

Principles Of Information Visualization

What is information visualization

Tufte's guidelines

Visual variables for representing information

The principle of small multiples for displaying information

How metaphors can be used and misused

Direct manipulation and direct engagement

James Tam

Representations

Good representations

- Captures essential elements of the event / world
- Deliberately leaves out / mutes the irrelevant
- Appropriate for the person and their interpretation
- Appropriate for the task, enhancing judgment ability

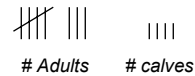
How many buffalo?



Buffalo



Buffalo

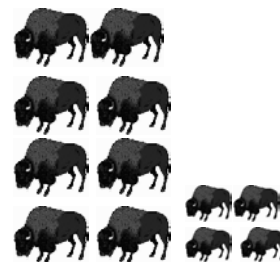


Adults

calves

8

4



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Representation

A representation is

- A formal system or mapping by which the information can be specified (D. Marr)
- A sign system in that it stands for something other than its self.

For example: the number thirty-four *or* the buffalo example

Decimal: 34,
Binary: 100010,
Roman: XXXIV

Different representations reveal different aspects of the information

Decimal: counting & information about powers of 10,
Binary: counting & information about powers of 2,
Roman: counting

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Presentation

Not the same as representation!

The presentation of information deals with how the representation is placed or organized on the screen

5, 5,
IV, IV

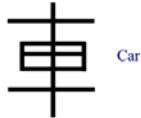
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Chinese...Sort Of

— One

≡ Two

≡≡ Three



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Representations: Finding Information

Solving a problem simply means representing it so as to make the solution transparent ... (Simon, 1981)

Good representations

- Allow people to *find* the relevant information
 - In contrast the information may be present but hard to find

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Representations: The Information Is Present But Hard To Find

