



ESCAPING FLATLAND



MICRO/MACRO READINGS



LAYERING AND SEPARATION



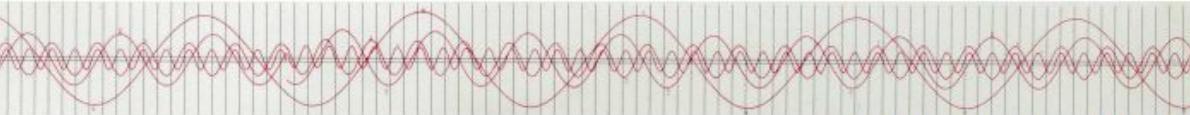
SMALL MULTIPLES



NARRATIVES OF SPACE AND TIME

Envisioning Information

Edward R. Tufte



Presented by:
Kevin Ebrahimoff
Sophie Fu
Yunja Yuan

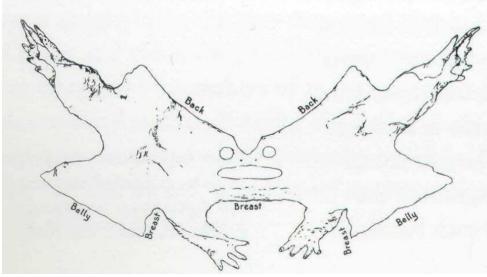
How do you escape from flatland?

1. increase the number of dimensions that can be represented on plane surfaces
2. increase **data density**



X

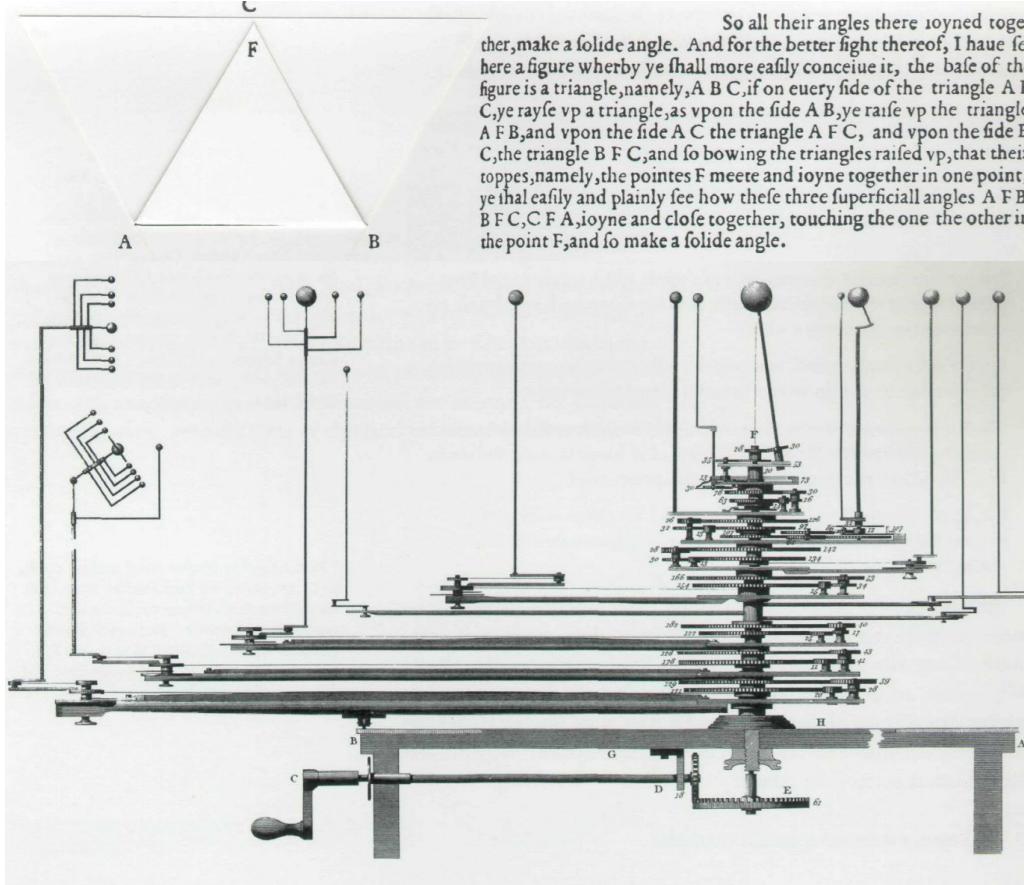
“spaceland”



“flatland”

compromise

one virtue against another



Direct methods: making models

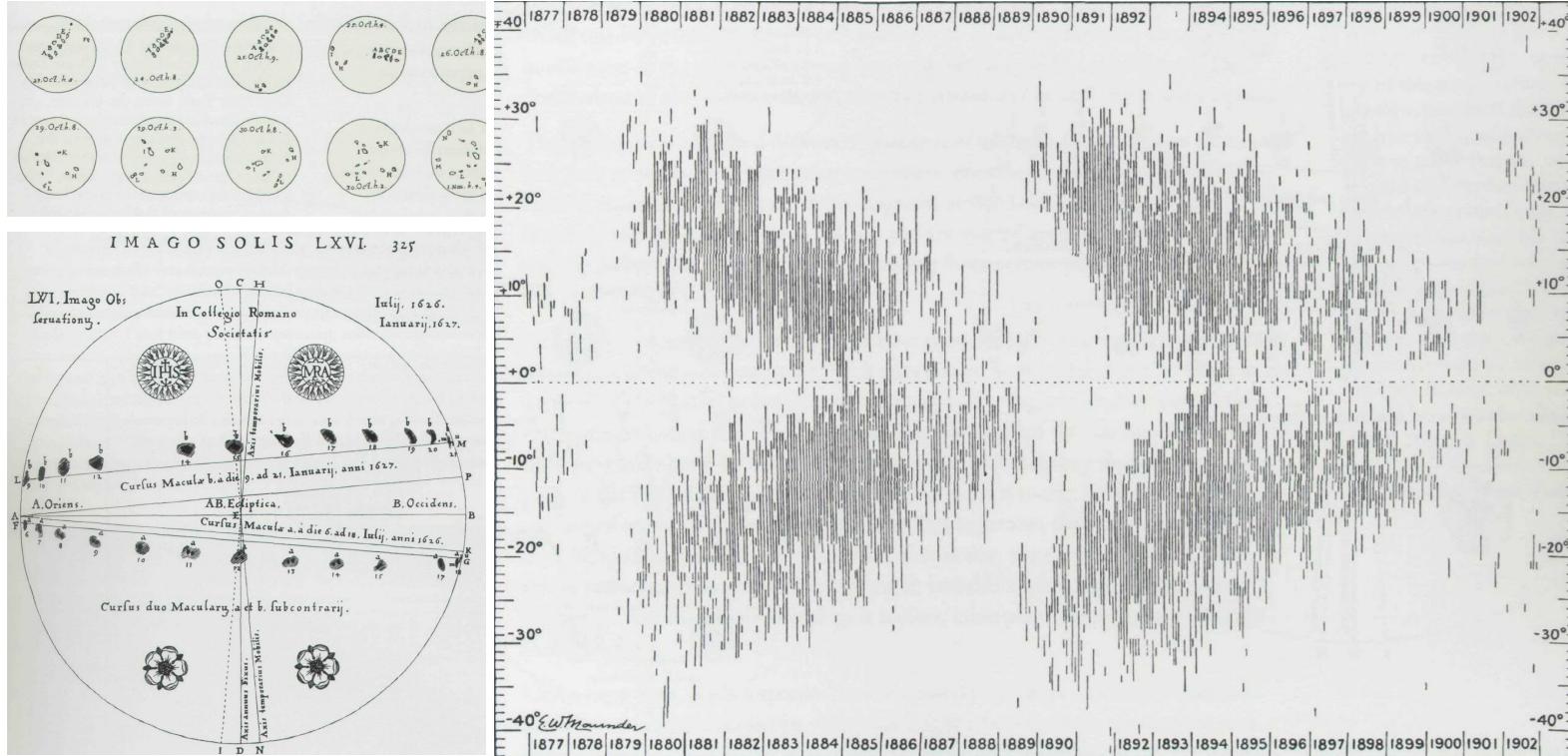
So all their angles there ioyned together, make a solide angle. And for the better sight thereof, I haue set here a figure wherby ye shall more easily conceiue it, the base of the figure is a triangle, namely, A B C, if on every side of the triangle A B C, ye rayse vp a triangle, as vpon the side A B, ye raise vp the triangle A F B, and vpon the side A C the triangle A F C, and vpon the side B C, the triangle B F C, and so bowing the triangles raised vp, that their topes, namely, the pointes F meeete and ioyne together in one point, ye shall easily and plainly see how these three superficall angles A F B B F C, C F A, ioyne and close together, touching the one the other in the point F, and so make a solide angle.

1. William Pearson, "Planetary Machines," in Abraham Rees, ed., *The Cyclopaedia; or, Universal Dictionary of Arts, Sciences, and Literature, Plates, Vol. IV* (London, 1820), plate XI; and Henry C. King with John R. Millburn, *Geared to the Stars: The Evolution of Planetariums, Orreries, and Astronomical Clocks* (Toronto, 1978).
2. Euclid, *The Elements of Geometry* (London, 1570), with preface by John Dee, English translation by Gay, Walker, Eccentric Books (New Haven: Yale University Library, 1988).



Color stereopair of Bonaduz, Canyon of Grisons, Switzerland, October, 1975, photographs taken with Wild Leitz aerial camera RC10. Scale about 1:11,000

stereoscopic viewers



1. Illustrations from Christopher Scheiner (writing under the pseudonym "Apelles"). *De Maculis Solaribus* (Rome, 1613), pp. 14–15, and his *Rosa Ursina sive Sol* (Bracciani, 1626–1630), p. 63. On the dispute between Galileo and Scheiner concerning sunspots, see William Shea, Galileo's Intellectual Revolution (New York, 1972), pp. 48–74.

