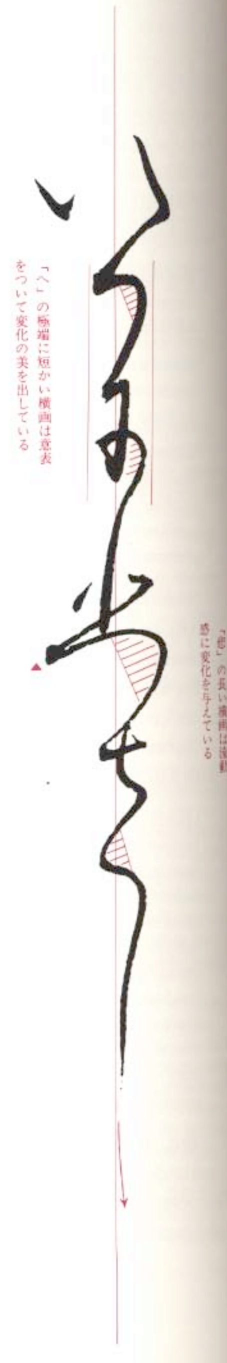

「へ」の極端に短かい横画は意表をついて変化の美を出している
「悲」の長い横画は流動感に変化を与えている


「へ」の極端に短かい横画は意表をついて変化の美を出している
「悲」の長い横画は流動感に変化を与えている

3 *Layering and Separation*

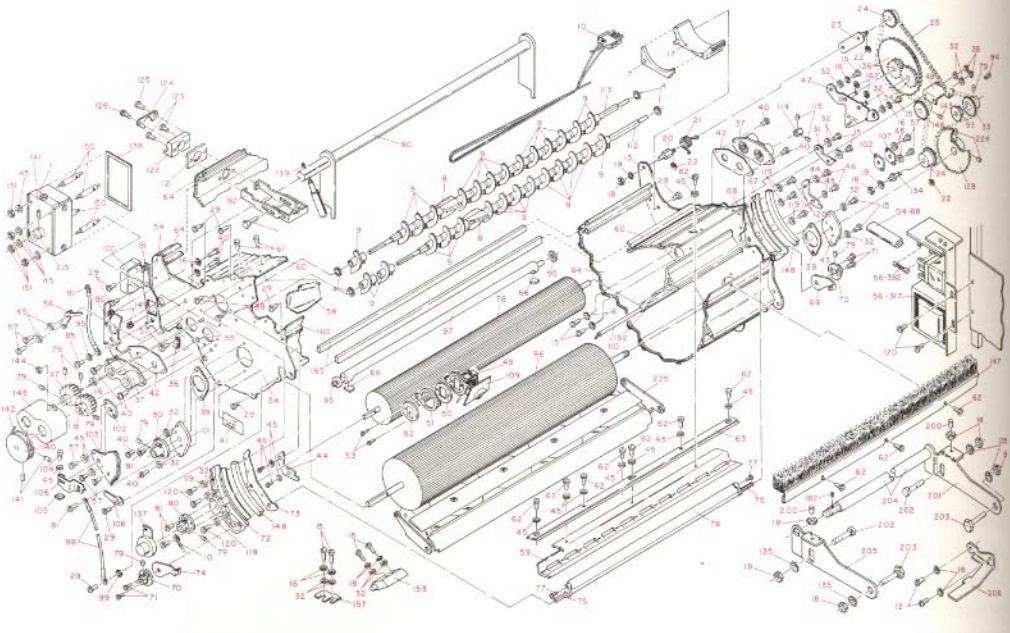
CONFUSION and clutter are failures of design, not attributes of information. And so the point is to find design strategies that reveal detail and complexity—rather than to fault the data for an excess of complication. Or, worse, to fault viewers for a lack of understanding. Among the most powerful devices for reducing noise and enriching the content of displays is the technique of layering and separation, visually stratifying various aspects of the data.

Effective layering of information is often difficult; for every excellent performance, a hundred clunky spectacles arise. An omnipresent, yet subtle, design issue is involved: the various elements collected together on flatland *interact*, creating non-information patterns and texture simply through their combined presence. Josef Albers described this visual effect as *1 + 1 = 3 or more*, when two elements show themselves along with assorted incidental by-products of their partnership—occasionally a basis for pleasing aesthetic effects but always a continuing danger to data exhibits.[1] Such patterns become dynamically obtrusive when our displays leave the relative constancy of paper and move to the changing video flatland of computer terminals. There, all sorts of unplanned and lushly cluttered interacting combinations turn up, with changing layers of information arrayed in miscellaneous windows surrounded by a frame of system commands and other computer administrative debris.

[1] Josef Albers, "One Plus One Equals Three or More: Factual Facts and Actual Facts," in Albers, *Search Versus Re-Search* (Hartford, 1969), pp. 17–18.

AT left a second color annotates the brush strokes of the calligrapher, Uboku Nishitani. By creating a distinct layer, the red commentary maintains detail, coherence, and serenity, in a crisp precision side-by-side with a gestural and expressive black line in this marriage of color and information. The saturated quality of the red partially offsets its lighter value and finer line (appropriate to meticulous annotation). Alone, each color makes a strong statement; together, a stronger one.

Uboku Nishitani, *Koyagire Daiishu* [*The First Seed of Koyagiri*], volume 17 of *Shodo Giho Koza* [*Techniques in Calligraphy*] (Tokyo, 1972), p. 56. Redrawn.



IBM Series III Copier/Duplicator, Adjustment Parts Manual (Boulder, Colorado, 1976), p. 101. Drawn by Gary E. Graham.

Similarly, color effortlessly differentiates between annotation and annotated, in this skillful industrial-strength diagram separating 300 small parts and their identifying numbers.

What matters—inevitably, unrelentingly—is the proper *relationship* among information layers. These visual relationships must be in relevant proportion and in harmony to the substance of the ideas, evidence, and data conveyed. "Proportion and harmony" need not be vague counsel; their meanings are revealed in the practice of detailed visual editing of data displays. For example, in this train timetable a heavy-handed grid interacts with the type, generating a stripy texture and fighting with the scheduled times. The prominent top position in the table shows the least important information, a four-digit train identifier used by railroad personnel and nobody else:

New Jersey Transit, *Northeastern Corridor Timetable* (Newark, 1985).

Train No.	3701	XM 3301	3801	A 67	3 3803	3 3201	A3 51	3 3703	3 3807	3 3203	A3 61	3 3809	A3 47	3 3901	3 3811	3 3903	3 3813	3205	3815	3817	3819	3207	3821	3823	3825	3209	3827	3829	3831
New York, N.Y.	A.M. 12 10	A.M. 12 40	A.M. 1.30	A.M. 3.52	A.M. 4.50	A.M. 6.10	A.M. 6.25	A.M. 6.35	A.M. 6.50	A.M. 7.10	A.M. 7.30	A.M. 7.33	A.M. 7.45	A.M. 7.50	A.M. 8.05	A.M. 8.25	A.M. 8.40	A.M. 8.50	A.M. 9.10	A.M. 9.40	A.M. 10.10	A.M. 10.25	A.M. 10.40	A.M. 11.10	A.M. 11.40	A.M. 11.50	P.M. **12.10**	P.M. **12.40**	P.M. **1.10**
Newark, N.J. P	12.24	12.55	1.44	4.07	5.04	6.24	6.38	6.49	7.04	7.24	7.45	7.47	7.59	8.04	8.19	8.39	8.54	9.04	9.24	9.54	10.24	10.39	10.54	11.24	11.54	**12.04**	**12.24**	**12.54**	**1.24**
North Elizabeth	....	....	....	....	....	....	....	....	....	7.30	....	....	....	8.10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Elizabeth	12.31	1.03	1.51	....	5.11	6.31	....	6.56	7.11	7.32	....	7.54	....	8.13	8.26	8.46	9.01	9.11	9.31	10.01	10.31	10.46	11.01	11.31	12.01	**12.11**	**12.31**	**1.01**	**1.31**
Linden	12.36	....	1.56	....	5.16	6.36	....	7.01	7.15	7.37	....	7.59	....	8.18	8.31	8.51	9.06	....	9.36	10.06	10.36	....	11.06	11.36	**12.06**	....	**12.36**	**1.06**	**1.36**
North Rahway	....	....	....	....	....	....	....	7.03	7.39	7.39	....	....	....	8.20	8.33	8.54	....	....	....	....	....	....	....	....	....	....	....	....	....
Rahway	12.40	1.11	2.00	....	5.20	6.40	....	7.06	7.20	7.42	....	8.03	....	8.24	8.36	8.57	9.10	9.18	9.40	10.10	10.40	10.53	11.10	11.40	**12.10**	**12.18**	**12.40**	**1.10**	**1.40**
Metro Park (Iselin)	12.44	....	2.04	4.26	5.24	....	6.56	7.10	7.25	....	8.04	8.07	8.15	....	8.40	....	9.14	....	9.44	10.14	10.44	....	11.14	11.44	**12.14**	....	**12.44**	**1.14**	**1.44**
Metuchen	12.48	....	2.08	....	5.28	....	....	7.14	7.29	....	....	8.11	....	....	8.44	....	9.18	....	9.48	10.18	10.48	....	11.18	11.48	**12.18**	....	**12.48**	**1.18**	**1.48**
Edison	12.51	....	2.11	....	....	....	....	7.17	7.32	....	....	8.14	....	....	8.47	....	9.21	....	....	10.21	....	....	11.21	....	**12.21**	....	....	**1.21**	....
New Brunswick	12.55	....	2.15	....	5.35	....	7.05	7.21	7.35	....	....	8.18	8.25	....	8.50	....	9.25	....	9.54	10.25	10.54	....	11.25	11.54	**12.25**	....	**12.54**	**1.25**	**1.54**
Jersey Avenue	1.02	....	2.18	....	....	....	....	7.28	....	....	....	8.21	....	....	....	....	9.28	....	....	10.28	....	....	11.28	....	**12.28**	....	....	**1.28**	....
Princeton Jct. S	....	....	2.31	....	5.50	....	7.19	....	7.50	....	....	8.34	8.41	....	9.05	....	9.41	....	10.09	10.41	11.09	....	11.41	**12.09**	**12.41**	....	**1.09**	**1.41**	**2.09**
Trenton, N.J.	....	....	2.42	4.58	6.03	....	7.28	....	8.01	....	8.31	8.44	8.52	....	9.16	....	9.52	....	10.16	10.52	11.19	....	11.52	**12.19**	**12.52**	....	**1.22**	**1.52**	**2.20**