5290 5290	Year	Stock	Market	High	Low	Chg.	Vol.
12.24	7/24	IBM	100	100.00	101.12	+1.12	100
12.25	7/25	IBM	100	101.12	102.24	+1.12	100
12.26	7/26	IBM	100	102.24	103.36	+1.12	100
12.27	7/27	IBM	100	103.36	104.48	+1.12	100
12.28	7/28	IBM	100	104.48	105.60	+1.12	100
12.29	7/29	IBM	100	105.60	106.72	+1.12	100
12.30	7/30	IBM	100	106.72	107.84	+1.12	100
12.31	7/31	IBM	100	107.84	108.96	+1.12	100
12.32	8/1	IBM	100	108.96	110.08	+1.12	100
12.33	8/2	IBM	100	110.08	111.20	+1.12	100
12.34	8/3	IBM	100	111.20	112.32	+1.12	100
12.35	8/4	IBM	100	112.32	113.44	+1.12	100
12.36	8/5	IBM	100	113.44	114.56	+1.12	100
12.37	8/6	IBM	100	114.56	115.68	+1.12	100
12.38	8/7	IBM	100	115.68	116.80	+1.12	100
12.39	8/8	IBM	100	116.80	117.92	+1.12	100
12.40	8/9	IBM	100	117.92	119.04	+1.12	100
12.41	8/10	IBM	100	119.04	120.16	+1.12	100
12.42	8/11	IBM	100	120.16	121.28	+1.12	100
12.43	8/12	IBM	100	121.28	122.40	+1.12	100
12.44	8/13	IBM	100	122.40	123.52	+1.12	100
12.45	8/14	IBM	100	123.52	124.64	+1.12	100
12.46	8/15	IBM	100	124.64	125.76	+1.12	100
12.47	8/16	IBM	100	125.76	126.88	+1.12	100
12.48	8/17	IBM	100	126.88	128.00	+1.12	100
12.49	8/18	IBM	100	128.00	129.12	+1.12	100
12.50	8/19	IBM	100	129.12	130.24	+1.12	100
12.51	8/20	IBM	100	130.24	131.36	+1.12	100
12.52	8/21	IBM	100	131.36	132.48	+1.12	100
12.53	8/22	IBM	100	132.48	133.60	+1.12	100
12.54	8/23	IBM	100	133.60	134.72	+1.12	100
12.55	8/24	IBM	100	134.72	135.84	+1.12	100
12.56	8/25	IBM	100	135.84	136.96	+1.12	100
12.57	8/26	IBM	100	136.96	138.08	+1.12	100
12.58	8/27	IBM	100	138.08	139.20	+1.12	100
12.59	8/28	IBM	100	139.20	140.32	+1.12	100
12.60	8/29	IBM	100	140.32	141.44	+1.12	100
12.61	8/30	IBM	100	141.44	142.56	+1.12	100
12.62	8/31	IBM	100	142.56	143.68	+1.12	100
12.63	9/1	IBM	100	143.68	144.80	+1.12	100
12.64	9/2	IBM	100	144.80	145.92	+1.12	100
12.65	9/3	IBM	100	145.92	147.04	+1.12	100
12.66	9/4	IBM	100	147.04	148.16	+1.12	100
12.67	9/5	IBM	100	148.16	149.28	+1.12	100
12.68	9/6	IBM	100	149.28	150.40	+1.12	100
12.69	9/7	IBM	100	150.40	151.52	+1.12	100
12.70	9/8	IBM	100	151.52	152.64	+1.12	100
12.71	9/9	IBM	100	152.64	153.76	+1.12	100
12.72	9/10	IBM	100	153.76	154.88	+1.12	100
12.73	9/11	IBM	100	154.88	156.00	+1.12	100
12.74	9/12	IBM	100	156.00	157.12	+1.12	100
12.75	9/13	IBM	100	157.12	158.24	+1.12	100
12.76	9/14	IBM	100	158.24	159.36	+1.12	100
12.77	9/15	IBM	100	159.36	160.48	+1.12	100
12.78	9/16	IBM	100	160.48	161.60	+1.12	100
12.79	9/17	IBM	100	161.60	162.72	+1.12	100
12.80	9/18	IBM	100	162.72	163.84	+1.12	100
12.81	9/19	IBM	100	163.84	164.96	+1.12	100
12.82	9/20	IBM	100	164.96	166.08	+1.12	100
12.83	9/21	IBM	100	166.08	167.20	+1.12	100
12.84	9/22	IBM	100	167.20	168.32	+1.12	100
12.85	9/23	IBM	100	168.32	169.44	+1.12	100
12.86	9/24	IBM	100	169.44	170.56	+1.12	100
12.87	9/25	IBM	100	170.56	171.68	+1.12	100
12.88	9/26	IBM	100	171.68	172.80	+1.12	100
12.89	9/27	IBM	100	172.80	173.92	+1.12	100
12.90	9/28	IBM	100	173.92	175.04	+1.12	100
12.91	9/29	IBM	100	175.04	176.16	+1.12	100
12.92	9/30	IBM	100	176.16	177.28	+1.12	100
12.93	10/1	IBM	100	177.28	178.40	+1.12	100
12.94	10/2	IBM	100	178.40	179.52	+1.12	100
12.95	10/3	IBM	100	179.52	180.64	+1.12	100
12.96	10/4	IBM	100	180.64	181.76	+1.12	100
12.97	10/5	IBM	100	181.76	182.88	+1.12	100
12.98	10/6	IBM	100	182.88	184.00	+1.12	100
12.99	10/7	IBM	100	184.00	185.12	+1.12	100
13.00	10/8	IBM	100	185.12	186.24	+1.12	100
13.01	10/9	IBM	100	186.24	187.36	+1.12	100
13.02	10/10	IBM	100	187.36	188.48	+1.12	100
13.03	10/11	IBM	100	188.48	189.60	+1.12	100
13.04	10/12	IBM	100	189.60	190.72	+1.12	100
13.05	10/13	IBM	100	190.72	191.84	+1.12	100
13.06	10/14	IBM	100	191.84	192.96	+1.12	100
13.07	10/15	IBM	100	192.96	194.08	+1.12	100
13.08	10/16	IBM	100	194.08	195.20	+1.12	100
13.09	10/17	IBM	100	195.20	196.32	+1.12	100
13.10	10/18	IBM	100	196.32	197.44	+1.12	100
13.11	10/19	IBM	100	197.44	198.56	+1.12	100
13.12	10/20	IBM	100	198.56	199.68	+1.12	100
13.13	10/21	IBM	100	199.68	200.80	+1.12	100
13.14	10/22	IBM	100	200.80	201.92	+1.12	100
13.15	10/23	IBM	100	201.92	203.04	+1.12	100
13.16	10/24	IBM	100	203.04	204.16	+1.12	100
13.17	10/25	IBM	100	204.16	205.28	+1.12	100
13.18	10/26	IBM	100	205.28	206.40	+1.12	100
13.19	10/27	IBM	100	206.40	207.52	+1.12	100
13.20	10/28	IBM	100	207.52	208.64	+1.12	100
13.21	10/29	IBM	100	208.64	209.76	+1.12	100
13.22	10/30	IBM	100	209.76	210.88	+1.12	100
13.23	10/31	IBM	100	210.88	212.00	+1.12	100
13.24	11/1	IBM	100	212.00	213.12	+1.12	100
13.25	11/2	IBM	100	213.12	214.24	+1.12	100
13.26	11/3	IBM	100	214.24	215.36	+1.12	100
13.27	11/4	IBM	100	215.36	216.48	+1.12	100
13.28	11/5	IBM	100	216.48	217.60	+1.12	100
13.29	11/6	IBM	100	217.60	218.72	+1.12	100
13.30	11/7	IBM	100	218.72	219.84	+1.12	100
13.31	11/8	IBM	100	219.84	220.96	+1.12	100
13.32	11/9	IBM	100	220.96	222.08	+1.12	100
13.33	11/10	IBM	100	222.08	223.20	+1.12	100
13.34	11/11	IBM	100	223.20	224.32	+1.12	100
13.35	11/12	IBM	100	224.32	225.44	+1.12	100
13.36	11/13	IBM	100	225.44	226.56	+1.12	100
13.37	11/14	IBM	100	226.56	227.68	+1.12	100
13.38	11/15	IBM	100	227.68	228.80	+1.12	100
13.39	11/16	IBM	100	228.80	229.92	+1.12	100
13.40	11/17	IBM	100	229.92	231.04	+1.12	100
13.41	11/18	IBM	100	231.04	232.16	+1.12	100
13.42	11/19	IBM	100	232.16	233.28	+1.12	100
13.43	11/20	IBM	100	233.28	234.40	+1.12	100
13.44	11/21	IBM	100	234.40	235.52	+1.12	100
13.45	11/22	IBM	100	235.52	236.64	+1.12	100
13.46	11/23	IBM	100	236.64	237.76	+1.12	100
13.47	11/24	IBM	100	237.76	238.88	+1.12	100
13.48	11/25	IBM	100	238.88	240.00	+1.12	100
13.49	11/26	IBM	100	240.00	241.12	+1.12	100
13.50	11/27	IBM	100	241.12	242.24	+1.12	100
13.51	11/28	IBM	100	242.24	243.36	+1.12	100
13.52	11/29	IBM	100	243.36	244.48	+1.12	100
13.53	11/30	IBM	100	244.48	245.60	+1.12	100
13.54	12/1	IBM	100	245.60	246.72	+1.12	100
13.55	12/2	IBM	100	246.72	247.84	+1.12	100
13.56	12/3	IBM	100	247.84	248.96	+1.12	100
13.57	12/4	IBM	100	248.96	250.08	+1.12	100
13.58	12/5	IBM	100	250.08	251.20	+1.12	100
13.59	12/6	IBM	100	251.20	252.32	+1.12	100
13.60	12/7	IBM	100	252.32	253.44	+1.12	100
13.61	12/8	IBM	100	253.44	254.56	+1.12	100
13.62	12/9	IBM	100	254.56	255.68	+1.12	100
13.63	12/10	IBM	100	255.68	256.80	+1.12	100