2. Christopher Scheiner, *Rosa Ursina sive Sol* (Bracciani, 1626–1630), pp. 317, 325, 333, and 339.

3. E. W. Maunder, "Notes on the Distribution of Sun-spots in Heliographic Latitude, 1874 to 1902," Royal Astronomical Society Monthly Notices, 64 (1904), 747–761

Galileo's theory and sunspots



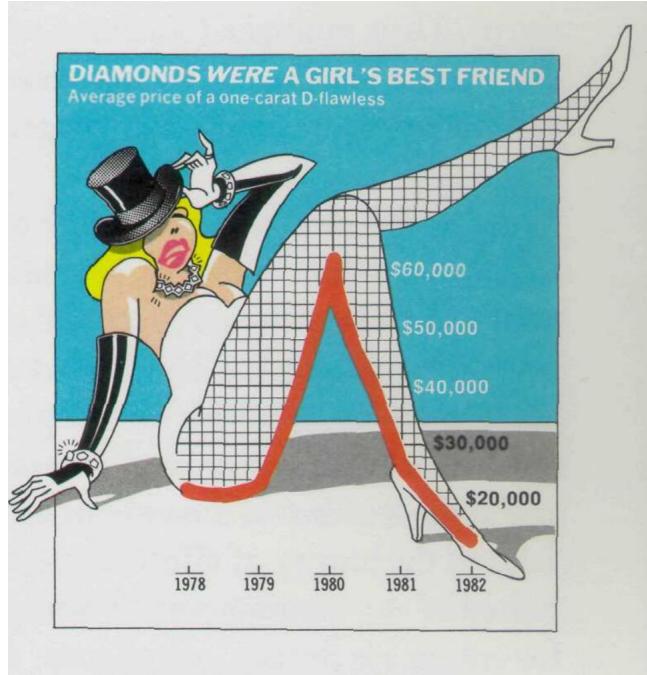
Kellom Tomlinson, *The Art of Dancing, Explained by Reading and Figures* (London, 1735), book I, plate XII.

Dance charts

Designs so good that they are invisible

focus on data vs data-containers

Robert Venturi, Denise Scott Brown, and Steven Izenour, Learning from Las Vegas (Cambridge, 1977), p. 163



Chartjunk

“

Posters are meant for viewing from a distance, with their strong images, large type, and thin data densities. Thus poster design provides very little counsel for making diagrams that are read more intensely

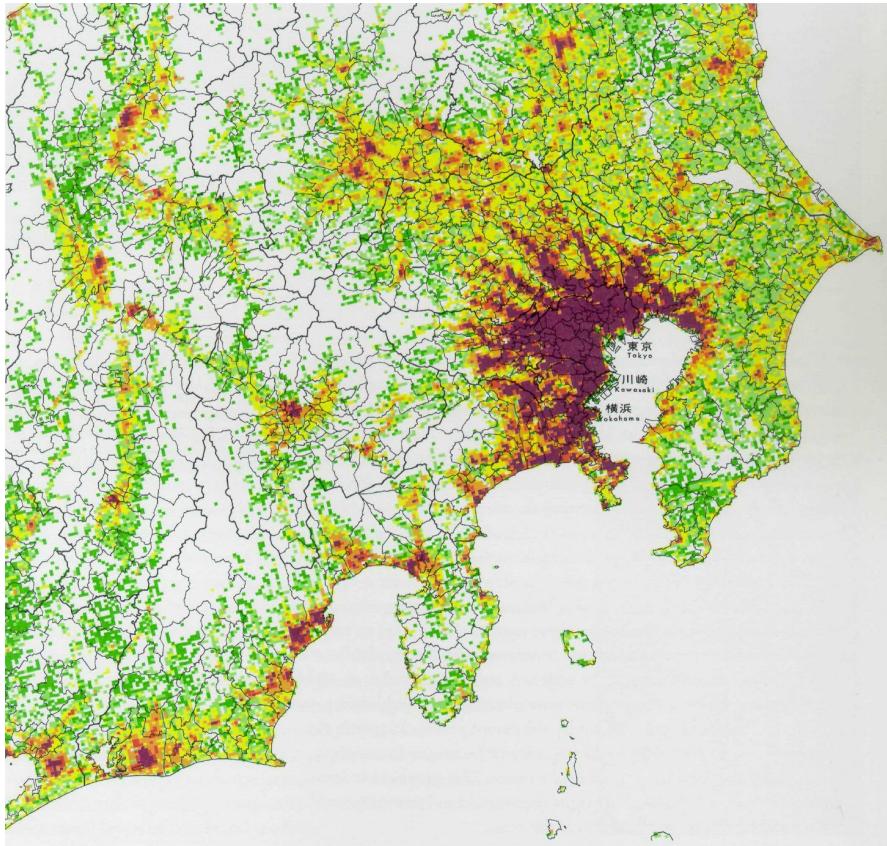
”



Manhattan © 1899 The Manhattan Map Company

Micro vs. Macro

overview: a capacity to compare and sort through detail



Tokyo

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



<https://www.cityjournal.org/html/power-name-13494.html>

Vietnam war memorial

“

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.

”

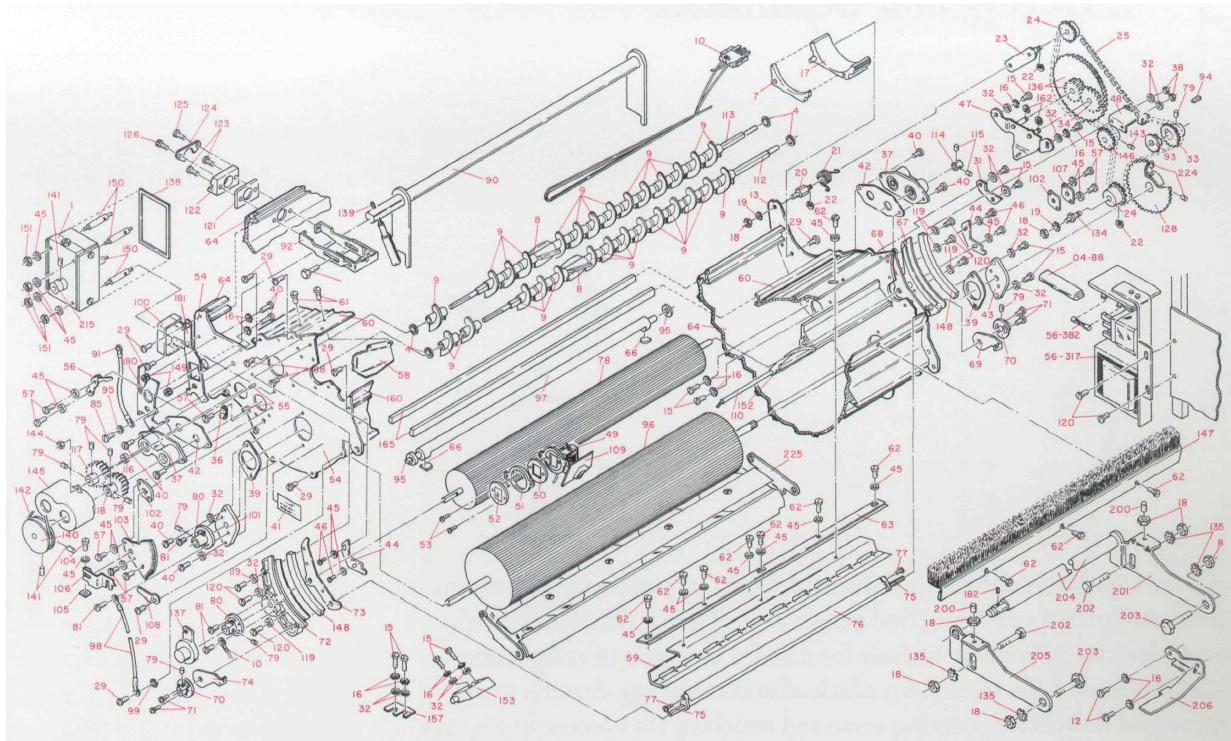
Layering and Separation

Confusion and clutter are failures of **design**,
not attributes of **information**.

“

$$1+1=3$$

”



Colors → Group information → Information separation



Color coded information & User friendly information hierarchy & Layers of referential elements

1+1=3

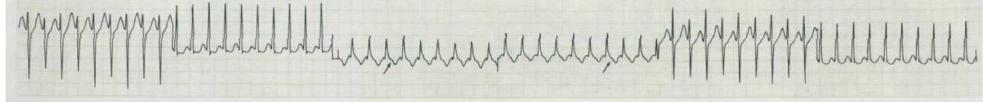
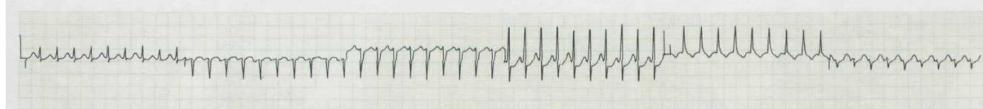
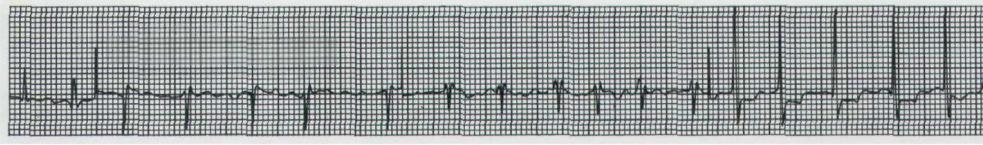
... Wait
Graphic noise

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 North Elizabeth Elizabeth	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	
Linden North Rahway Rahway	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	
Metro Park (Iselin) Metuchen	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	
Edison New Brunswick Jersey Avenue	12.51	...	2.11	7.17	7.32	8.14	...	8.47	...	9.21	...	10.21	11.21	...	12.21	1.21	1.21	...	
Princeton Jct. S Trenton, N.J.	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		
	1.02	...	2.18	7.28	8.21	9.28	...	10.28	11.28	...	12.28	1.28	1.28	...	
	2.31	...	5.50	...	7.19	...	7.50	...	8.31	8.44	8.52	...	9.05	...	9.41	...	10.09	10.41	11.09	...	11.41	12.09	12.41	...	1.09	1.41	2.09	...
	2.42	4.58	6.03	...	7.28	...	8.01	9.16	...	9.52	...	10.19	10.52	11.19	...	11.52	12.19	12.52	...	1.22	1.52	2.20	...

