and choice—as so often it is—then the more relevant information within eyespan, the better. Vacant, low-density displays, the dreaded posterization of data spread over pages and pages, require viewers to rely on visual memory—a weak skill—to make a contrast, a comparison, a choice.

Micro/macro designs enforce both local and global comparisons and, at the same time, avoid the disruption of context switching. All told, exactly what is needed for reasoning about information.[11]

High-density designs also allow viewers to select, to narrate, to recast and personalize data for their own uses. Thus control of information is given over to *viewers*, not to editors, designers, or decorators. Data-thin, forgetful displays move viewers toward ignorance and passivity, and at the same time diminish the credibility of the source. Thin data rightly prompts suspicions: "What are they leaving out? Is that really everything they know? What are they hiding? Is that all they did?" Now and then it is claimed that vacant space is "friendly" (anthropomorphizing an inherently murky idea) but *it is not how much empty space there is, but rather how it is used. It is not how much information there is, but rather how effectively it is arranged.*

Showing complexity often demands hard, thoughtful work. Detailed micro/macro designs have substantial costs for data collection, design, custom computing, image processing, and production—expenses similar to that of first-class cartography. But once there's a good template, intense data flows can be managed routinely, as the initial front-end investment in design is repaid by a great longrun template. And the usual economies of declining costs for each additional data packet may well persist. One excellent high-resolution data display image can replace 20 scattered slides. And our readers might keep that one really informative image, although they will surely discard those twenty slides and all their chartjunk, administrative debris, and empty space.

[10] Kristin Koch, Judith McLean, Ronen Segev, Michael A. Freed, Michael J. Berry, Vijay Balasubramanian, Peter Sterling, "How Much the Eye Tells the Brain," *Current Biology* 16 (July 25, 2006), 1428-1434.

[11] In user interfaces for computers, a problem undermining information exchange between human and software is "constant *context switches*. By this we mean that the user is not presented with one basic display format and one uniform style of interaction, but instead, with frequent changes: A scatterplot is present; it goes away, and is replaced by a menu; the menu goes away, and is replaced by the scatterplot; and so on. While the menu is present, the user cannot see the scatterplot, and vice versa. This means that users constantly have to adjust to a changing visual environment rather than focusing on the data. The user is also forced to remember things seen in one view so that he or she can use the other view effectively. This means that the user's short-term memory is occupied with the incidentals rather than with the significant issues of analysis." Andrew W. Donoho, David L. Donoho, and Miriam Gasko, "MacSpin: Dynamic Graphics on a Desktop Computer," *Computer Graphics & Applications* (July 1988), 58.

What about confusing clutter? Information overload? Doesn't data have to be "boiled down" and "simplified"? These common questions miss the point, for the quantity of detail is an issue completely separate from the difficulty of reading. *Clutter and confusion are failures of design, not attributes of information.* Often the less complex and less subtle the line, the more ambiguous and less interesting is the reading. Stripping the detail out of data is a style based on personal preference and fashion, considerations utterly indifferent to substantive content. What Josef Albers wrote about typography is true for information design:

> The concept that "the simpler the form of a letter the simpler its reading" was an obsession of beginning constructivism. It became something like a dogma, and is still followed by "modernistic" typographers.
>
> This notion has proved to be wrong, because in reading we do not read letters but words, words as a whole, as a "word picture." Ophthalmology has disclosed that the more the letters are differentiated from each other, the easier is the reading.
>
> Without going into comparisons and the details, it should be realized that words consisting of only capital letters present the most difficult reading—because of their equal height, equal volume, and, with most, their equal width. When comparing serif letters with sans-serif, the latter provide an uneasy reading. The fashionable preference for sans-serif in text shows neither historical nor practical competence.[12]

[12] Josef Albers, *Interaction of Color* (New Haven, 1963; revised edition, 1975), 4.

So much for the conventional, facile, and false equation: simpleness of data and design = clarity of reading. Simpleness is another aesthetic preference, not an information display strategy, not a guide to clarity. What we seek instead is a rich texture of data, a comparative context, an understanding of complexity revealed with an economy of means.

Robert Venturi opens his *Complexity and Contradiction in Architecture* with a broad extension of Albers' point:

> I like complexity and contradiction in architecture. . . . I speak of a complex and contradictory architecture based on the richness and ambiguity of modern experience, including that experience which is inherent in art. Everywhere, except in architecture, complexity and contradiction have been acknowledged, from Gödel's proof of inconsistency in mathematics to T. S. Eliot's analysis of "difficult" poetry and Joseph Albers' definition of the paradoxical quality of painting. . . . Architects can no longer afford to be intimidated by the puritanically moral language of orthodox Modern architecture . . . . an architecture of complexity and contradiction has a special obligation toward the whole: its truth must be in its totality or its implications of totality. It must embody the difficult unity of inclusion rather than the easy unity of exclusion. . . . Where simplicity cannot work, simpleness results. Blatant simplification means bland architecture. Less is a bore. [13]

[13] Robert Venturi, *Complexity and Contradiction in Architecture* (New York, 1966), 16–17.

But, finally, the deepest reason for displays that portray complexity and intricacy is that the worlds we seek to understand are complex and intricate."God is in the details," said Mies van der Rohe, capturing the essential quality of micro/macro performances.