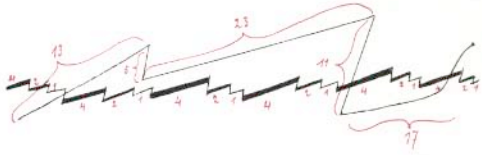
A redesign calms the dominating grid, moves the New York departure times to the very top, de-emphasizes less important data, and adds new information. A separating line is formed by tiny leader dots, which read as gray, making a distinction but not a barricade:

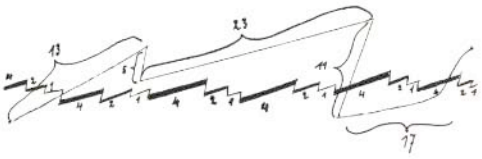
	am																							
New York, NY	12 10	12 40	1 30	3 52	4 50	6 10	6 25	6 35	6 50	7 10	7 30	7 33	7 45	7 50	8 05	8 25	8 40	8 50	9 10	9 40	10 10	10 25	10 40	11 10	11 40
Newark, NJ[P]	12 24	12 55	1 44	4 07	5 04	6 24	6 38	6 49	7 04	7 24	7 45	7 47	7 59	8 04	8 19	8 39	8 54	9 04	9 24	9 54	10 24	10 39	10 54	11 24	11 54
North Elizabeth										7 30				8 10											
Elizabeth	12 31	1 03	1 51		5 11	6 31		6 56	7 11	7 32		7 54		8 13	8 26	8 46	9 01	9 11	9 31	10 01	10 31	10 46	11 01	11 31	12 01
Linden	12 36		1 56		5 16	6 36		7 01	7 15	7 37		7 59		8 18	8 31	8 51	9 06		9 36	10 06	10 36		11 06	11 36	12 06
North Rahway								7 03		7 39				8 20	8 33	8 54									
Rahway	12 40	1 11	2 00		5 20	6 40		7 06	7 20	7 42		8 03		8 24	8 36	8 57	9 10	9 18	9 40	10 10	10 40	10 53	11 10	11 40	12 10
Metro Park (Iselin)	12 44		2 04	4 26	5 24		6 56	7 10	7 25		8 04	8 07	8 15		8 40		9 14		9 44	10 14	10 44		11 14	11 44	12 14
Metuchen	12 48		2 08		5 28			7 14	7 29			8 11			8 44		9 18		9 48	10 18	10 48		11 18	11 48	12 18
Edison	12 51		2 11					7 17	7 32			8 14			8 47		9 21			10 21			11 21		12 21
New Brunswick	12 55		2 15		5 35		7 05	7 21	7 35			8 18	8 25		8 50		9 25		9 54	10 25	10 54		11 25	11 54	12 25
Jersey Avenue	1 02		2 18					7 28				8 21					9 28			10 28			11 28		12 28
Princeton Junction[S]			2 31		5 50		7 19		7 50			8 34	8 41		9 05		9 41		10 09	10 41	11 09		11 41	12 09	12 41
Trenton, NJ			2 42	4 58	6 03		7 28		8 01		8 31	8 44	8 52		9 16		9 52		10 19	10 52	11 19		11 52	12 19	12 52
TRAIN NUMBER	3701	3301	3801	67	3803	3201	51	3703	3807	3203	61	3809	47	3901	3811	3903	3813	3205	3815	3817	3819	3207	3821	3823	3825
NOTES		XM		⟜	3	3	⟜3	3	3	3	⟜3	3	⟜3	3	3	3	3								

The focus is now given over to information, transparently organized by an *implicit* typographical grid, defined simply by the absence of type. Nevertheless, data-imprisonment spans centuries of information-design struggles. At right is a touchingly ramshackle grid from a 1535 edition of *Cosmographia*. But, from the virtuoso of typographic design: "Tables should not be set to look like nets with every number enclosed," wrote Jan Tschichold in *Asymmetric Typography:*

> The setting of tables, often approached with gloom, may with careful thought be turned into work of great pleasure. First, try to do without rules altogether. They should be used only when they are absolutely necessary. Vertical rules are needed only when the space between columns is so narrow that mistakes will occur in reading without rules. Tables without vertical rules look better; thin rules are better than thick ones.[2]

Even quite small changes in line can have significant visual effects. For Paul Klee's sketch, the easy and graceful separation of black line and red commentary collapses into a mishmash when color and light/dark differences are minimized:





[2] Jan Tschichold, *Asymmetric Typography* (Basel, 1935; Toronto, 1967), p. 62.

Paul Klee, *Symptomatic.* Pen and ink drawing, 1927/F2. From *Das bildnerische Denken* (Basel, 1956), p. 300.

Separate macro-annotation explains the micro-detail of hospital costs in this 26-day narrative of one person passing through an intensive care unit. The design is transparent to the disturbing information, as a layered polyphony of voices—time sequence, accounting data, commentary—weave together to trace out days, hours, minutes, dollars.

Redrawn from David Hellerstein, "The Slow, Costly Death of Mrs. K——," *Harper's*, 268 (March 1984), 84–89.

Mrs. K—— has been taken to the emergency room of a renowned hospital on Manhattan's Upper East Side. The doctors "work her up." More than $200 worth of blood tests are ordered ("emer rm lab," "lab serology out"), $232 worth of X-rays taken, $97.50 worth of drugs administered. I never saw Mrs. K——, she wasn't in my hospital, I don't know her medical history. But I am a doctor, and can reconstruct from her hospital bill what is going on, more or less. She is sick, very sick.

Mrs. K—— has been moved to the Intensive Care Unit ("room ICU"). It costs $500 a day to stay in the ICU, base rate. California has the highest average ICU rates in the country: $632 a day. In Mississippi, the average is $265. ICUs were developed in the 1960s. They provide technological life-support systems and allow for extraordinary patient monitoring. An inhalation blood-gas monitor ("inhal blood gas mont") is being used to keep a close check on the amount of oxygen in her blood. Without the attention she is receiving in the ICU, Mrs. K—— might already be dead.

Mrs. K—— has been running a high fever. The doctors have sent cultures of her blood, urine, and sputum to the lab to find out why. She is put on gentamicin ("lab gentamycin troug"), a powerful antibiotic. Such strong drugs can have toxic side effects. Gentamicin kills bacteria, but can also cause kidney failure.

It is Mrs. K——'s fifth day at the hospital, and she is slipping closer to death: her lungs begin to fail. She is put on a respirator ("inhal respirator"), which costs $119 a day to rent and requires a special technician to operate. A hospital can buy the machine for about $15,000.