Relationship / Proportion: information hierarchy & data-ink ratio

	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																										
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																										
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		X	M		→	3	3	→	3	3	3	→	3	3	3	3	3	3	3	3	3	3	3	3		

User friendly information hierarchy & less prominent referencial elements



Layering → Dimension & Density

CROSSWIND TAKEOFF

THE SLIP

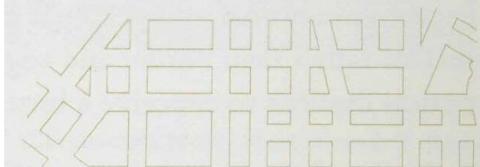
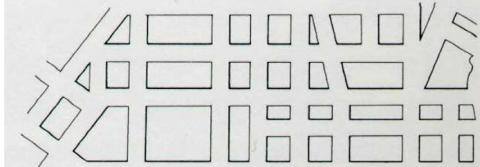
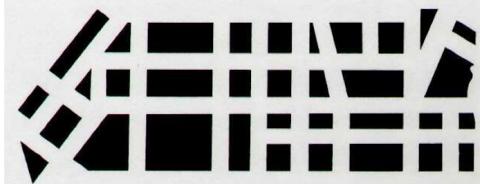
CROSSWIND LANDINGS

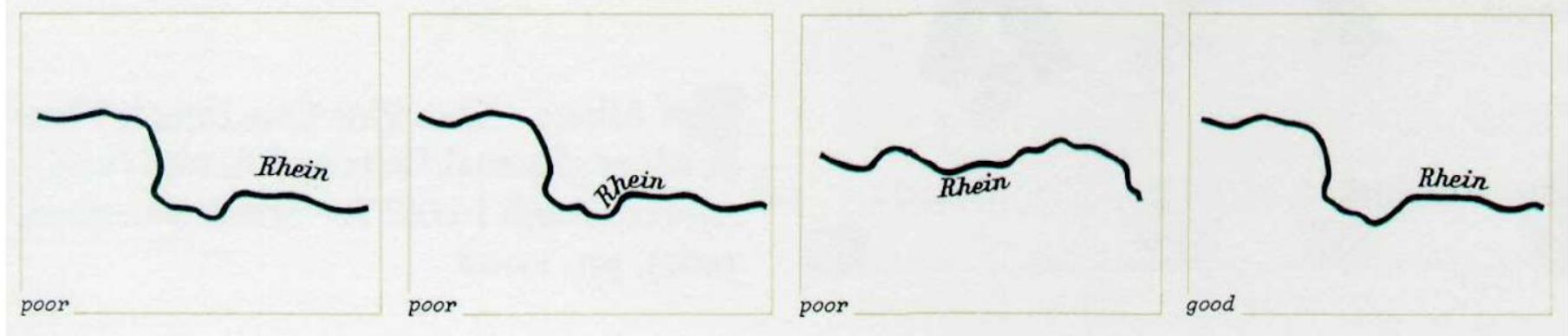
SHORT FIELD TAKE OFF & LANDING

SOFT FIELD TAKE OFF & LANDING

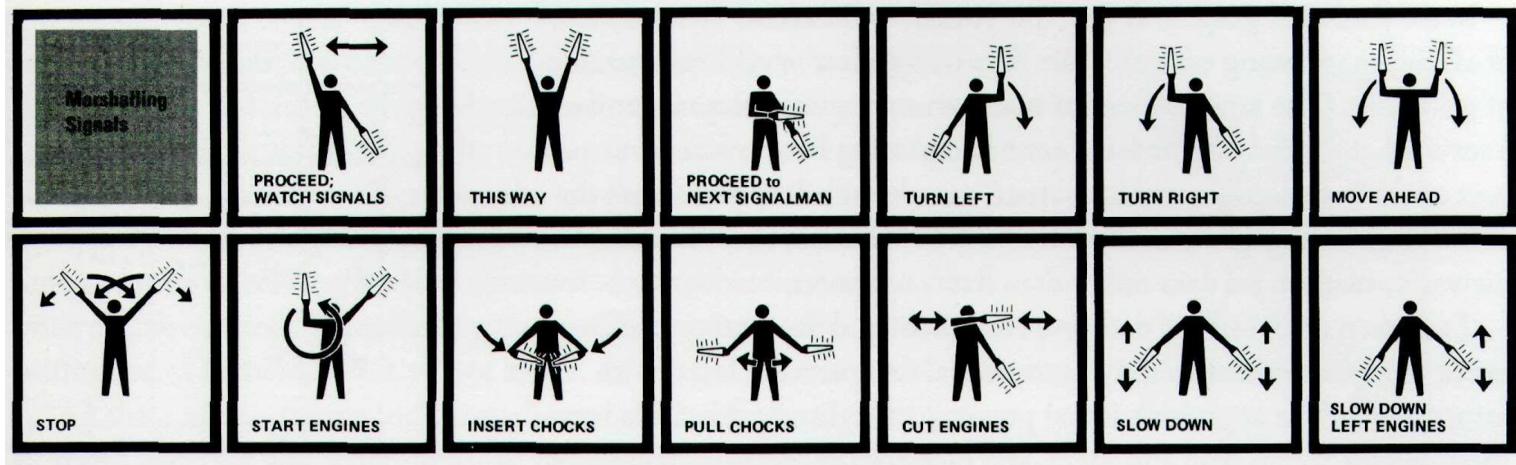
FORCED LANDING

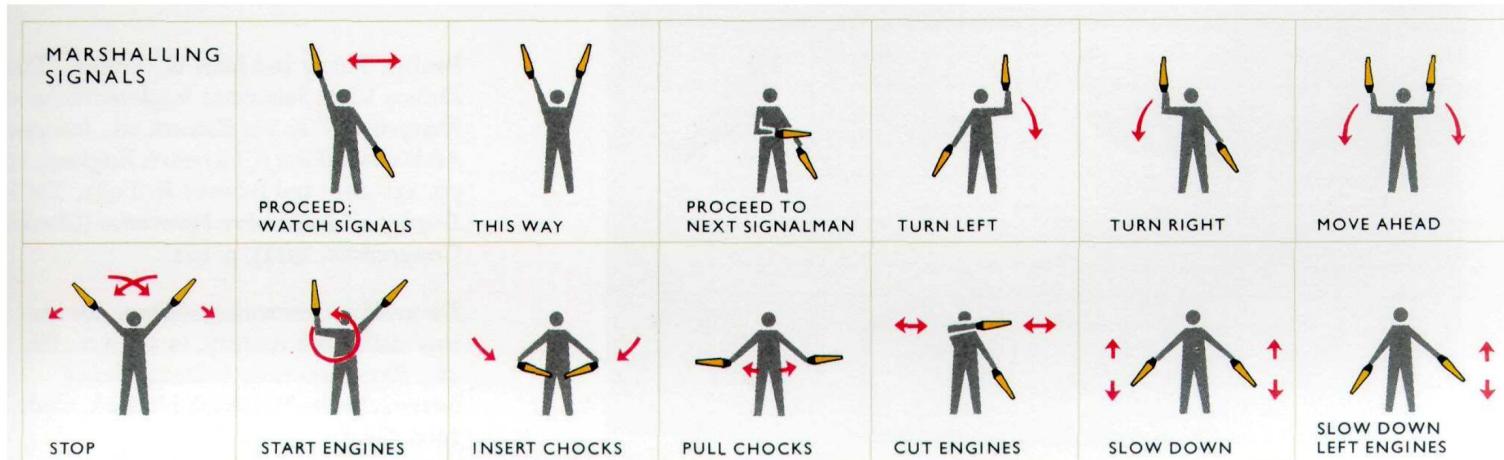
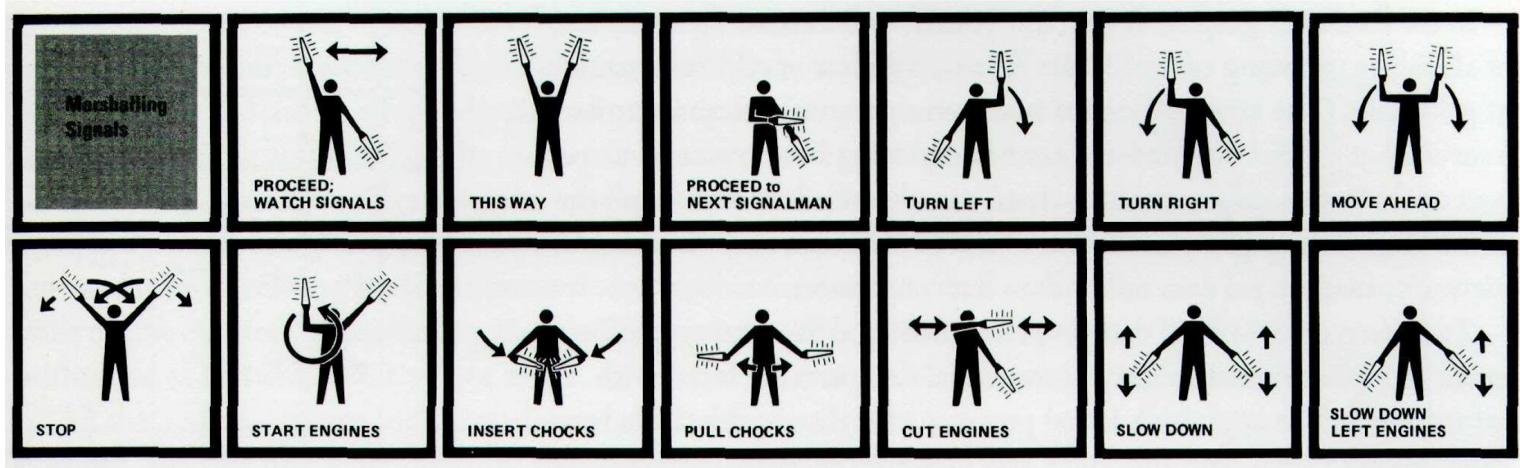
720 POWER TURNS