Representations: The Information Is Present But Making Sense Of It Requires Much Effort

Quarterly Income Statements
in millions, except earnings per share

	Q2-01*	Q3-01*	Q4-01*	Q1-02	Q2-02	Q3-02	Q4-02	Q1-03	(\$)
Revenue	\$ 6,550	\$ 6,403	\$ 6,577	\$ 6,126	\$ 7,741	\$ 7,245	\$ 7,253	\$ 7,746	\$
Operating expenses:									
Cost of revenue	864	899	867	978	1,691	1,567	1,463	1,344	
Research and development	990	1,069	1,364	1,398	1,595	1,474	1,832	1,707	
Acquired in-process technology									
Sales and marketing	1,290	1,198	1,359	1,457	1,676	1,449	1,670	1,415	
General and administrative	212	239	236	286	885	343	329	252	
Other expenses									
Total operating expenses	3,356	3,405	3,826	4,119	5,847	4,833	5,294	4,718	
Operating income	3,194	2,998	2,751	2,007	1,894	2,412	1,959	3,028	
Losses on equity investees and other	(28)	(46)	(33)	(30)	(37)	(11)	(14)	(22)	
Investment Income	751	706	(2,620)	(980)	553	739	(617)	41	
Noncontinuing items									
Income before income taxes	3,917	3,658	98	997	2,410	3,140	1,328	3,047	
Provision for income taxes	1,293	1,207	33	319	771	1,005	425	1,006	
Income before accounting change	2,624	2,451	65	678	1,639	2,135	903	2,041	
Cumulative effect of accounting change	-	-	-	-	-	-	-	-	
Net income	\$ 2,624	\$ 2,451	\$ 65	\$ 678	\$ 1,639	\$ 2,135	\$ 903	\$ 2,041	\$
Preferred stock dividends									
Net income available for common shareholders	\$ 2,624	\$ 2,451	\$ 65	\$ 678	\$ 1,639	\$ 2,135	\$ 903	\$ 2,041	\$
Basic EPS before accounting change	\$0.25	\$0.23	\$0.01	\$0.06	\$0.15	\$0.20	\$0.08	\$0.19	
Diluted EPS before accounting change	\$0.24	\$0.22	\$0.01	\$0.06	\$0.15	\$0.19	\$0.08	\$0.19	