BILL TO: JOHN K——

INSURANCE COVERAGE: BLUE CROSS STD 21

DATE	DESCRIPTION		TOTAL CHARGES
DETAIL	OF CURRENT CHARGES AND PAYMENTS		
09/23	EMER RM OTHER	5009000	119.00
09/23	EMER RM LAB	5006000	172.00
09/23	LAB SEROLOGY OUT	1406800	35.00
09/23	EMER RM EKG	5007000	61.00
09/23	X-RAY ABDOMEN	1501000	58.00
09/23	X-RAY CHEST RTN	1501009	58.00
09/23	X-RAY CHEST RTN	1501009	58.00
09/23	PHARMACY	2601000	2.25
09/23	EMER RM PHARMACY	5002000	46.00
09/23	PHARMACY	2601000	49.25
09/23	ROOM ICU		500.00
09/24	LAB AUTO BLOOD CT	1402101	17.00
09/24	LAB ACT PAR THROM	1404001	27.00
09/24	LAB PROTH DETER	1404011	17.00
09/24	LAB BLOOD CULT	1405002	37.00
09/24	LAB BLOOD CULT	1405002	37.00
09/24	LAB CHEM-20	1401104	31.00
09/24	SP HEM CBC	1402010	28.00
09/24	SP HEM RETIC CT	1402046	17.00
09/24	SP HEM PLATELET CT	1402091	17.00
09/24	LAB SEROLOGY OUT	1406800	35.00
09/24	LAB MAGNES	1401042	27.00
09/24	LAB RTN URINAL	1403000	31.00
09/24	LAB RTN CULT	1405003	37.00
09/24	LAB BACTERIA SM	1405011	16.00
09/24	LAB RTN CULT	1405003	37.00
09/24	LAB DIFF	1402099	15.00
09/24	LAB PROT ELEC	1401042	27.00
09/24	LAB FUNGUS	1405008	31.00
09/24	LAB FUNGUS	1405008	31.00
09/24	LAB TBC CULT	1405014	42.00
09/24	LAB DIFF	1402099	15.00
09/24	LAB AUTO BLOOD CT	1402101	17.00
09/24	X-RAY CHEST-BED	1501128	74.00
09/24	PHARMACY	2601000	10.00
09/24	PHARMACY	2601000	8.00
09/24	PHARMACY	2601000	8.00
09/24	PHARMACY	2601000	4.50
09/24	SPECIMEN MUCUS TRAP	2709085	3.00
09/24	SPECIMEN MUCUS TRAP	2709035	3.00
09/24	INHAL BLOOD GAS MONT	2101034	354.00
09/24	ROOM ICU		500.00
09/25	LAB SALICYLATE	1401050	49.00
09/25	LAB AMMONIA	1401006	40.00
09/25	LAB CHEM-20	1401104	31.00
09/25	LAB PROTH DETER	1404011	17.00
09/25	LAB CHEM-8	1401111	31.00
09/25	LAB BACTERIA SM	1405011	16.00
09/25	LAB AUTO BLOOD CT	1402101	17.00
09/25	LAB AUTO BLOOD CT	1402101	17.00
09/25	LAB ACT PAR THROM	1404001	27.00
09/25	LAB TBC CULT	1405014	42.00
09/25	LAB TBC CULT	1405014	42.00
09/25	LAB FUNGUS	1405008	31.00
09/25	LAB RTN CULT	1405003	37.00
09/25	LAB RTN CULT	1405003	37.00
09/25	CARDIO ROUTINE EKG	1801001	61.00
09/25	X-RAY CHEST-BED	1501128	74.00
09/25	X-RAY ABDOMEN	1501001	58.00
09/25	X-RAY CHEST-BED	1501128	74.00
09/25	PHARMACY	2601000	13.50
09/25	PHARMACY	2601000	3.00
09/25	PHARMACY	2601000	3.70
09/25	PHARMACY	2601000	14.50
09/25	PHAR IV SOLUTIONS	2601003	16.00
09/25	PHARMACY	2601000	2.50
09/25	PHAR IV SOLUTIONS	2601003	12.50
09/25	PHAR IV SOLUTIONS	2601003	13.50
09/25	PHARMACY	2601000	3.35
09/25	PHARMACY	2601000	2.25
09/25	INHAL BLOOD GAS MONT	2101014	354.00
09/25	ROOM ICU		500.00
09/26	LAB PROTH DETER	1404011	17.00
09/26	LAB CHEM-8	1401111	31.00
09/26	LAB AUTO BLOOD CT	1402101	17.00
09/26	LAB UR SODIUM	1401077	27.00
09/26	LAB UR POTASS	1401076	27.00
09/26	LAB DIFF	1402099	15.00
09/26	LAB CHEM-8	1401111	31.00
09/26	LAB GENTAMYCIN TROUG	1401137	27.00
09/26	CARDIO ROUTINE EKG	1801001	61.00
09/26	X-RAY CHEST BED	1501128	74.00
09/26	PHARMACY	2601000	31.20
09/26	PHARMACY	2601000	3.70
09/26	PHARMACY	2601000	13.50
09/26	PHARMACY	2601000	39.00
09/27	LAB CHEM-8	1401111	31.00
09/27	LAB PROTH DETER	1404011	17.00
09/27	LAB DIFF	1402099	15.00
09/27	LAB AUTO BLOOD CT	1402101	17.00
09/27	LAB ACT PAR THROM	1404001	27.00
09/27	LAB CHEM-8	1401111	31.00
09/27	LAB CHEM-20	1401104	31.00
09/27	LAB CHEMISTRY OUT	1401800	10.00
09/27	LAB FECES CULT	1405007	10.00
09/27	LAB CARDIO ROUTINE EKG	1801001	61.00
09/27	BLD BK ANTIBDY SCRN	1701004	23.00
09/27	BLD BK ADMIN FEE	1701028	23.00
09/27	PHAR IV SOLUTIONS	2601003	37.50
09/27	PHAR IV SOLUTIONS	2601003	11.00
09/27	PHAR IV SOLUTIONS	2601003	13.50
09/27	PHAR IV SOLUTIONS	2601003	13.50
09/27	PHAR IV SOLUTIONS	2601003	40.50
09/27	PHARMACY	2601000	11.00
09/27	PHARMACY	2601000	3.70
09/27	PHARMACY	2601000	13.50
09/27	PHARMACY	2601000	39.00
09/27	PHARMACY	2601000	3.70
09/27	PHARMACY	2601000	2.50
09/27	PACK CE 250 PROC FEE	1701078	46.00
09/27	25 NSA SOMU PROC FEE	1701077	35.00
09/27	INFUSION PUMP	2705527	30.00
09/27	INHAL RESPIRATOR	2102015	119.00
09/27	ROOM ICU		500.00
09/28	OPER OP RM 150	1001005	521.00
09/28	LAB OCC BLOOD	1403021	16.00
09/28	LAB GENTAMYCIN TROUG	1401137	27.00
09/28	LAB DIFF	1402079	15.00
09/28	LAB RTN CULT	1405003	37.00
09/28	CARDIO ROUTINE EKG	1801001	61.00
09/28	BLD BK GROUP RH	1701002	28.00
09/28	BLD BK MATCH	1701006	46.00
09/28	BLD BK ANTIBDY SCRN	1701004	23.00
09/28	X-RAY CHEST-BED	1501128	74.00
09/28	X-RAY CHEST-BED	1501128	74.00
09/28	PHARMACY	2601000	11.00
09/28	PHAR IV SOLUTIONS	2601003	13.50
09/28	PHAR IV SOLUTIONS	2601003	59.00
09/28	PHARMACY	2601000	3.70
09/28	PHARMACY	2601000	39.00
09/28	PHARMACY	2601000	9.00
09/28	PHARMACY	2601000	13.50
09/28	ANEST ANEST DRUGS	1103001	12.40
09/28	INHAL RESPIRATOR	2102015	119.00
09/28	OPER OP RM SUPPLY	1002000	198.00
09/28	SUCT MACHINE-CONT	2704015	22.00
09/28	DIAL SOLN 1.5-CASE	2709040	24.00
09/28	INHAL BLOOD GAS MONT	2101034	354.00
09/29	LAB CHEM-8	1401111	31.00
09/29	LAB CHEM-20	1701102	28.00
09/29	LAB AUTO BLOOD CT	1402101	17.00
09/29	LAB DIFF	1402099	15.00
09/29	LAB DIAG SM/MILL	1407002	40.00
09/29	LAB AUTO BLOOD CT	1402101	17.00
09/29	LAB AUTO BLOOD CT	1402101	17.00
09/29	LAB DIFF	1402099	15.00
09/29	LAB DIFF	1402099	15.00
09/29	LAB GENTAMYCIN TROUG	1401137	27.00
09/29	LAB SP FL CELL CT	1402018	26.00
09/29	LAB CHEM-8	1401111	31.00
09/29	LAB CHEM-8	1401111	31.00
09/29	LAB CHEM-8	1401111	31.00
09/29	LAB FUNGUS	1405008	31.00
09/29	LAB BACTERIOLOGY OUT	1405800	35.00
09/29	LAB OVA & PARASITES	1405018	31.00
09/29	LAB PHAECELL BLOCK	1407003	53.00
09/29	LAB FIBRIN QUAN	1404007	40.00
09/29	LAB COAG FIBRIN SPLT	1404018	49.00
09/29	LAB ACT PAR THROM	1404001	27.00
09/29	LAB AUTO BLOOD CT	1402101	17.00
09/29	LAB FROZEN SECT	1408004	119.00
09/29	LAB RTN CULT	1405003	37.00
09/29	BLD BK COLD AGG	1701007	18.00
09/29	BLD BK ADMIN FEE	1701028	23.00
09/29	X-RAY CHEST-BED	1501128	74.00
09/29	X-RAY ABDOMEN	1501001	58.00
09/29	PHARMACY	2601000	13.50
09/29	PHARMACY	2601000	11.00
09/29	PHAR IV SOLUTIONS	2601003	13.50
09/29	PHARMACY	2601000	39.00
09/29	PHARMACY	2601000	3.70
09/29	ISOLATION GLOVES-BOX	2706025	9.00
09/29	HEEL-ELBOW PROTECTOR	2706025	9.00
09/29	HEEL-ELBOW PROTECTOR	2706025	9.00
09/29	DIAL PERID KIT 87110	2708015	14.00
09/29	DIAL SOLN 1.5 CASE	2709040	24.00
09/29	SPECIMEN MUCUS TRAP	2709035	3.00
09/29	INHAL BLOOD GAS MONT	2101034	354.00
09/29	INHAL BLOOD GAS MONT	2101034	354.00
09/29	INHAL BLOOD GAS MONT	2101034	354.00
09/29	ROOM ICU		500.00
09/30	LAB AUTO BLOOD CT	1402101	17.00
09/30	LAB CHEM-8	1401111	31.00
09/30	LAB CHEM-8	1401111	31.00
09/30	LAB DIFF	1402099	15.00
09/30	SP HEM COAG STDY COM	1402007	239.00
09/30	SP HEMATOLOGY	1402003	49.00
09/30	SP HEM RETIC CT	1402046	17.00
09/30	SP HEM CBC	1402010	28.00
09/30	LAB BACTERIA SM	1405011	16.00
09/30	LAB ACT PAR THROM	1404001	27.00
09/30	LAB PROTH DETER	1404011	17.00
09/30	LAB FIBRIN QUAN	1404007	40.00
09/30	LAB AUTO BLOOD CT	1402101	17.00
09/30	LAB CHEM-20	1401104	31.00
09/30	LAB CULT	1405014	42.00
09/30	LAB CHEM-20	1401104	31.00
09/30	LAB RTN CULT	1405003	37.00
09/30	LAB RTN CULT	1405003	37.00
09/30	BLD BK ADMIN FEE	1701028	207.00
09/30	X-RAY CHEST-BED	1501128	74.00
09/30	X-RAY CHEST-BED	1501128	74.00
09/30	PHAR IV SOLUTIONS	2601003	14.00
09/30	PHARMACY	2601000	39.00
09/30	PHAR IV SOLUTIONS	2601003	21.00
09/30	PHAR IV SOLUTIONS	2601003	16.00
09/30	PHARMACY	2601000	3.70
09/30	PHARMACY	2601000	13.50
09/30	PHARMACY	2601000	11.00
09/30	PHARMACY	2601000	2.25
09/30	PHAR IV SOLUTIONS	2601003	21.00
09/30	PHAR IV SOLUTIONS	2601003	21.00
09/30	PHAR IV SOLUTIONS	2601003	18.50
09/30	PHARMACY	2601000	2.50
09/30	PLAT CONC PROC FEE	1701014	180.00
09/30	FRSH FR PLA PROC FEE	1701019	26.00
09/30	INHAL RESPIRATOR	2102015	119.00
09/30	DRESSING SET-DISP.	2708041	7.00
09/30	VEST RESTRAINT	2709033	12.00
09/30	INHAL BLOOD GAS MONT	2101034	354.00
09/30	ROOM ICU		500.00
10/01	LAB CHEM-20	1401104	31.00
10/01	LAB CHEM-8	1401111	31.00
10/01	LAB CHEM-8	1401111	31.00
10/01	LAB CHEM-8	1401111	31.00
10/01	LAB DIFF	1402099	15.00
10/01	LAB AUTO BLOOD CT	1402101	17.00
10/01	BLD BK ADMIN FEE	1701028	23.00
10/01	X-RAY CHEST-BED	1501128	74.00
10/01	PHAR IV SOLUTIONS	2601003	37.50
10/01	PHARMACY	2601000	13.50
10/01	PHARMACY	2601000	11.00
10/01	PHARMACY	2601000	3.70
10/01	PHARMACY	2601000	31.20
10/01	PHARMACY	2601000	2.40
10/01	PHARMACY	2601000	27.20
10/01	PHAR IV SOLUTIONS	2601003	13.50
10/01	25 NSA SOMU PROC FEE	1701077	35.00
10/01	INHAL RESPIRATOR	2102015	119.00
10/02	PHARMACY	2601000	27.20