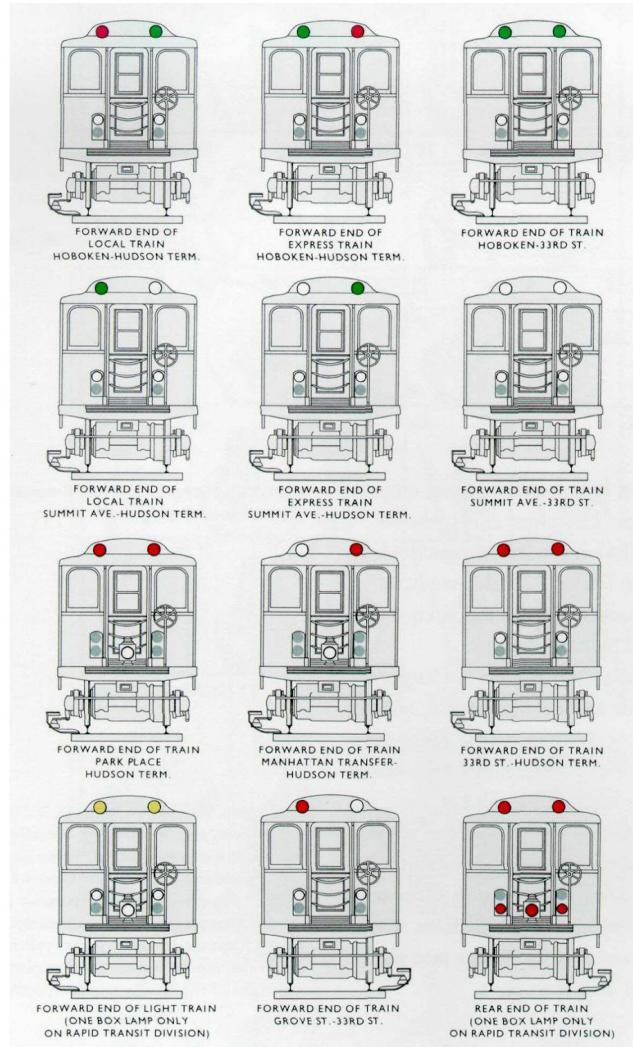
Type!!! Negative space matters



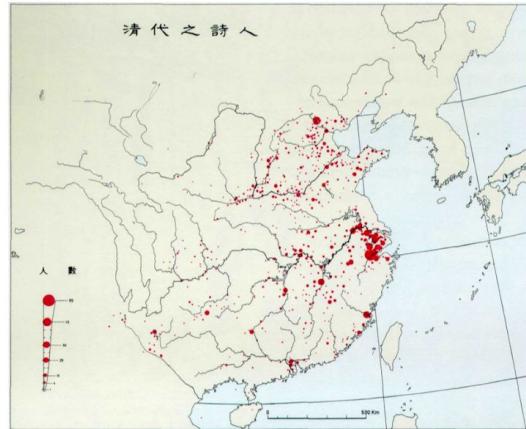
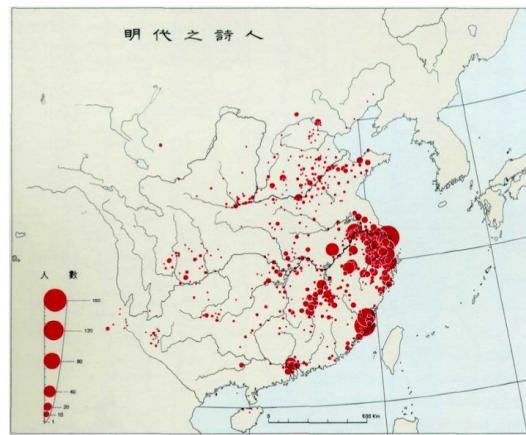


Color as annotation & separation; Data hierarchy; Various visual weights

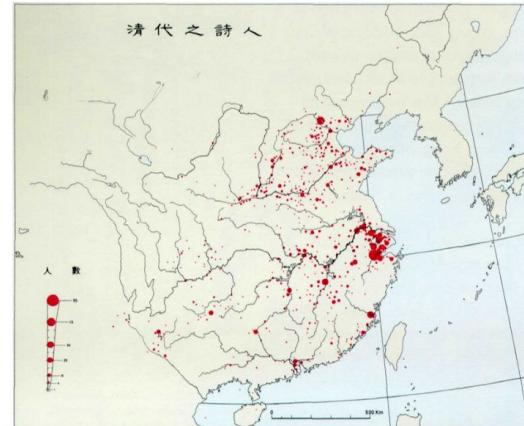
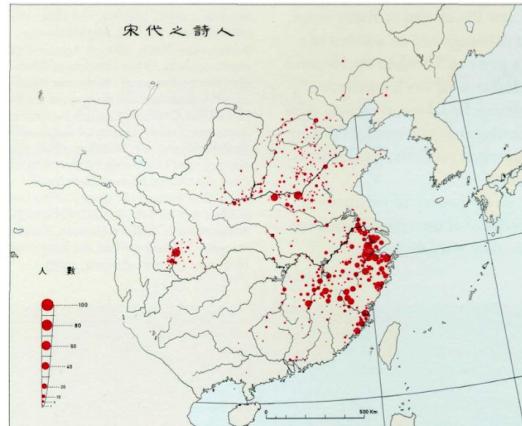
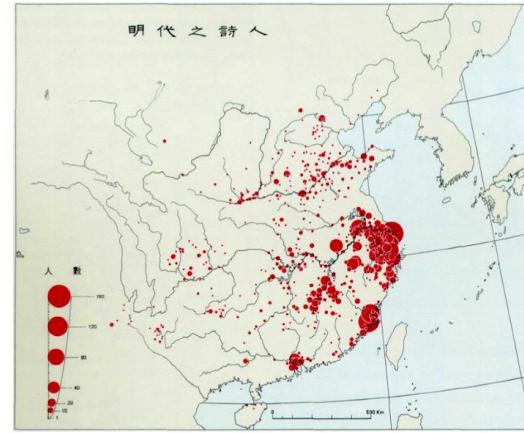
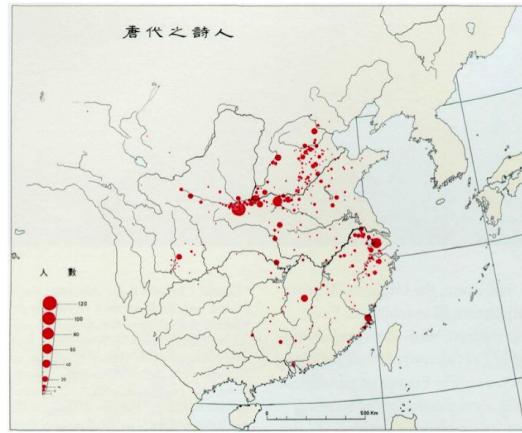
Small Multiples Controlled variables











Comparison exists within eyespan spaces

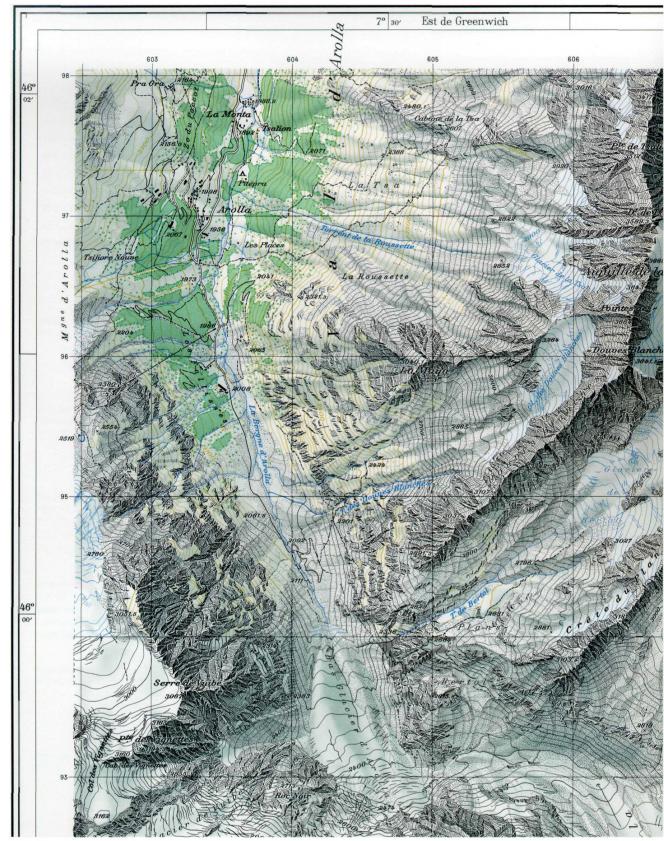
But never to this extend



Color and Information

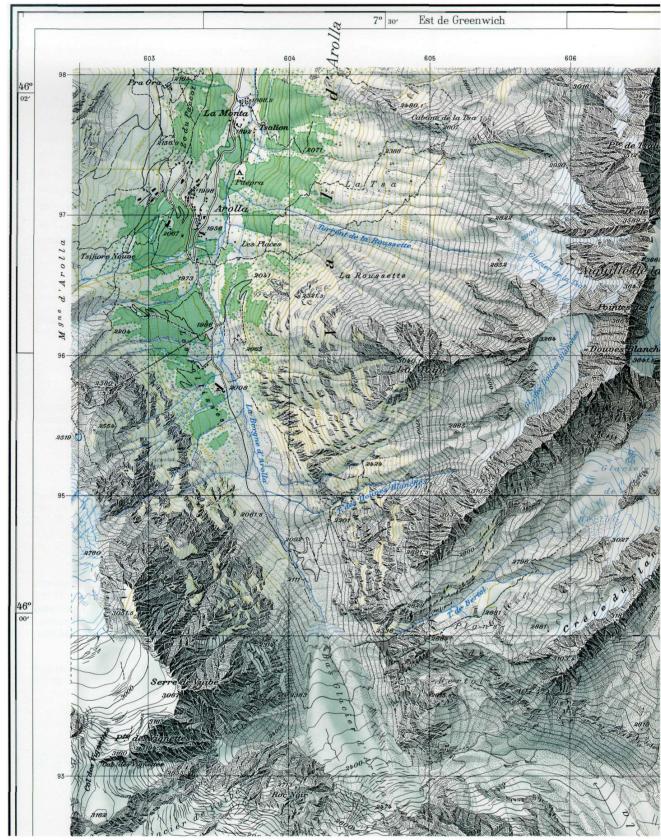
Fundamentals of color in formation design

Labeling: using color to distinguish between stone, ice, water, and fields



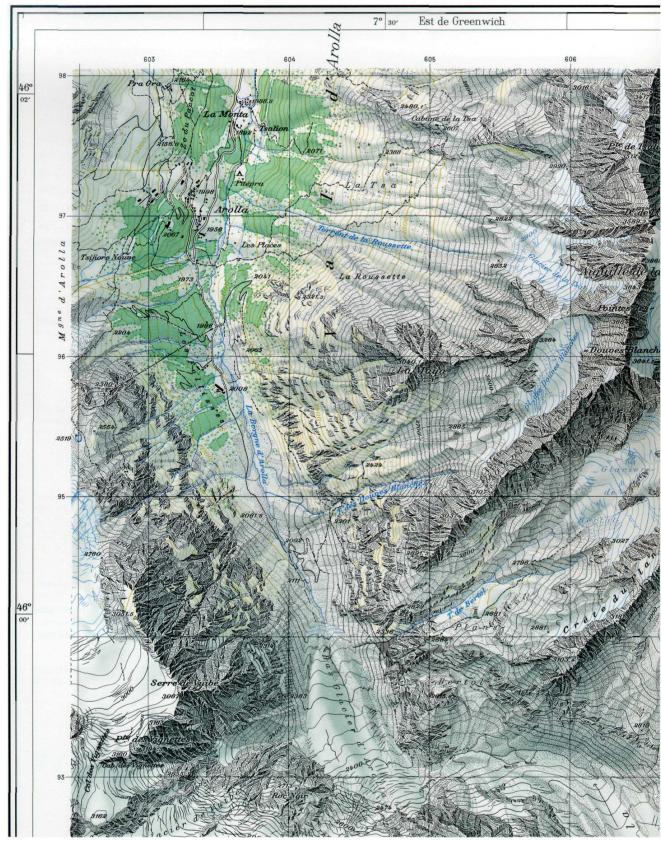
Fundamentals of color in formation design