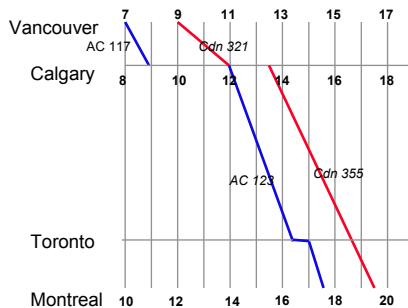
James Tam

Example One: Which Is The Best Flight?

Length, stop-overs, switches...

		Depart	Arrive
AC 117	Vancouver - Calgary	7:00	9:00
Cdn 321	Vancouver - Calgary	9:00	12:00
Cdn 355	Calgary - Montreal	13:30	19:30
AC 123	Calgary - Toronto	12:30	16:30
AC 123	Toronto - Montreal	16:45	17:30

*time zone: +1 van-cal, +2 cal-tor, mtl



James Tam

Example Two: When Do I Take My Drugs? (From “Things That Make Us Smart” By Don Norman)

Note: 10 - 30% error rate in taking pills, same for pillbox organizers

Inderal - 1 tablet 3 times a day
 Lanoxin - 1 tablet every a.m.
 Carafate - 1 tablet before meals and at bedtime
 Zantac - 1 tablet every 12 hours (twice a day)
 Quinag - 1 tablet 4 times a day
 Couma - 1 tablet a day

	Breakfast	Lunch	Dinner	Bedtime		Breakfast	Lunch	Dinner	Bedtime
Lanoxin	O				Lanoxin				
Inderal	O	O	O		Inderal	Inderal		Inderal	
Quinag	O	O	O	O	Quinag	Quinag		Quinag	Quinag
Carafate	O	O	O	O	Carafate	Carafate	Carafate	Carafate	Carafate
Zantac		O		O	Zantac	Zantac		Zantac	
Couma				O	Couma				Couma

Organized by both time of day and by drug

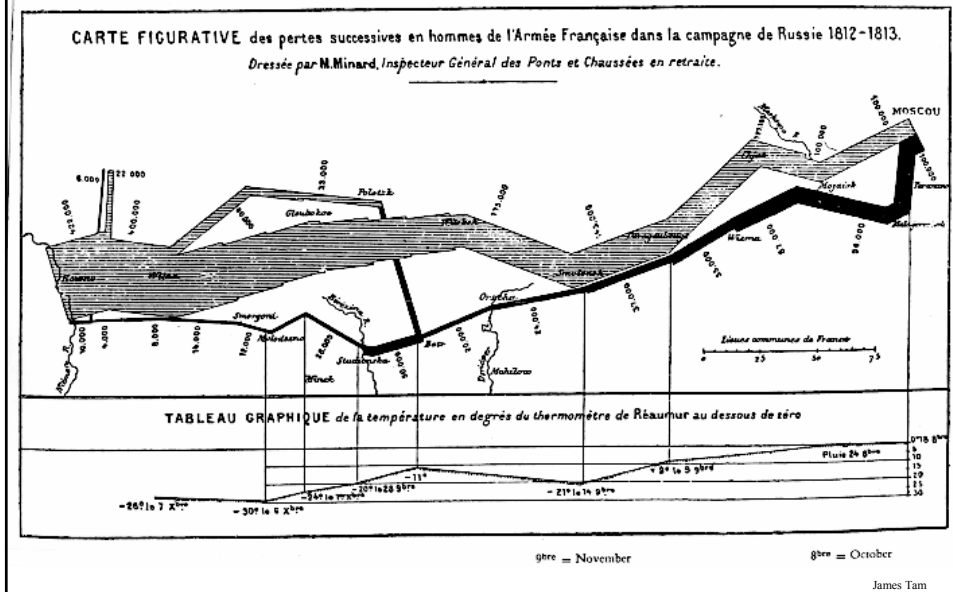
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Example Three: Napoleon's March To Moscow by Charles Minard