Mrs. K——'s first week in Intensive Care ends in a flourish of blood tests. She has five Chem-8s ("lab chem-8")—tests that measure the levels of sodium, potassium, and six other chemicals in her blood. The hospital charges Mrs. K——$31 for each Chem-8. Most independent labs charge about half as much; some hospitals charge up to $60. The *New England Journal of Medicine* has said: "The clinical laboratory [is] a convenient profit center that can be used to support unrelated deficit-producing hospital operations." The *Annals of Internal Medicine* estimates that the number of clinical lab tests being done is rising 15 percent a year.

Mrs. K—— has started peritoneal dialysis ("dial-perid kit 87110"). Her kidneys are failing. She is still hooked up to the respirator. She is being kept alive by what Lewis Thomas calls "halfway technologies" — "halfway" because kidney dialysis machines and respirators can support organ systems for long periods of time, but can't cure the underlying disease. Some doctors are beginning to question this practice. A recent study at the George Washington University Medical Center concluded: "Substantial medical resources are now being used in aggressive but frequently futile attempts to avoid death."

Mrs. K—— has been put in a vest restraint. Restraints are used in Intensive Care to keep patients from thrashing about or pulling their tubes out. Many ICU patients develop what is called "ICU psychosis." They become disoriented, begin hallucinating. The condition is brought on by lack of sleep, toxic drugs, the noise of the ICU staff and machines, and pain.

Mrs. K ____ has been on the respirator for six days. It is breathing for her. But there has been a problem. The tube running from the machine into her mouth and down her throat was not bringing enough oxygen to her lungs. She needed a tracheotomy ("trach care set"). The tube from the respirator is now attached directly to her trachea, through a hole cut into her neck.

This charge—for a blood product ("5 NSA 250MU proc fee") —is not covered by Mrs. K ____ 's Blue Cross policy. The policy also does not cover the cost of fresh blood plasma ("frsh fr pla proc fee"). These charges have been mounting. Mrs. K ____ is bleeding internally.

Mrs. K ____ has been in Intensive Care for two weeks. She is still running a very high fever. The doctors are still testing. Mrs. K ____ has been placed on a special blanket; it is hooked up to a machine that functions like a refrigerator ("hypothermia machine"). The machine cools the blanket, and the blanket helps lower Mrs. K ____ 's body temperature. Should her temperature rise too high, she may suffer permanent brain damage.

Mrs. K ____ has undergone a gated blood-pool study ("nuc med sec/pool sty"). The doctors have "tagged" her red blood cells with a radioactive isotope. Using a camera that picks up the isotope, the doctors can watch the passage of blood through her heart. In this way, they see firsthand whether the ventricles are functioning properly—whether enough blood is getting pumped, enough oxygen is being sent through the body. First her lungs, then her kidneys. Now Mrs. K ____ 's heart seems to be going.