Measuring: color to depict quantity



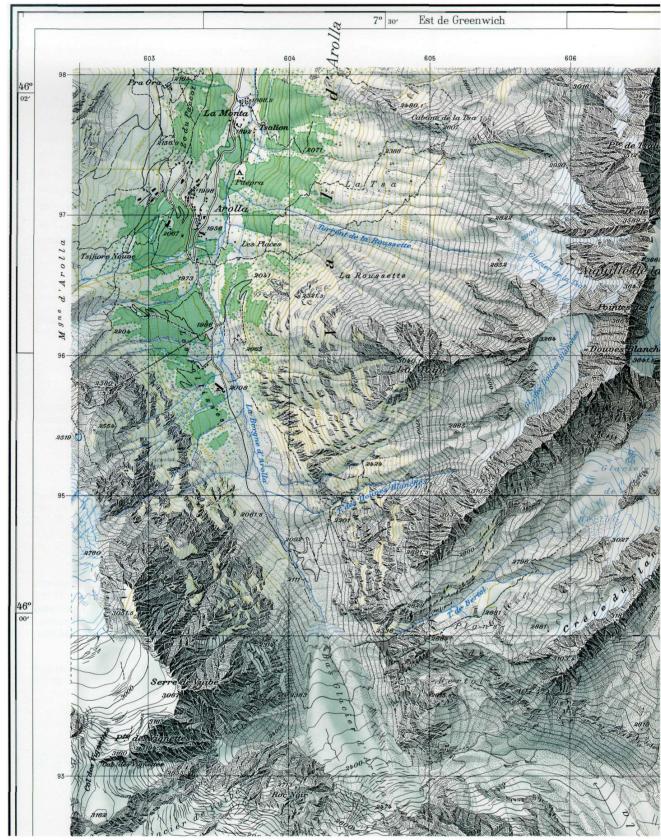
Fundamentals of color in formation design