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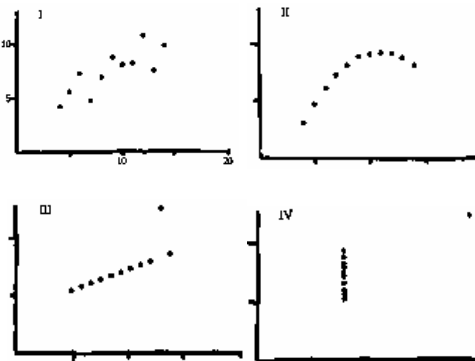
Example Three: Napoleon's March To Moscow by Charles Minard



Example Four: Anscombe's Quartet

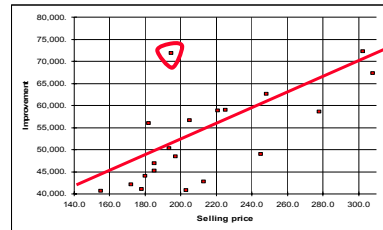
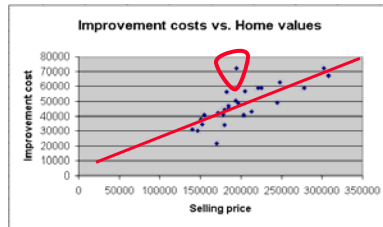
I		II		III		IV	
X	Y	X	Y	X	Y	X	Y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.80

N: 11.0
 mean X's : 9.0
 mean Y's : 7.5
 standard error of slope estimate: 0.1
 sum of squares: 110.0
 regression sum of squares: 27.5
 residual sum of squares of Y: 13.8
 correlation coefficient: 0.8
 r squared: 0.7
 regression line: $Y=3+0.5X$



Example Five: Do I Deserve A Tax Break

	A	B
1	Market value (\$)	Improvement cost (\$)
2	140000	31120
3	147000	29980
4	151000	38120
5	152000	34360
6	155000	40710
7	170000	21620
8	172000	42100
9	178000	41070
10	180000	34210
11	180000	44090
12	182000	55960
13	185000	45170
14	185000	46820
15	193400	50200
16	194500	71860
17	197000	48460
18	203000	40720
19	205000	56600
20	213000	42780
21	221000	58770
22	225000	58960
23	245000	48910
24	248000	62620
25	278000	58580
26	302500	72200
27	308000	67320

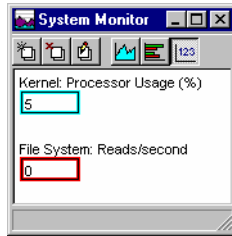


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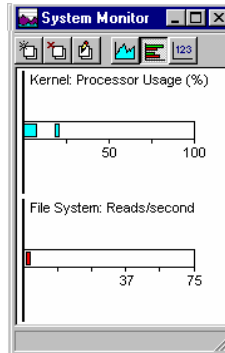
Which Representation Is Best?

Depends heavily on task

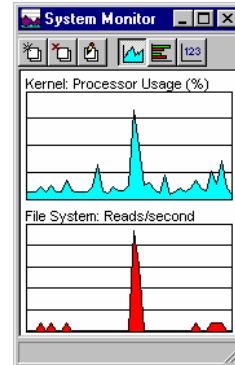
What is the precise value?



What is the performance now compared to the peak?



How does performance change over time?