10/02		PHARMACY	2601000	27.20
10/02		PHARMACY	2601000	2.40
10/02		PHARMACY	2601000	2.50
10/02		PHARMACY	2601000	2.25
10/02	FRSH FR PLA PROC FEE		1701019	26.00
10/02	TRACH CARE SET		2705009	3.00
10/02	TRACH CARE SET		2705009	3.00
10/02	TRACH CARE SET		2705009	3.00
10/02	TRACH CARE SET		2705009	3.00
10/03	INHAL BLOOD GAS MONT		2101034	354.00
10/03	ROOM ICU			500.00
10/04	LAB CHEM-8		1401111	31.00
10/04	LAB AUTO BLOOD CT		1402101	17.00
10/04	LAB PROTH DETER		1404011	17.00
10/04	LAB DIFF		1402099	15.00
10/04	LAB ACT PAR THROM		1404001	27.00
10/04	LAB RTN URINAL		1403001	36.00
10/04	LAB RTN CULT		1405003	37.00
10/04	BLD BK ADMIN FEE		1701028	69.00
10/04	X-RAY CHEST-BED		1501128	74.00
10/04	PHAR IV SOLUTIONS		2601003	16.00
10/04	PHAR IV SOLUTIONS		2601003	11.00
10/04	PHAR IV SOLUTIONS		2601003	58.50
10/04	PHAR IV SOLUTIONS		2601003	21.00
10/04	PHARMACY		2601000	55.50
10/04	PHARMACY		2601000	31.20
10/04	PHARMACY		2601000	2.40
10/04	PHARMACY		2601000	5.00
10/04	25 NSA SOMU PROC FEE		1701077	35.00
10/04	FRSH FR PLA PROC FEE		1701019	52.00
10/04	INHAL BLOOD GAS MONT		2101034	354.00
10/04	ROOM ICU			500.00
10/05	LAB AUTO BLOOD CT		1402101	17.00
10/05	LAB DIFF		1402099	15.00
10/05	LAB CHEM-8		1401111	31.00
10/05	LAB CHEM-20		1401104	31.00
10/05	LAB CORTISOL		1401021	27.00
10/05	LAB ACTH		1401021	27.00
10/05	LAB RTN CULT		1405003	37.00
10/05	LAB ACT PAR THROM		1404001	27.00
10/05	LAB PROTH DETER		1404011	17.00
10/05	BLD BK ADMIN FEE		1701028	46.00
10/05	X-RAY CHEST-BED		1501128	74.00
10/05	XRAY SONOGRAM		1505012	117.00
10/05	PHAR IV SOLUTIONS		2601003	23.50
10/05	PHARMACY		2601000	2.40
10/05	PHARMACY		2601000	31.20
10/05	PHARMACY		2601000	55.50
10/05	PHARMACY		2601000	2.40
10/05	PHAR IV SOLUTIONS		2601003	50.00
10/05	PHARMACY		2601000	96.00
10/05	PHARMACY		2601000	15.00
10/05	5 NSA SOMU PROC FEE		1701076	35.00
10/05	25 NSA SOMU PROC FEE		1701077	35.00
10/05	DIALYSIS CART		2704008	70.00
10/05	INHAL BLOOD GAS MONT		2101034	354.00
10/05	ROOM ICU			500.00
10/06	LAB CHEM-20		1401104	31.00
10/06	LAB ACT PAR THROM		1404001	27.00
10/06	LAB PROTH DETER		1404011	17.00
10/06	LAB DIFF		1402099	15.00
10/06	LAB AUTO BLOOD CT		1402101	17.00
10/06	LAB CHEM-8		1401111	31.00
10/06	LAB CHEM-20		1401104	31.00
10/06	LAB BLOOD CULT		1405002	37.00
10/06	LAB BLOOD CULT		1405002	37.00
10/06	LAB PROTH DETER		1404011	17.00
10/06	LAB ACT PAR THROM		1404001	27.00
10/06	BLD BK ADMIN FEE		1701028	23.00
10/06	X-RAY CHEST-BED		1501128	74.00
10/06	X-RAY CHEST-BED		1501128	74.00
10/06	PHAR IV SOLUTIONS		2601003	26.00
10/06	PHARMACY		2601000	2.40
10/06	PHARMACY		2601000	55.50
10/06	PHARMACY		2601000	31.20
10/06	PHAR IV SOLUTIONS		2601003	99.00
10/06	PHARMACY		2601000	249.60
10/06	PHAR IV SOLUTIONS		2601003	13.50
10/06	PHAR IV SOLUTIONS		2601003	37.50
10/06	PHARMACY		2601000	2.40
10/06	25 NSA SOMU PROC FEE		1701077	35.00
10/06	INFUSION PUMP		2705027	30.00
10/06	DIAL SOLN 1.5-CASE		2709040	24.00
10/06	HYPOTHERMIA MACHINE		2704006	25.00
10/06	ROOM ICU			500.00
10/07	LAB ACT PAR THROM		1404001	27.00
10/07	LAB PROTH DETER		1404011	17.00
10/07	LAB AUTO BLOOD CT		1402101	17.00
10/07	LAB DIFF		1402099	15.00
10/07	LAB CHEM-8		1401111	31.00
10/07	LAB CHEM-8		1401111	31.00
10/07	LAB CHEM-20		1401104	31.00
10/07	LAB CHEM-8		1401111	31.00
10/07	LAB CHEM-20		1401104	31.00
10/07	LAB CHEM-8		1401111	31.00
10/08	PHARMACY		2601000	55.50
10/08	PHARMACY		2601000	31.20
10/08	PHAR IV SOLUTIONS		2601003	18.50
10/08	PHARMACY		2601000	5.00
10/08	PHARMACY		2601000	5.00
10/08	PHARMACY		2601000	5.00
10/08	PHARMACY		2601000	62.00
10/08	INHAL RESPIRATOR		2102015	119.00
10/08	ISOLATION GLOVES-BOX		2709025	7.00
10/08	DIAL SOLN 1.5-CASE		2709040	24.00
10/08	INHAL BLOOD GAS MONT		2101034	354.00
10/08	ROOM ICU			500.00
10/09	LAB ACT PAR THROM		1404001	27.00
10/09	LAB PROTH DETER		1404011	17.00
10/10	LAB ACT PAR THROM		1404001	27.00
10/10	CARDIO ROUTINE EKG		1801001	61.00
10/10	X-RAY CHEST-BED		1501128	74.00
10/11	LAB CHEM-8		1401111	31.00
10/11	LAB CHEM-8		1401111	31.00
10/11	ROOM ICU			500.00
10/12	PHAR IV SOLUTIONS		2601003	37.50
10/12	PHARMACY		2601000	2.40
10/12	25 NSA SOMU PROC FEE		1701077	70.00
10/12	INHAL RESPIRATOR		2102015	119.00
10/12	INHAL RESPIRATOR		2102015	119.00
10/12	DIAL SOLN 1.5-CASE		2709040	24.00
10/12	PLASTIC TRACH TUBE		2705007	26.00
10/12	PLASTIC TRACH TUBE		2705007	26.00
10/12	DIALYSIS CART		2704008	70.00
10/12	INHAL BLOOD GAS MONT		2101034	354.00
10/12	ROOM ICU			500.00
10/13	LAB DIFF		1402099	15.00
10/13	LAB AUTO BLOOD CT		1402101	17.00
10/13	LAB PROTH DETER		1404011	17.00
10/13	LAB ACT PAR THROM		1404001	27.00
10/13	LAB CHEM-20		1401104	31.00
10/13	LAB CHEM-8		1401111	31.00
10/13	LAB CHEM-8		1401111	31.00
10/13	LAB CHEM-8		1401111	31.00
10/13	LAB CHEM-8		1401111	31.00
10/13	LAB DIFF		1402099	15.00
10/13	LAB RTN CULT		1405003	37.00
10/13	LAB AUTO BLOOD CT		1402101	17.00
10/13	LAB BACTERIA SM		1405011	16.00
10/13	LAB RTN CULT		1405003	37.00
10/13	LAB RTN CULT		1405003	37.00
10/13	NUC MED SEC/POOL STY		3001021	170.00
10/13	BLD BK ADMIN FEE		1701028	23.00
10/13	BLD BK ANTIBDY SCRN		1701004	23.00
10/13	BLD BK DIR COOMBS		1701031	18.00
10/13	X-RAY CHEST-BED		1501128	74.00
10/13	PHARMACY		2601000	2.40
10/13	PHAR IV SOLUTIONS		2601003	26.00
10/13	PHAR IV SOLUTIONS		2601003	26.00
10/13	PHARMACY		2601000	31.20
10/13	PHARMACY		2601000	55.50
10/13	PHARMACY		2601000	14.50
10/13	PHARMACY		2601000	2.40
10/13	PHAR IV SOLUTIONS		2601003	21.00
10/14	PACK CE 250 PROC FEE		1701013	92.00
10/14	25 NSA SOMU PROC FEE		1701077	35.00
10/14	INHAL RESPIRATOR		2102015	119.00
10/14	INHAL BLOOD GAS MONT		2101034	354.00
10/14	ROOM ICU			500.00
10/15	LAB CHEM-8		1401111	31.00
10/15	LAB CHEM-20		1401104	31.00
10/15	LAB INDIA INK		1405009	17.00
10/15	LAB FUNGUS		1405008	31.00
10/15	LAB TBC CULT		1405014	42.00
10/15	LAB HETER MONO		1406005	25.00
10/15	LAB UR ELECTROPHORES		1403007	26.00
10/15	LAB CHEM-8		1401111	31.00
10/15	LAB CHEM-8		1401111	31.00
10/15	LAB SP FL CELL CT		1402018	26.00
10/15	LAB CHEM-8		1401111	31.00
10/15	LAB SP FL GLUC		1401056	27.00
10/15	LAB SP FL PROT		1401057	27.00
10/15	LAB MAGNES		1401042	27.00
10/15	LAB TOT BILI		1401008	28.00
10/16	LAB CHEM-8		1401111	31.00
10/16	LAB CHEM-8		1401111	31.00
10/16	LAB AUTO BLOOD CT		1402101	17.00
10/16	LAB RTN CULT		1405003	37.00
10/16	LAB ANTIBIOT SENS		1405001	40.00
10/16	LAB BACTERIA SM		1405011	16.00
10/16	X-RAY CHEST-BED		1501128	74.00
10/16	PHAR IV SOLUTIONS		2601003	13.50
10/16	PHARMACY		2601000	14.50
10/16	PHARMACY		2601000	2.40
10/16	PHARMACY		2601000	31.20
10/16	PHARMACY		2601000	2.40
10/16	PHARMACY		2601000	24.00
10/16	PHARMACY		2601000	297.00
10/16	INHAL RESPIRATOR		2102015	119.00
10/16	HYPOTHERMIA MACHINE		2704006	25.00
10/16	ISOLATION GLOVES-BOX		2709025	7.00
10/16	ISOLATION GLOVES-BOX		2709025	7.00
10/16	INHAL BLOOD GAS MONT		2101034	354.00
10/16	ROOM ICU			500.00
10/17	TELEPHONE CHARGE		0000002	48.00
10/17	LAB ACT PAR THROM		1404001	27.00
10/17	LAB CHEM-8		1401111	31.00
10/17	LAB CHEM-8		1401111	31.00
10/17	LAB CHEM-20		1401104	31.00
10/17	LAB CHEM-8		1401111	31.00
10/17	LAB PROTH DETER		1404011	17.00
10/17	LAB CHEM-20		1401104	31.00
10/17	X-RAY CHEST-BED		1501128	74.00
10/17	PHARMACY		2601000	55.50
10/17	PHARMACY		2601000	31.20
10/17	PHARMACY		2601000	2.40
10/17	PHARMACY		2601000	25.00
10/17	PHARMACY		2601000	2.40
10/17	PHARMACY		2601000	2.40
10/17	PHARMACY		2601000	14.50
10/17	PHARMACY		2601000	.80
10/17	PHARMACY		2601000	2.25
10/17	PHARMACY		2601000	2.40
10/17	PHAR IV SOLUTIONS		2601003	13.50
10/17	PHAR IV SOLUTIONS		2601003	37.50
10/17	PHAR IV SOLUTIONS		2601003	16.00
10/17	PHAR IV SOLUTIONS		2601003	21.00
10/17	PHAR IV SOLUTIONS		2601003	13.50
10/17	PHAR IV SOLUTIONS		2601003	16.00
10/17	PHAR IV SOLUTIONS		2601003	16.00
10/17	PHAR IV SOLUTIONS		2601003	16.00
10/17	PHAR IV SOLUTIONS		2601003	50.00
10/17	PHAR IV SOLUTIONS		2601003	37.50
10/17	PHAR IV SOLUTIONS		2601003	37.50
10/17	PHAR IV SOLUTIONS		2601003	16.00
10/18	PLAT CONC PROC FEE		1701014	117.50
10/18	25 NSA SOMU PROC FEE		1701077	35.00
10/18	INHAL RESPIRATOR		2102015	119.00
10/18	INHAL BLOOD GASES		2101006	119.00
10/18	INHAL BLOOD GASES		2101006	119.00