Imitate reality: using colors from reality to help understand the visuals



Fundamentals of color in formation design

Enliven or Decorate: color as beauty

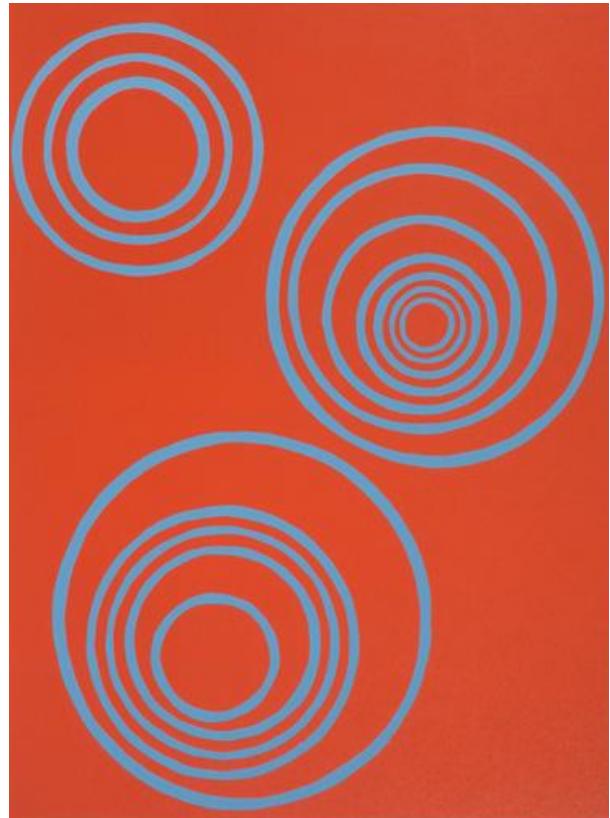


Colors cannot be arbitrary

Designers must stand behind and **defends** their design choices

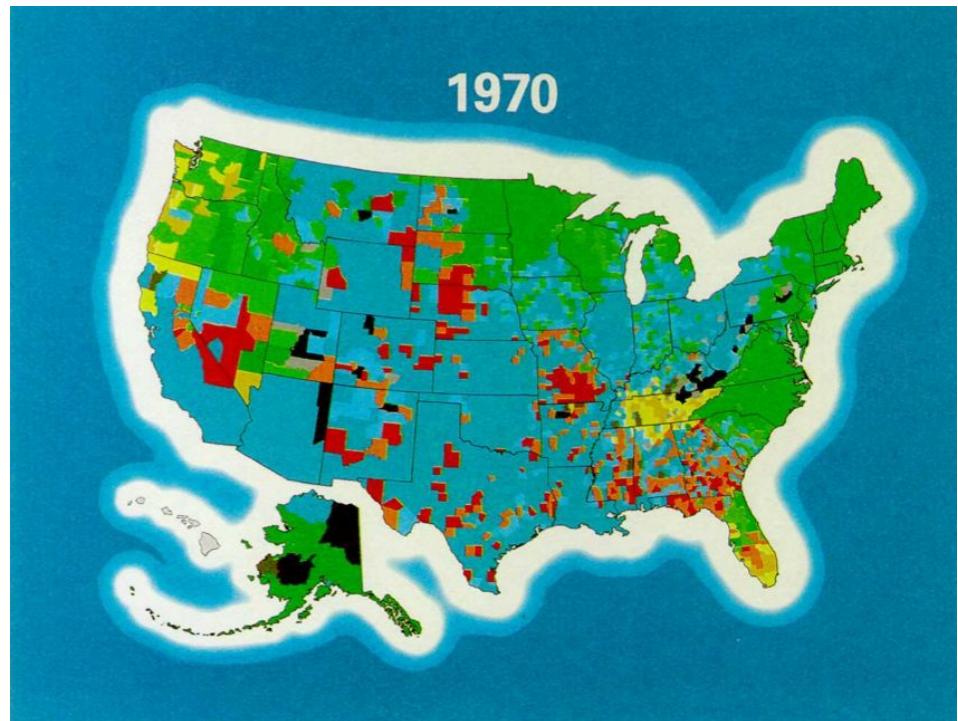
The Principles of Color-Clutter

1. Effective information design has a **non-competing base** with accents to place emphasis on areas.



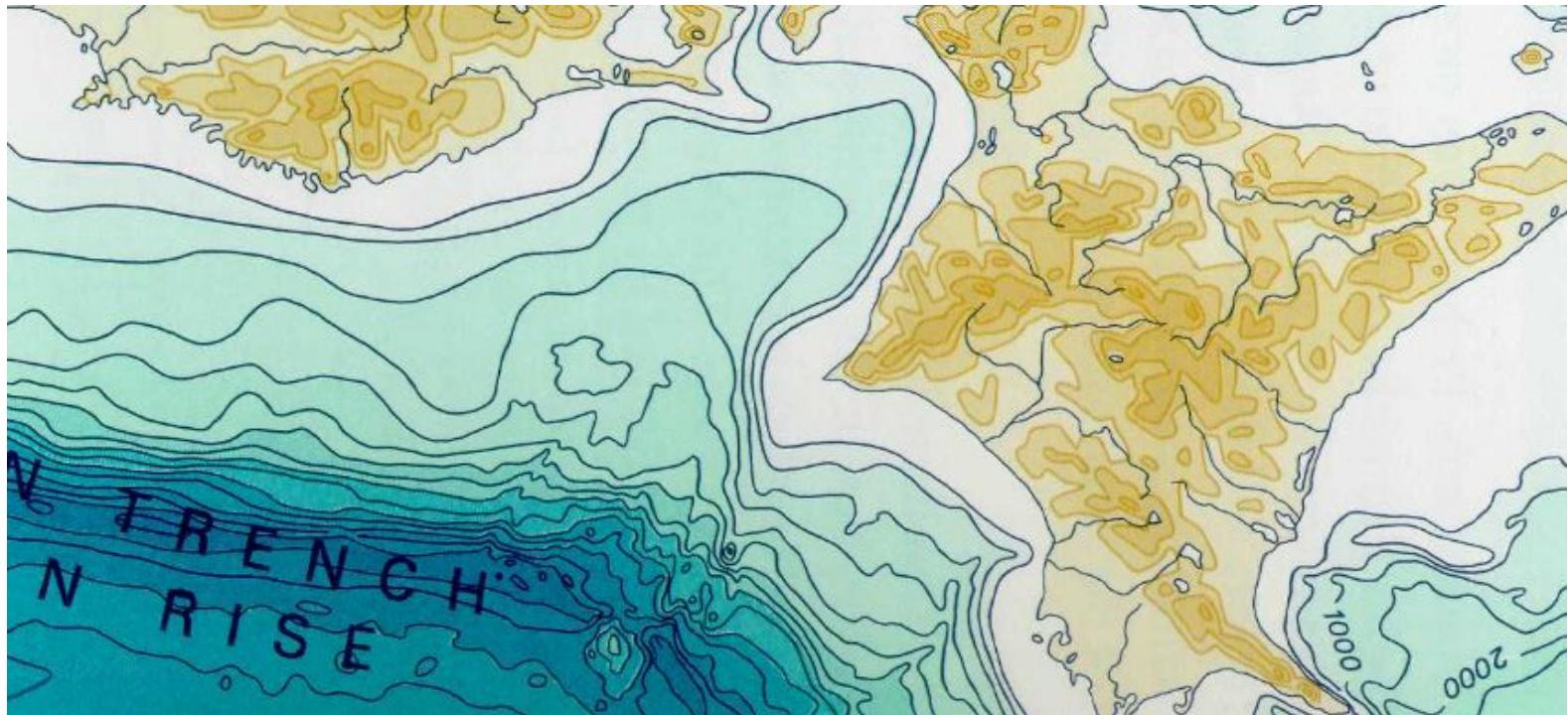
The Principles of Color-Clutter

2. Bright or **low contrasting colors** next to each other with result in **unpleasant visual effects.**



The Principles of Color-Clutter

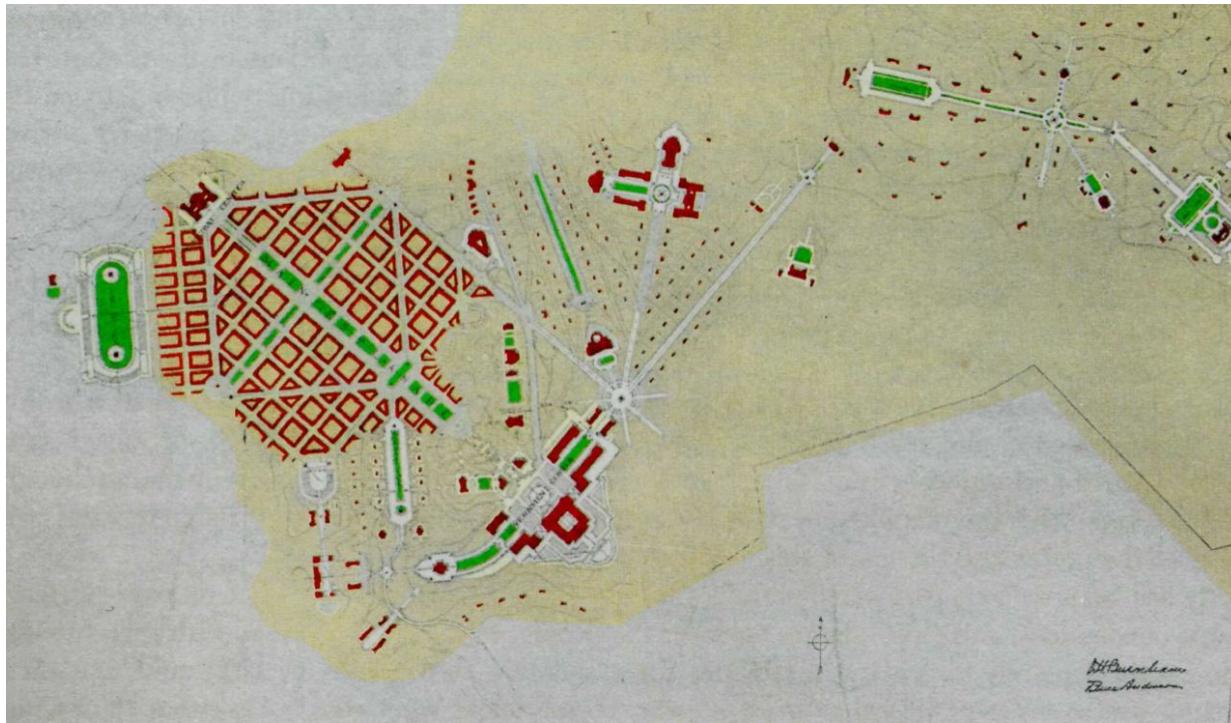
2.



The Principles of Color-Clutter

3. Large areas of color or backgrounds should be there **subtly**, drawing **attention to the smaller details** that contrast it

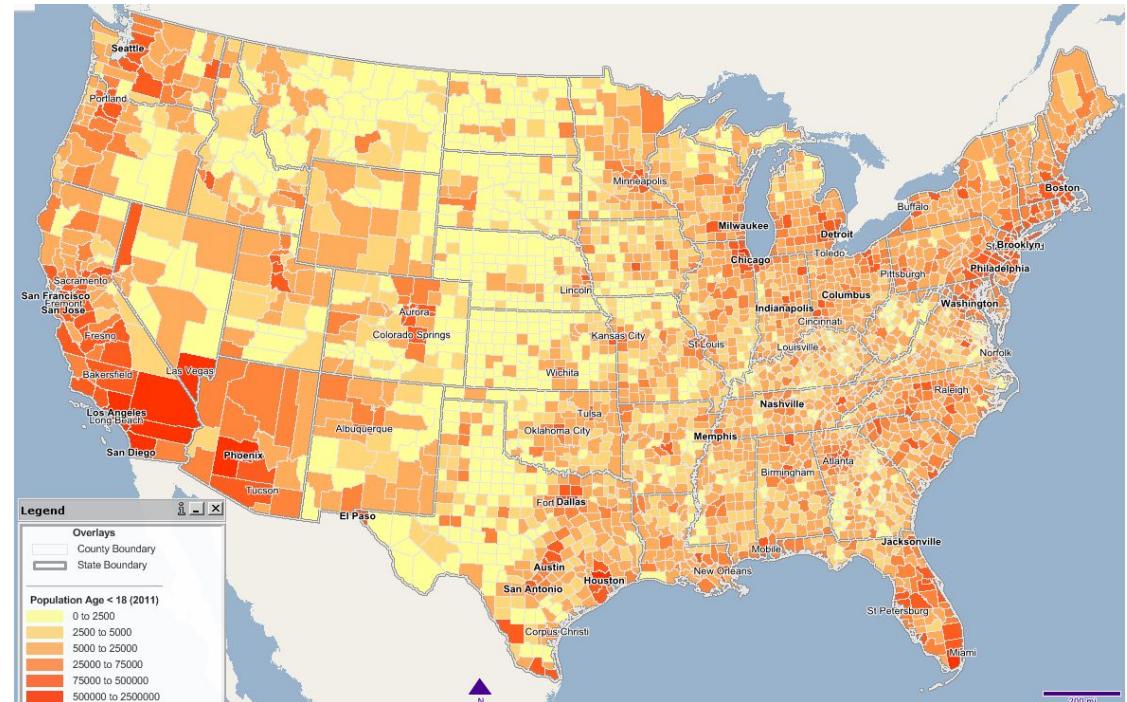
The Principles of Color-Clutter



The Principles of Color-Clutter

4. Large splotches of different color spread out will cause lack of effectiveness of the data.

Color should intertwine.



Color used to clarify information

THEOREM 27. (Pythagoras' Theorem.)

In any right-angled triangle, the square on the hypotenuse is equal to the sum of the squares on the sides containing the right angle.

Given $\angle BAC$ is a right angle.

To prove the square on BC = the square on BA + the square on AC.

Let ABHK, ACMN, BCPQ be the squares on AB, AC, BC.

Join CH, AQ. Through A, draw AXY parallel to BQ, cutting BC, QP at X, Y.

Since $\angle BAC$ and $\angle BAK$ are right angles, KA and AC are in the same straight line.

Again $\angle HBA = 90^\circ = \angle QBC$.

Add to each $\angle ABC$, $\therefore \angle HBC = \angle ABQ$.

In the \triangle s HBC, ABQ,

$HB = AB$, sides of square.

$CB = QB$, sides of square.

$\angle HBC = \angle ABQ$, proved.

$\therefore \triangle HBC \equiv \triangle ABQ$ (2 sides, inc. angle).

Now $\triangle HBC$ and square HA are on the same base HB and between the same parallels HB, KAC;

$\therefore \triangle HBC = \frac{1}{2}$ square HA.

Also $\triangle ABQ$ and rectangle BQYX are on the same base BQ and between the same parallels BQ, AXY.

$\therefore \triangle ABQ = \frac{1}{2}$ rect. BQYX.

\therefore square HA = rect. BQYX.

Similarly, by joining AP, BM, it can be shown that square MA = rect. CPYX;

\therefore square HA + square MA = rect. BQYX + rect. CPYX
= square BP. Q.E.D.

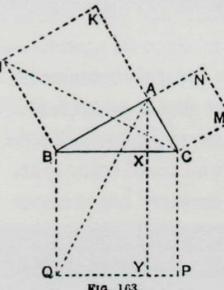
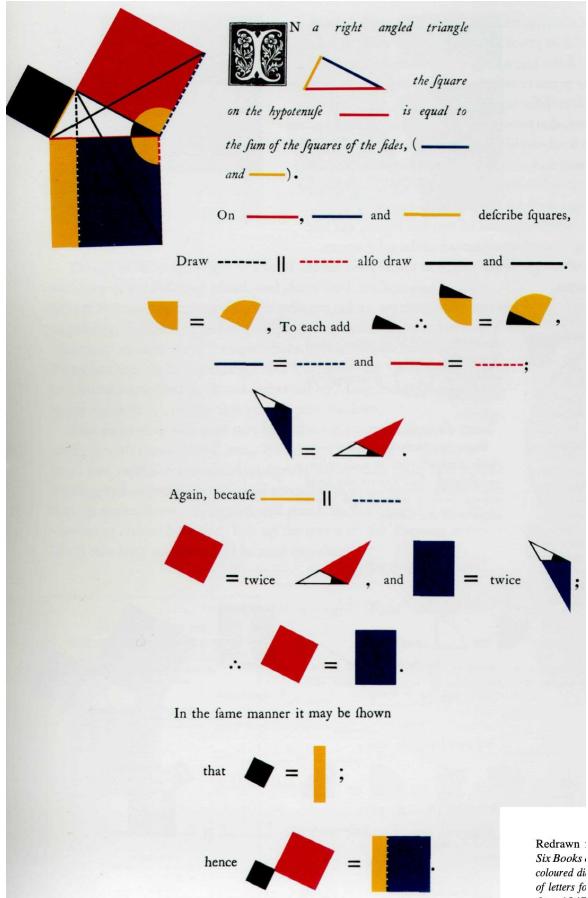


FIG. 163.



THEOREM 27. (Pythagoras' Theorem.)

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$\therefore \triangle HBC \cong \triangle ABQ$ (2 sides, inc. angle).

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$\therefore \triangle HBC = \frac{1}{2}$ square HA.