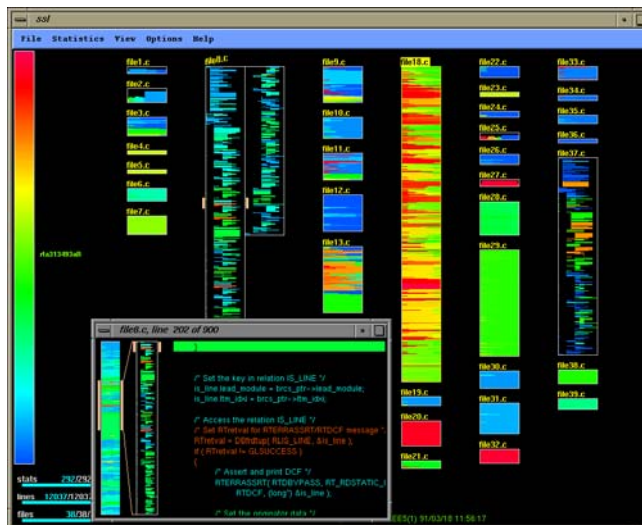
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Visualization

- **Representing data in a way that amplifies cognition (acquiring and using knowledge).**
- **It's related to representations:**
 - Representation are methods of encoding information.
 - Visualizations are good representations

James Tam

An Example Visualization: The Change History Of A Software System : SeeSoft¹



1) "Seesoft—A Tool for Visualizing Line Oriented Software Statistics", Eick S.G., Steffen J.L. and Sumner E.E

James Tam

Tufte's Principles Of Information Visualization₁

Graphics should reveal the data

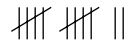
- Show the data
- Not get in the way of the message
- Avoid distortion
- Present many numbers in a small space
- Make large data sets coherent
- Encourage comparison between data
- Supply both a broad overview and fine detail
- Serve a clear purpose

1 *"Visual Display of Quantitative Information"* by E. Tufte

Note: Some of the visual examples on the following slides are taken from Tufte's books

James Tam

Show The Data



Buffalo

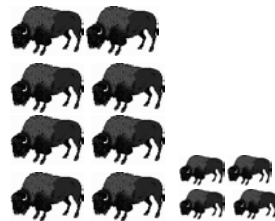


Buffalo



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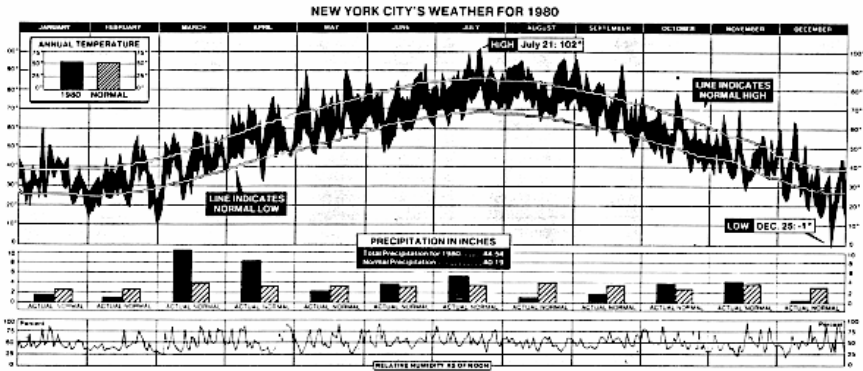


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Present Many Numbers In A Small Space, Make Large Data Sets Coherent