SUMMARY OF CHARGES

OPERATING ROOM	521.00
DRUGS	6361.50
BLOOD SERV & FRACT	1389.50
LABORATORY	11201.00
X-RAY	2870.00
SUPPLIES	3698.00
EKG, EEG, ETC.	366.00
THERAPY	8734.00
MICS NON COVERED	167.00
R&C IN.CARE 24 DAYS 500.00/DAY	12000.00
SUB-TOTAL OF CHARGES	47311.20

TOTAL 47311.20

Mrs. K ____ 's fourth week in the hospital begins with a spinal tap. Using a long needle, a doctor drains fluid from her spinal cord. The fluid is sent to the lab for about a dozen tests ("lab sp fl cell ct"). A spinal tap is performed when a patient has what are called "neurological signs." Partial paralysis is one such sign, loss of consciousness another. When doctors order a spinal tap, they suspect brain disease.

Weeks of halfway technology have given the doctors time for testing. The doctors may even have diagnosed what is wrong with Mrs. K ____ ; it is hard to say. But the ICU and its technology have not given them the ability to cure her. Now the heart, which has been failing, gives out. Cardiac arrest. There is a burst of activity. Bicarbonate, epinephrine, and other drugs ("pharmacy") are administered. Thirteen bottles of intravenous solution ("phar iv solutions") are poured in.

Mrs. K ____ 's last minutes are recorded on the various ICU monitors. The level of oxygen in her blood falls. She dies.

Mrs. K ____ 's bottom line. Total cost of twenty-six days in the hospital, nearly all this time in Intensive Care: $47,311.20. Of this, Blue Cross will pay $41,933.87. The doctors' bills, not covered by hospitalization insurance, probably come to thousands of dollars more. Perhaps Mrs. K ____ had Blue Shield, which covers doctors' fees. In 1982, the last year for which figures are available, Americans spent $322 billion on health care. Of this, $135.5 billion was spent on hospital care. There were 56,241 ICU beds in 1982 like the one Mrs. K ____ was kept alive in, and about $27 billion was spent for their use. That represented nearly one percent of the gross national product.

All elements in the map at right—contours, rivers, roads, names—are at the same visual level with equal values, equal texture, equal color, and even nearly equal shape. An undifferentiated, unlayered surface results, jumbled up, blurry, incoherent, chaotic with unintentional optical art. What we have here is a failure to communicate.

Far more detailed than the perfect jumble, this map below separates and layers information by means of distinctions in shape, value (light to dark), size, and especially color. The negative areas are also informative;

Simla, India (U.S. Army map series U 502, NH 43–4, 1954), based on the Survey of India, 1921–1943.

Tokyo Prefecture. Musashino, Ueno Park, Kurumazaka area (Tokyo, 1884).

light strips formed by the grid of buildings identify roads and paths. The water symbol is a blue field, further differentiated from other color fields by a gentle fading away from each outlined edge. Shown against a dull background rather than bright white, these colors remain both calm and distinctive, avoiding clutter. The map exemplifies the "first rule of color composition" of the illustrious Swiss cartographer, Eduard Imhof:

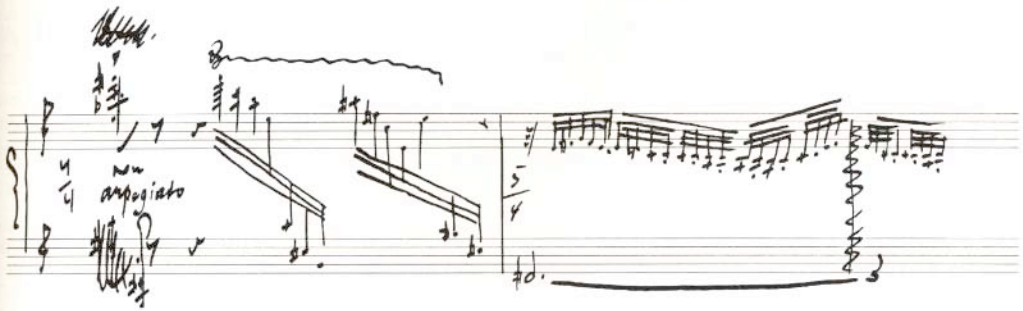
> Pure, bright or very strong colors have loud, unbearable effects when they stand unrelieved over large areas adjacent to each other, but extraordinary effects can be achieved when they are used sparingly on or between dull background tones. "Noise is not music . . . only on a quiet background can a colorful theme be constructed," claims Windisch.[3]

[3] Eduard Imhof, *Cartographic Relief Presentation* (Berlin, 1982), edited and translated by H. J. Steward from Imhof's *Kartographische Geländedarstellung* (Berlin, 1965), p. 72. The internal quotation is from H. Windisch, *Schule der Farbenphotographie* (Seebruck, 6th edition, 1958).

Signal and background compete above, as an electrocardiogram traceline becomes caught up in a thick grid. Below, the screened-down grid stays behind traces from each of 12 monitoring leads:[4]

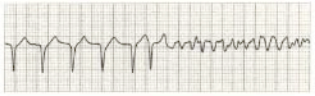
Similarly for music notation, some staff paper is better than others:

In Stravinsky's sketchbook for *Sacre du printemps*, a grid quietly but clearly and precisely locates the music. Gray grids almost always work well and, with a delicate line, may promote more accurate data reading



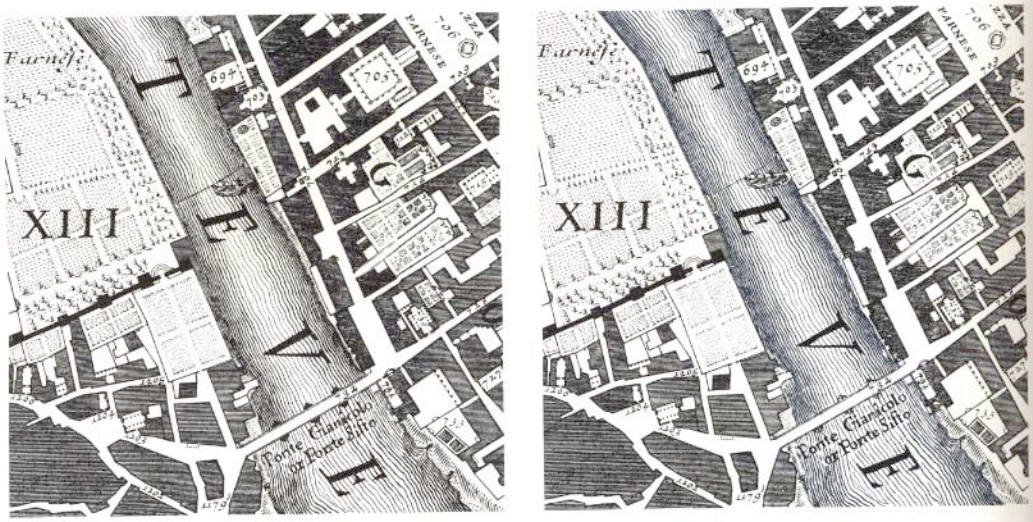
and reconstruction than a heavy grid. Dark grid lines are chartjunk. When a graphic serves as a look-up table (rare indeed), then a grid may help with reading and interpolation. But even then the grid should be muted relative to the data. Often ready-made graph paper comes with darkly printed lines. The reverse unprinted side should be used, for then lines show through faintly and do not clutter the data. If the paper is heavily gridded on both sides, throw it out.