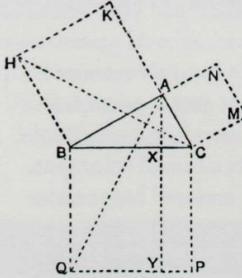
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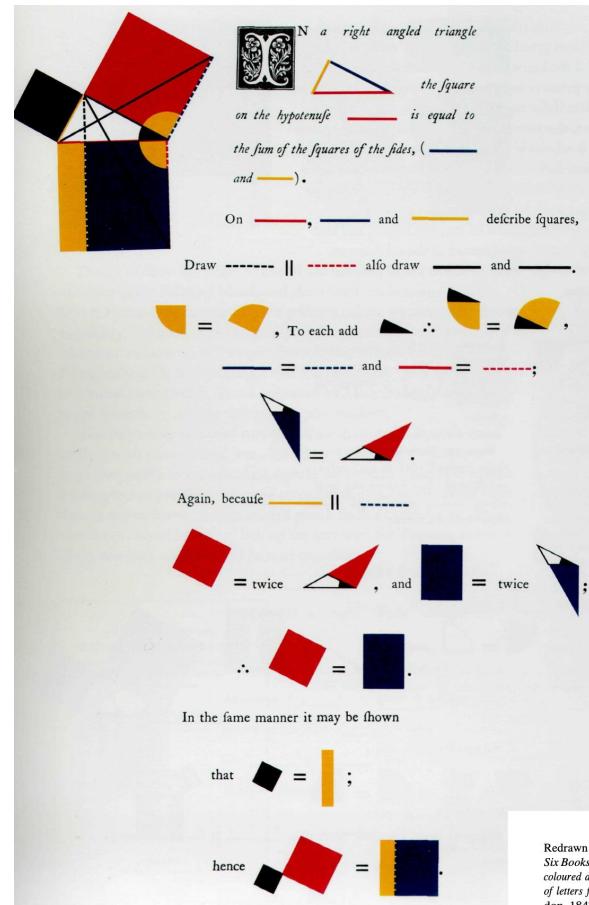
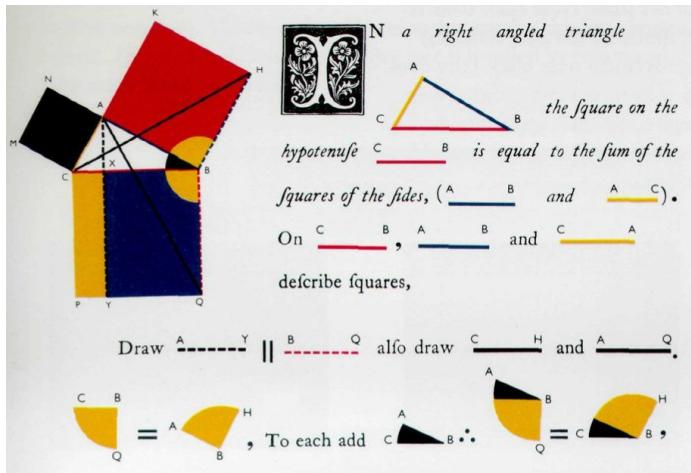
$\therefore \triangle ABQ = \frac{1}{2}$ rect. BQYX.

\therefore square HA = rect. BQYX.

Similarly, by joining AP, BM, it can be shown that square MA = rect. CPYX;

\therefore square HA + square MA = rect. BQYX + rect. CPYX
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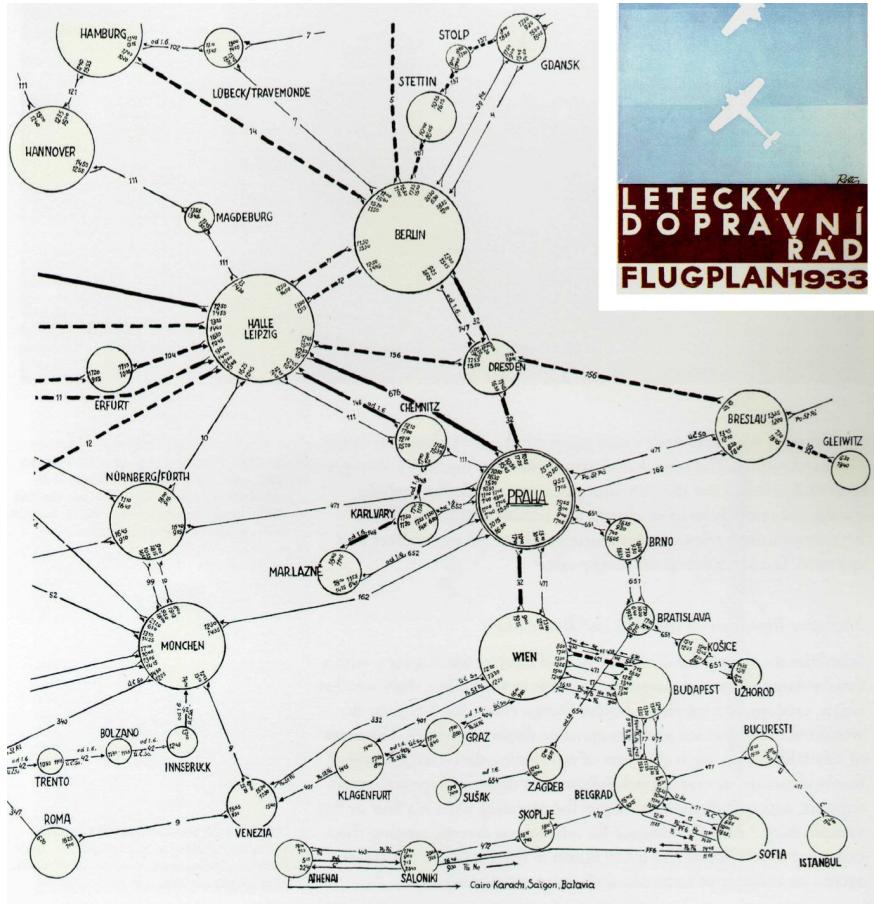
Narratives of Time and Space

Timetable Design

Some common issues with timetable design are **large arrays of precise numbers, densely packed data points, type and imagery, and numerous layers and variables** can all get confusing.

Timetables do provide a unique form of **narrative** in its display of information.

Timetable Design



Bad Timetable Design

NEW YORK TO NEW HAVEN					
MONDAY TO FRIDAY, EXCEPT HOLIDAYS					
Leave	Arrive	Leave	Arrive	Leave	Arrive
New York	New Haven	New York	New Haven	New York	New Haven
AM 12:35 5:40 7:05 8:05 9:05 10:05 11:05 12:05 1:05 PM	AM 2:18 7:44 8:45 9:45 10:45 11:45 12:45 1:45 2:45 PM	PM 2:05 3:05 4:45 5:45 6:55 XY 5:02E XY 5:20 X 5:42 XY 6:07E PM	PM 3:45 4:45 5:45 6:25 6:33 11:20 7:08 7:26 7:46 PM	PM T 6:25 T 7:05 T 8:05 T 9:05 10:05 11:20 12:35 1:00 12:35 PM	PM 8:19 8:56 9:45 10:50 11:45 1:05 2:18 PM
SATURDAY, SUNDAY & HOLIDAYS					
AM 12:35 5:40 8:05 10:05 12:05 PM	AM 2:18 7:37 9:45 11:47 1:45 PM	PM 2:05 S 3:05 4:05 5:05 6:05 PM	PM 3:45 S 4:45 5:45 6:48 7:48 PM	PM 7:05 H 8:05 9:05 11:20 12:35 AM	PM 8:45 H 9:45 10:45 1:00 2:18 AM
The service shown herein is operated by Metro-North Commuter R.R.					

REFERENCE NOTES

Economy off-peak tickets are not valid on trains in shaded areas.

Check displays in G.C.T. for departure tracks.

E-Express

X-Does not stop at 125th Street.

S-Saturdays and Washington's Birthday only.

H-Sundays and Holidays only.

T-Snack and Beverage Service.

HOLIDAYS-New Year's Day, Washington's Birthday, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas.

NEW YORK → NEW HAVEN
Grand Central Station

Monday to Friday,
except holidays

Leaves New York	Arrives New Haven
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12:35 am	2.18
5:40 am	7.44 am

7:05	8.45
8:05	9.45

9:05	10.45
10:05	11.45

11:05	12.45 pm
12:05 pm	1.45

1.05	2.45
2.05	3.45

3.05	4.45
4.01	5.45

4.41	6.25
4.59	6.53

x 5.02	*
• 6.33	

5.20	*
5.42	*

x 6.07	*
7.46	

6.25	8.19
7.05	8.56

8.05	9.45
9.05	10.50

10:05	11.45
11:20	1.05 am

12:35 am	2.18
X Express	

*	Does not stop at 125th Street.
Holidays:	New Year's Day, Washington's Birthday, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas.

Saturday, Sunday,
and holidays

Leaves New York	Arrives New Haven
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12:35 am	2.18
5:40 am	7.37 am

8:05	9.45
10:05	11.47

12:05 pm	1.45
12:05 pm	12.05 pm

1.05	2.45
2.05	3.45

3.05	4.45
3.05 Saturday only	4.45

4.05	5.45
4.05	5.05

5.05	6.48
6.05	7.42

7.05	8.45
8.05 Sunday only	9.45

9.05	10.45
10:05	11.20

11:20	1.05 am
12:35 am	2.18

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H-Sundays and Holidays only.	
T-Snack and Beverage Service.	
HOLIDAYS-New Year's Day, Washington's Birthday, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas.	

NEW YORK TO NEW HAVEN

MONDAY TO FRIDAY, EXCEPT HOLIDAYS

Leave New York	Arrive New Haven	Leave New York	Arrive New Haven	Leave New York	Arrive New Haven
AM 12:35	AM 2:18	PM 2:05	PM 3:45	T 6:25	8:19
5:40	7:44	3:05	4:45	T 7:05	8:56
7:05	8:45	4:01	5:45	T 8:05	9:45
8:05	9:45	4:41	6:25	T 9:05	10:50
9:05	10:45	Y 4:59	6:53	10:05	11:45
10:05	11:45	XY 5:02E	6:33	11:20	1:05
11:05	12:45	XY 5:20	7:08	12:35	2:18
12:05	1:45	X 5:42	7:26
1:05	2:45	XY 6:07E	7:46
PM	PM	PM	PM	PM	PM

SATURDAY, SUNDAY & HOLIDAYS

AM 12:35	AM 2:18	PM 2:05	PM 3:45	PM 7:05	PM 8:45
5:40	7:37	S 3:05	S 4:45	H 8:05	H 9:45
8:05	9:45	4:05	5:45	9:05	10:45
10:05	11:47	5:05	6:48	11:20	1:00
12:05	1:45	6:05	7:48	12:35	2:18
PM	PM	PM	PM	AM	AM

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Metro-North Commuter R.R.

REFERENCE NOTES

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Check displays in G.C.T. for departure tracks.

E-Express

X-Does not stop at 125th Street.