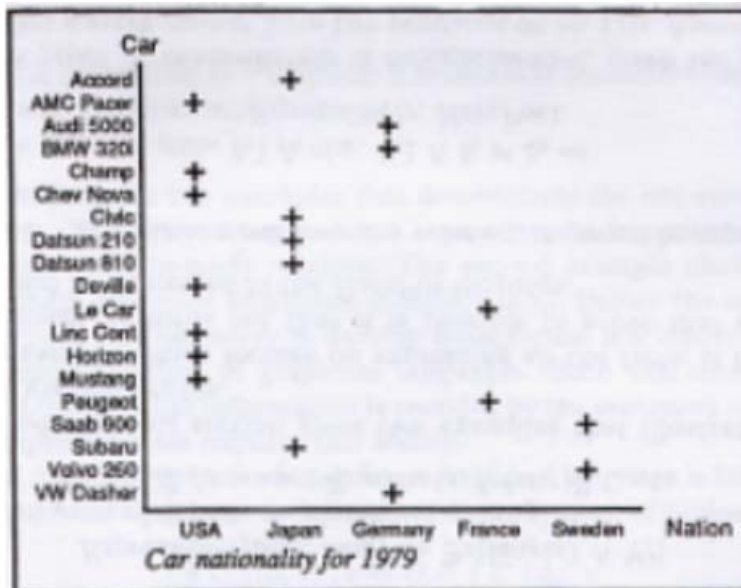
New York Weather History

- 181 numbers/sq inch



James Tam

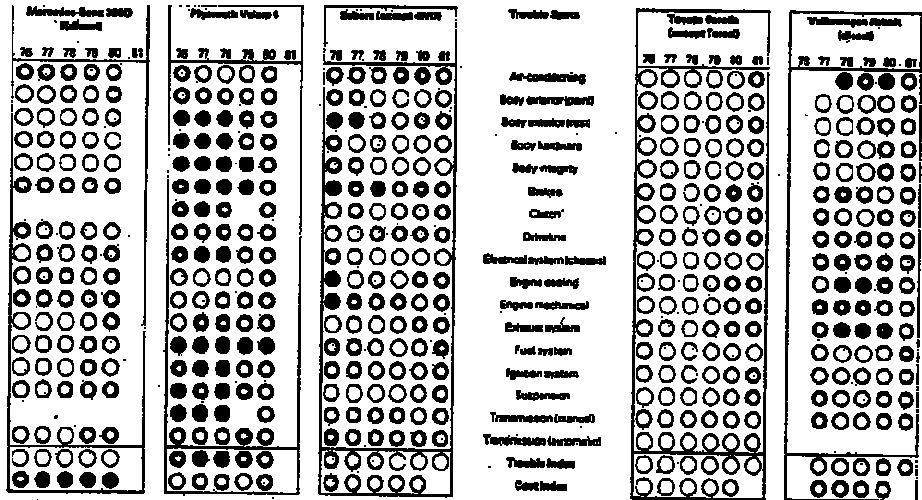
Encourage Comparison Between The Data



Mackinlay J.D. (1986) Automatic Design of Graphical Presentations.

James Tam

Broad Overview And Fine Detail

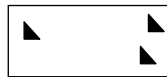


James Tam

Visual Variables

Position

- Changes in the x, y, z location



Size

- Changes in length, area or repetition



Shape

- Changes in form



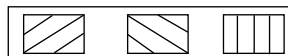
Value

- Changes in brightness



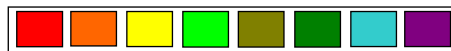
Orientation

- Changes in alignment



Colour

- Changes in hue



James Tam

Visual Variables (2)

Texture

- Variations in pattern



Motion



www.st-duffer.com

James Tam

Visual Variables (3)

Characteristics of visual variables

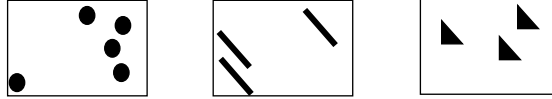
- **Selective**
Is a change in this variable enough to allow us to select it *from a group*?
- **Associative**
Is a change in this variable enough to allow us to perceive them *as a group*?
- **Quantitative**
Is there a numerical reading obtainable from changes in this variable?
- **Order**
Do changes in the visual variable indicate some sort of ranking?
- **Length¹**
Across how many changes in this variable are distinctly perceptible?

¹ I Think of it as variation

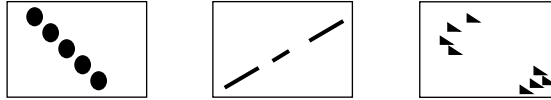
James Tam

Visual Variable: Position

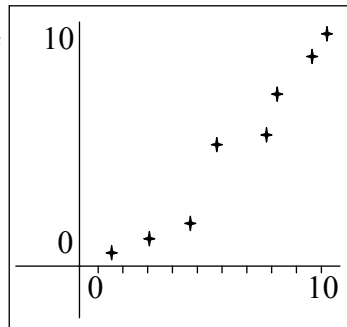
✓ Selective



✓ Associative



✓ Quantitative



✓ Order

✓ Length

James Tam

Visual Variable: Size

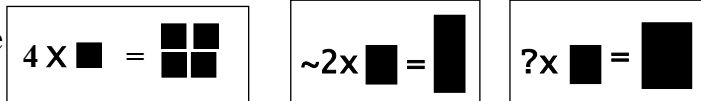
✓ Selective



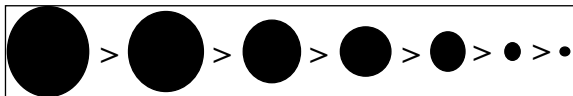
✓ Associative



≈ Quantitative



✓ Order



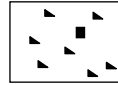
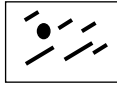
✓ Length