[4] The preferred example is redrawn from J. Marcus Wharton and Nora Goldschlager, *Interpreting Cardiac Dysrhythmias* (Oradell, New Jersey, 1987), p. 123. Color also layers, as a gray grid calibrates this signal of ventricular fibrillation, a final collapse of the



heart, with only a disorganized rhythm remaining. A similar trace can result from recording artifacts such as a loose monitoring wire; however, one textbook dryly notes, "As the patient will usually have lost consciousness by the time you have realized that it is not just due to a loose connection, diagnosis is easy." John R. Hampton, *The ECG Made Easy* (Edinburgh, 1986), p. 66.

Igor Strawinsky, *Sacre-Skizzenbuch*, p. 135, top; Paul Sacher Stiftung, Kunstmuseum Basel, and in Hans Oesch, "Im Schatten des *Sacre du printemps* Beobachtungen zu den Trois poésies de la lyrique japonaise, einem Schlüsselwerk von Igor Strawinsky," *Komponisten des 20. Jahrhunderts in der Paul Sacher Stiftung* (Basel, 1986), p. 100.



In the masterly 1748 Nolli map of Rome, the river's heavy inking activates what should be a visually tranquil area, causing bridge names and a little boat to vibrate in a moiré prison, albeit a quiet one. Muting the river encoding calms vibration and brings names and other details forward, while retaining a symbolism of rippling water.[5] This redesign and others that we have seen are visual equivalents of Italo Calvino's approach to writing:

> My working method has more often than not involved the subtraction of weight. I have tried to remove weight, sometimes from people, sometimes from heavenly bodies, sometimes from cities; above all I have tried to remove weight from the structure of stories and from language. . . . Maybe I was only then becoming aware of the weight, the inertia, the opacity of the world—qualities that stick to writing from the start, unless one finds some way of evading them.[6]

Layering of data, often achieved by felicitous subtraction of weight, enhances representation of both data dimensionality and density on flatland. Usually this involves creating a hierarchy of visual effects, possibly matching an ordering of information content. Small, modest design moves can yield decisive visual results, as in these intriguing demonstrations of the illusory borders of subjective contours:

[5] Giambattista Nolli, *Pianta Grande di Roma* (Rome, 1748; from a facsimile edition by J. H. Aronson, Highmount, New York, 1984). Note the seemingly English word "or" in the names under the bridge, a result of the 18th-century custom of contracting the Italian *ora*, meaning *now, at this time, currently*. On his map, Nolli cites first the old name *Ponte Gianicolo or[a] Ponte Sisto* (the bridge's new name). Ironically, the English "or" works in this context, although the meaning is not quite right. See Barbara Reynolds, *The Cambridge Italian Dictionary, Italian-English* (Cambridge, 1962), p. 521.

[6] Italo Calvino, *Six Memos for the Next Millennium* (Cambridge, 1988), pp. 3–4.

Gaetano Kanizsa, "Contours without Gradients or Cognitive Contours?" *Italian Journal of Psychology*, 1 (April 1974), 93–112; and Gaetano Kanizsa, "Subjective Contours," *Scientific American*, 234 (April 1976), 48–52.

Visual activation of negative areas of white space in these exhibits illustrates *the endlessly contextual and interactive nature of visual elements.* This idea is captured in a fundamental principle of information design: *1 + 1 = 3 or more.* In the simplest case, when we draw two black lines, a third visual activity results, a bright white path between lines (note that this path appears even to have an angled end). And a complexity

of marks generates an exponential complexity of negative shapes. *Most of the time, that surplus visual activity is non-information, noise, and clutter.*[7] This two-step logic—recognition of 1 + 1 = 3 effects and the consideration that they generate noise—provides a valuable guide for refining and editing designs, for graphical reasoning, for subtraction of weight.[8]

In a little-known essay on 1 + 1 = 3 effects, Josef Albers conducts the demonstrations below, a visually sensitive and artistic approach to the cognitive contours of perceptual psychologists. Albers, seeing area and surface rather than border and edge, escapes the preoccupying magic of optical illusions to conceive a broad idea of negative space activation:

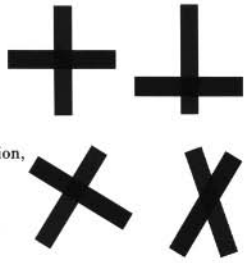
Here I have 2 equal strips of cardboard (1" x 6")

Here is one (vertical), here another (also vertical).
Seeing one strip plus one strip, we count 2 strips:
1 + 1 = 2.

We recognize the equal width of the strips.
Now, 1 width + 1 width (strips touching)
equals 2 widths: 1 + 1 = 2.

But now, separating them (both remain vertical)
by 1 width — we count 3 widths
(one of them negative): 1 + 1 = 3.

Of the 2 vertical strips,
one crosses the other horizontally
in their centers.
Result: 2 lines form a crossing
thus producing 4 arms, as 4 extensions,
to be read inward as well as outward.
We also see 4 rectangles, and with some imagination,
4 triangles, 4 squares.
By shifting centers and angles,
arms and the in-between figures become unequal.



All together: one line plus one line
results in many meanings — *Quod erat demonstrandum.*

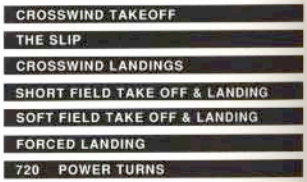
Keith Haring, Untitled 4/29/82, sumi ink on paper. © 1992 Estate of Keith Haring.

[7] Rare exceptions are the Turgot-Bretez map of Paris and the Nolli map of Rome: streets, absent of ink, are defined—tersely, clearly, and precisely—by the surrounding ink of blocks and buildings, creating subjective contours.

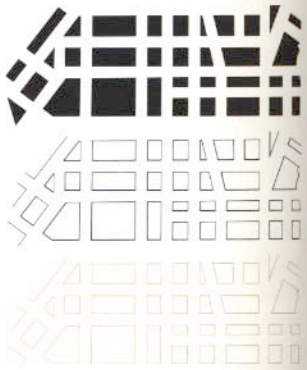
[8] Note the additional 1 + 1 = 3 effects, on this page, as the interaction between the examples and the surrounding type enlivens the white space, forming shapes, profiles, and paths. These reverberations are vivid because our examples are printed in black; strong light/dark contrasts accentuate the clutter of 1 + 1 = 3 or more.

Josef Albers, "One Plus One Equals Three or More: Factual Facts and Actual Facts," in Albers, *Search Versus Re-Search* (Hartford, 1969), pp. 17–18.

Stumbling over 1 + 1 = 3 has produced perhaps the worst index ever designed, a rare perfect failure. The preface to this guide for flying small aircraft says, "This manual is primarily intended for use during actual flight instruction." Imagine now noisy vibration in a plane as we search through this visually vibrating list, looking for, say, an entry on "forced landing" . . . and the index turns out to have no page numbers. Only a small segment of the unbearable original is shown.

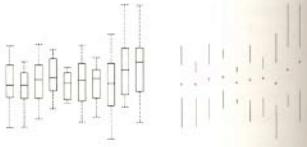


The noise of 1 + 1 = 3 is directly proportional to the contrast in value (light/dark) between figure and ground. On white backgrounds, therefore, a varying range of lighter colors will minimize incidental clutter. Three maps at right show these tactics in action. In the first, the bold shapes promote vibration all over; and with only nameless streets down on paper, this map is already in visual trouble. At center, thinning two sides of each block results in every street bordered by one thick *and* one thin line, thus deflecting 1 + 1 = 3 effects (the thin lines, like gray lines, are *visually* light in value). On the bottom map, gray establishes serene, motionless edges—an arrangement that will easily accommodate additional geographic detail.



Middle map above, student project by Jon Wertheimer, Studies in Graphic Design, Yale University, 1985–1986.

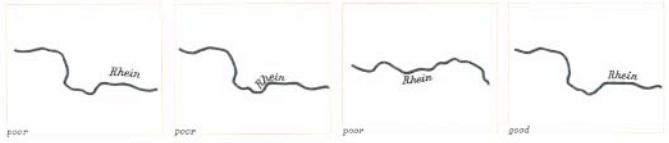
Careful visual editing diminishes 1 + 1 = 3 clutter. These are not trivial cosmetic matters, for signal enhancement through noise reduction can reduce viewer fatigue as well as improve accuracy of readings from a computer interface, a flight-control display, or a medical instrument. Clarity is not everything, but there is little without it. Editing this statistical graph (showing variability about local averages) remedies the visual clutter induced by parallel lines and equal-width white bands. The redesign, at far right, sweeps the noise away, with color spots now smartly tracking the path of averages.