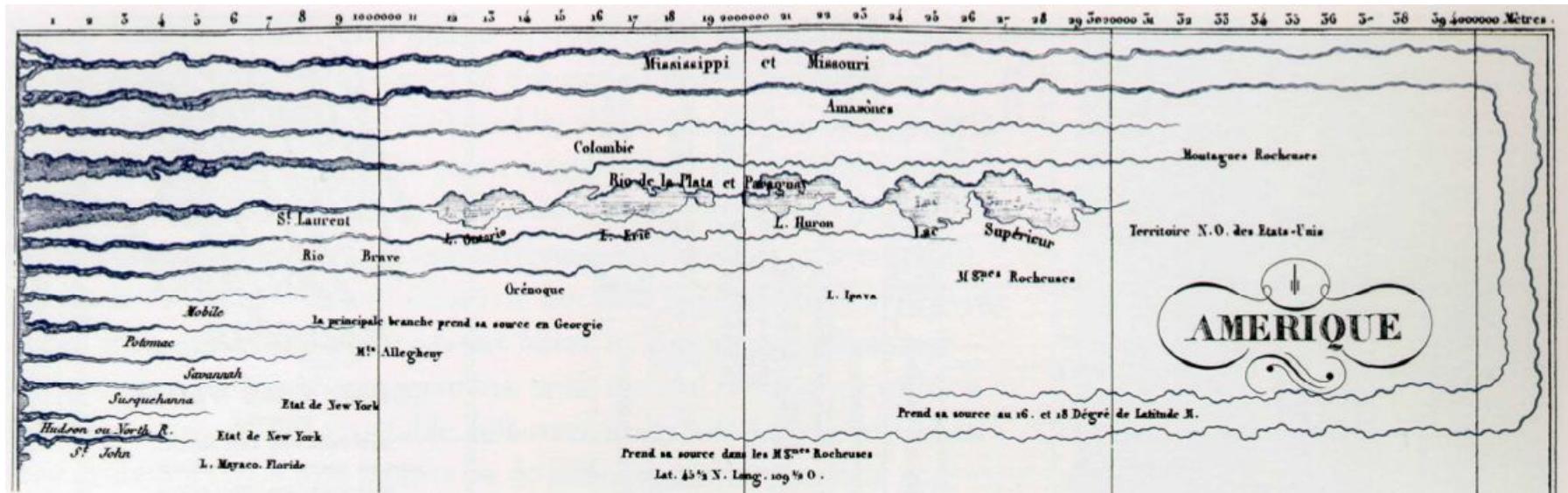
S-Saturdays and Washington's Birthday only.

H-Sundays and Holidays only.

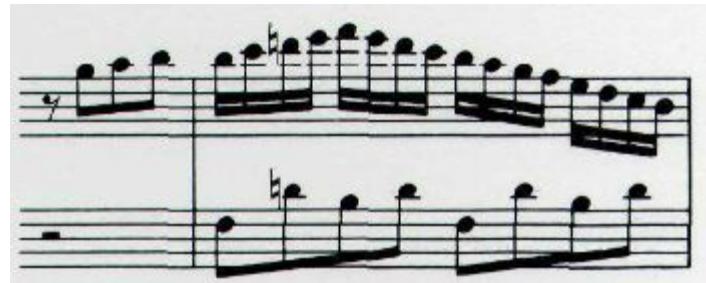
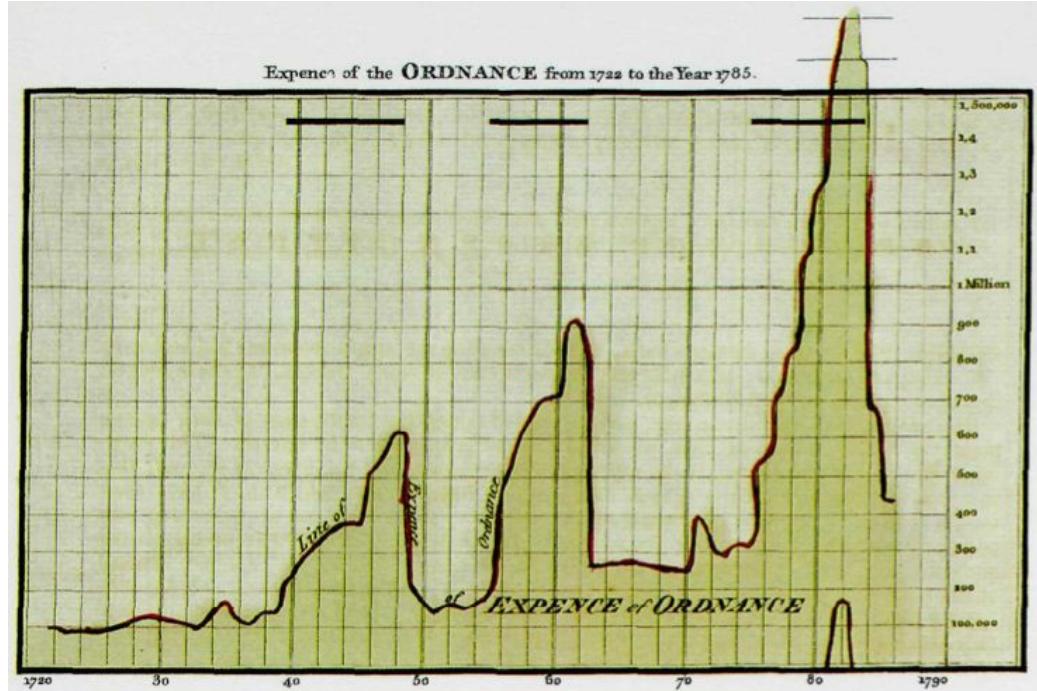
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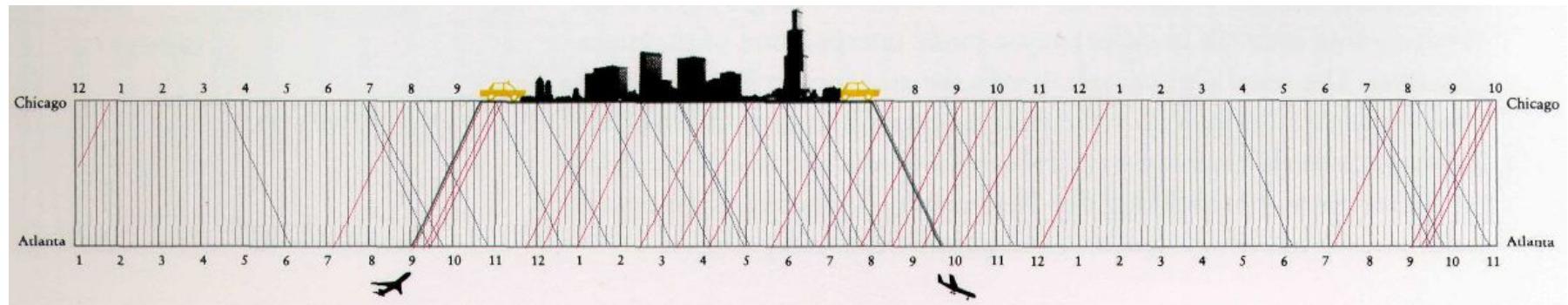
Bad Timetable Design



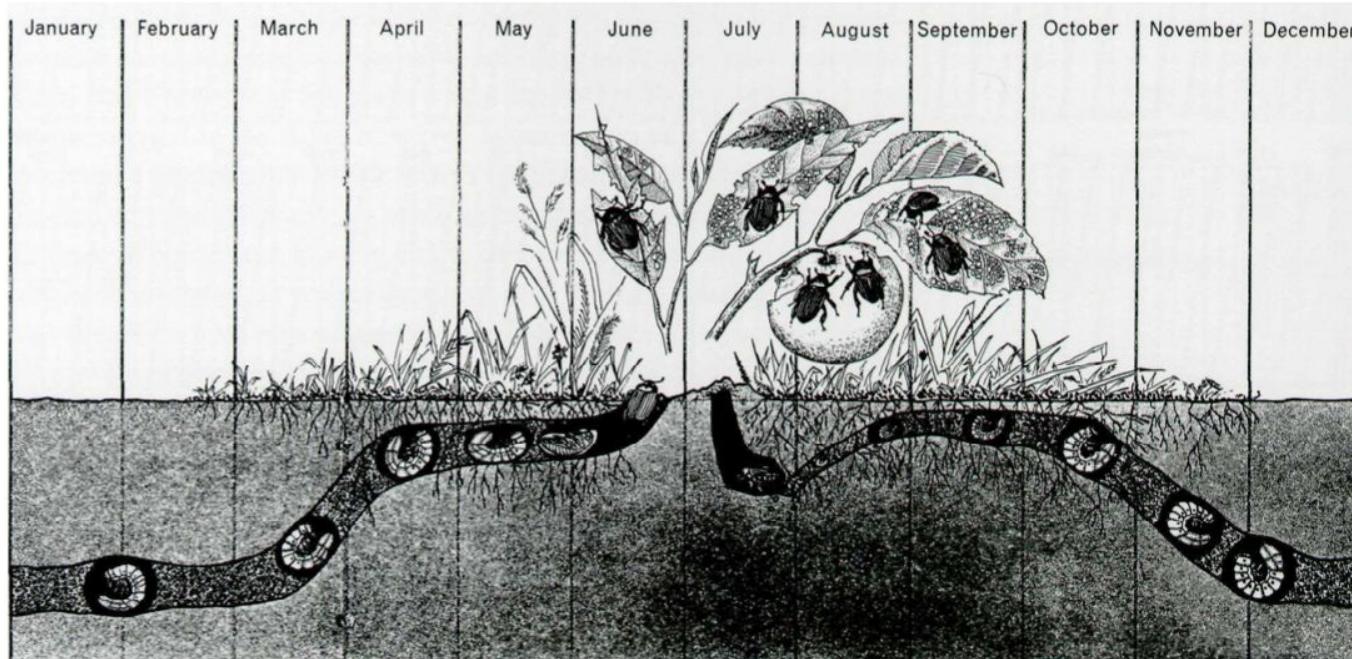
Clever Timetable Design



Narrative Timetable Design



Narrative Timetable Design



Narrative Timetable Design

Castagnettes.

A musical score for castagnettes featuring two staves of music and two staves of stick figures. The top staff shows a continuous sequence of eighth notes and sixteenth-note patterns. The bottom staff shows stick figures performing various actions, such as walking and jumping, in sync with the music. Two numbered figures, 'Fig. 3.' and 'Fig. 4.', are shown in boxes at the beginning of each staff. The first figure, 'Fig. 3.', depicts a person walking in a loop. The second figure, 'Fig. 4.', depicts a person jumping over a circle. The stick figures are drawn with simple lines and arrows indicating movement. The music is in common time, and the key signature is one sharp (F#). The score consists of eight measures of music followed by eight measures of stick figures.

Fig. 3.

1

Fig. 3.

2

Thank you