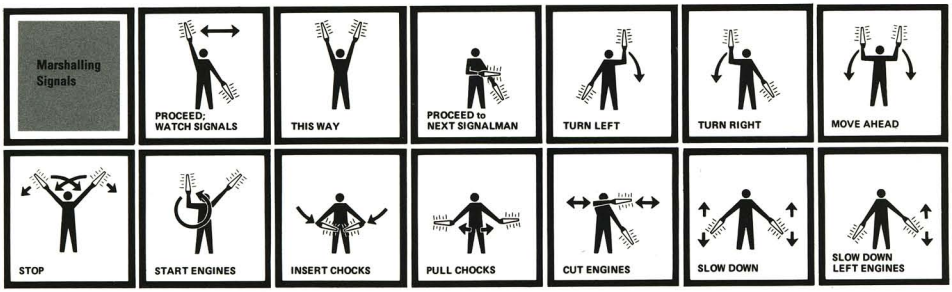
John W. Tukey, *Exploratory Data Analysis* (Reading, Massachusetts, 1977), p. 269; and, right, Edward R. Tufte, *The Visual Display of Quantitative Information* (Cheshire, Connecticut, 1983), p. 125.

Harmonizing text and line-drawing requires sensitive appraisals of prolific interaction effects. Unless deliberate obscurity is sought, avoid surrounding words by little boxes, which activate negative white spaces

between word and box. And below, the first three maps place the type poorly, with an awkward white stripe materializing between name and river. Type from above adjusts to graphics better, in part because most words have fewer descenders than ascenders (in map 3, a diverting white shape is formed by the ascending letters).[9] These small local details will promptly accumulate on the entire map surface, deciding quality.



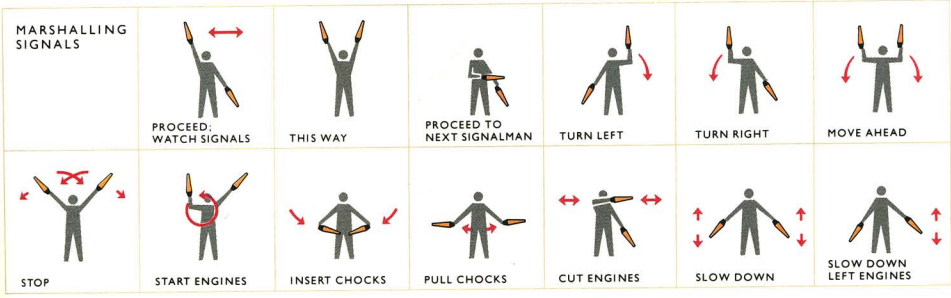
[9] Eduard Imhof, "Die Anordnung der Namen in der Karte," *International Yearbook of Cartography*, 2 (1962), 93–129; and, in English translation, "Positioning Names on Maps," *The American Cartographer*, 2 (1975), 128–144; showing here 4 of Imhof's total of 106 examples! Also, Paul Bühler, "Schriftformen und Schrifterstellung unter besonderer Berücksichtigung der schweizerischen topographischen Kartenwerke," *International Yearbook of Cartography*, 1 (1961), 153–181.



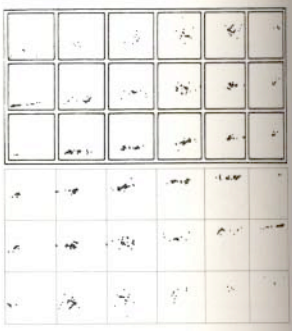
This array above, an information prison, employs a narrow range of strong shapes. Grid, silhouette, and type compete at the same nervous visual level. Too loud and too similar. Thick bars of grid boxes generate little paths around both type and silhouette by exciting the negative white space: 1 + 1 = 3, all over again. Why should the trivial task of dividing up the already free-standing elements become the dominant statement of the entire display?

To direct attention toward the information at hand, the revision below extends the light to dark range of color, separating and layering the data in rough proportion to their relevance. Gray calms a contrasty silhouette, bringing about in turn more emphasis on the lamps and their position and motion. Coloring these lights helps to separate the signals from all the rest. Some 460 lamp-whiskers were erased, whiskers which originally read in confusion as glowing light and also trembling motion. Note the effectiveness and elegance of *small spots of intense, saturated color* for carrying information—a design secret of classical cartography[10] and, for that matter, of traffic lights. Finally, in our revised version, the type for the title (upper left corner) has emerged from its foggy closet. Also the labels, now set in Gill Sans, are no longer equal in visual weight to the motion arrows, among several typographical refinements.

[10] "If one limits strong, heavy, rich, and solid colors to the small areas of extremes, then expressive and beautiful colored area patterns occur. . . . Large area background or base-colors do their work most quietly, allowing the smaller, bright areas to stand out most vividly, if the former are muted, grayish or neutral." Eduard Imhof, *Cartographic Relief Presentation* (Berlin, 1982), edited and translated by H. J. Steward from Imhof's *Kartographische Geländedarstellung* (Berlin, 1965), p. 72. On visual issues and map-making, see essays by Samuel Y. Edgerton, Jr., Svetlana Alpers, Juergen Schulz, Ulla Ehrensvärd, James A. Welu, and David Woodward, in Woodward, ed., *Art and Cartography* (Chicago, 1987).



In the statistical graphic at top, the visually most active elements are, of all things, glowing optical white dots that appear at each intersection of grid lines. (The arrangement of many computer interfaces is similarly overwrought.) The doubled-up, tremor-inducing lines consume 18 percent of this technically ingenious chart, a multi-window plot. Here the redrawing, in ungrid style, eliminates the visual noise, concentrating our viewer's attention on data rather than data containers.



Too often epidemics of data-imprisonment and decorative gridding break out when contemporary commercial designers are faced with information. The aggressive visual presence of stylized grids, little boxes surrounding words here and there, and cadenced accents—all so empty of content, irrelevant—becomes the only way you can tell if something has been "designed". At any rate, the self-important grid is for the birds, providing only a nice place to perch:

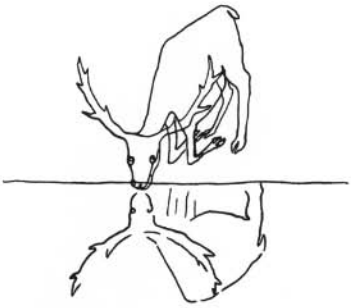
Paul A. Tukey and John W. Tukey, "Data-Driven View Selection; Agglomeration and Sharpening," in Vic Barnett, ed., *Interpreting Multivariate Data* (Chichester, England, 1981) pp. 231–232; and Edward R. Tufte, *The Visual Display of Quantitative Information* (Cheshire, Connecticut, 1983), p. 114.

Dioscorides (Constantinopolitanus), De materia medica, 6th century, ca 512 A.D., fol. 483. Illumination on vellum, Vienna österreichische Nationalbibliothek, Cod. Med. Gr. I.

INFORMATION consists of *differences that make a difference*. A fruitful method for the enforcement of such differences is to layer and separate data, much as is done on a high-density map. In representing various layers of meaning and reading, the most economical of means can yield distinctions that make a difference: the small gestures of Calder's pen easily separate the stag and his watery reflection. Failure to differentiate among layers of reading leads to cluttered and incoherent displays filled with disinformation, generated by the unrelenting interactive visual arithmetic of flatland, 1 + 1 = 3 or more.

All these ideas—figure and ground, interaction effects, 1 + 1 = 3 or more, layering and separation—have compelling consequences for information displays. Such concepts (operating under an assortment of names) are thoroughly tested, long familiar the world over in the flatlands of typographers, calligraphers, graphic designers, illustrators, artists, and, in three dimensions, architects:

> In every clear concept of the nature of vision and in every healthy approach to the spatial world, this dynamic unity of figure and background has been clearly understood. Lao Tse showed such grasp when he said: "A vessel is useful only through its emptiness. It is the space opened in a wall that serves as a window. Thus it is the nonexistent in things which makes them serviceable." Eastern visual culture has a deep understanding of the role of empty space in the image. Chinese and Japanese painters have the admirable courage to leave empty large paths of their picture-surface so that the surface is divided into unequal intervals which, through their spacing, force the eye of the spectator to movements of varying velocity in following up relationships, and thus create the unity by the greatest possible variation of surface. Chinese and Japanese calligraphy also have a sound respect for the white interval. Characters are written in imaginary squares, the blank areas of which are given as much consideration as the graphic units, the strokes. Written or printed communications are living or dead depending upon the organization of their blank spaces. A single character gains clarity and meaning by an orderly relationship of the space background which surrounds it. The greater the variety and distinction among respective background units, the clearer becomes the comprehension of a character as an individual expression or sign.[11]



Fables of Aesop, According to Sir Roger L'Estrange with drawings by Alexander Calder (Paris, 1931; New York, 1967), p. 1.

[11] Gyorgy Kepes, *The Language of Vision* (Chicago, 1948).