Theoretically infinite but practically limited

James Tam

Visual Variable: Shape

 Selective



 Associative



 Quantitative



 Order

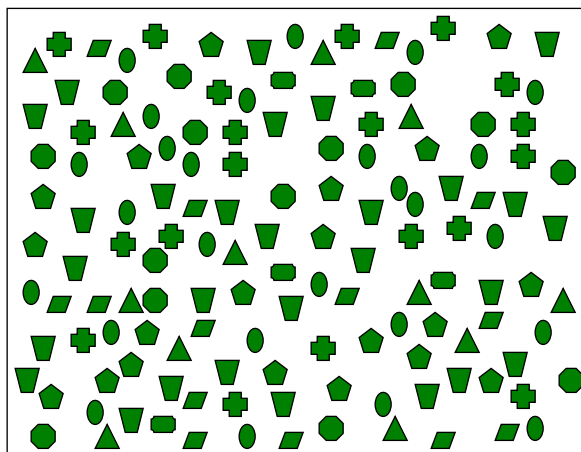


 Length



James Tam

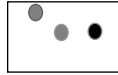
Shape



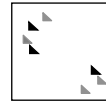
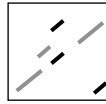
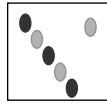
James Tam

Visual Variable: Value

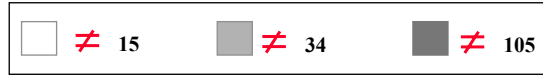
✓ Selective



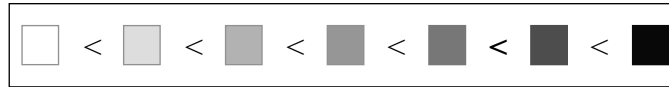
✓ Associative



≠ Quantitative



✓ Order



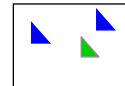
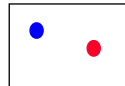
✓ Length

- Theoretically infinite but practically limited
- Association ~ < 7 and selection ~ 10

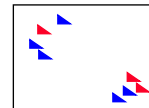
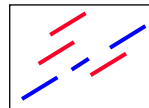
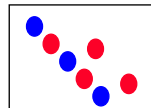
James Tam

Visual Variable: Color

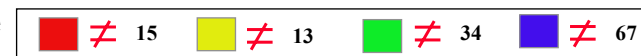
✓ Selective



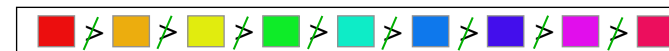
✓ Associative



≠ Quantitative



≠ Order

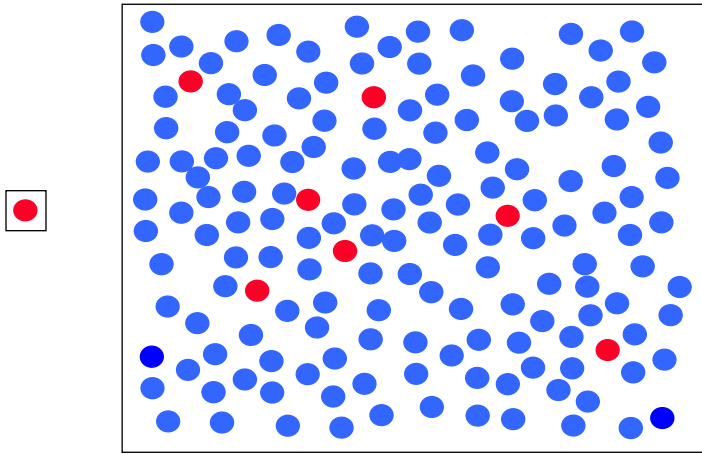


✓ Length

- Theoretically infinite but practically limited
- Association ~ < 7 and selection ~ 20

James Tam

Color

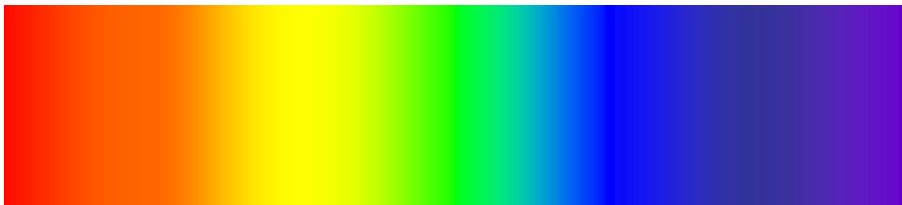


James Tam

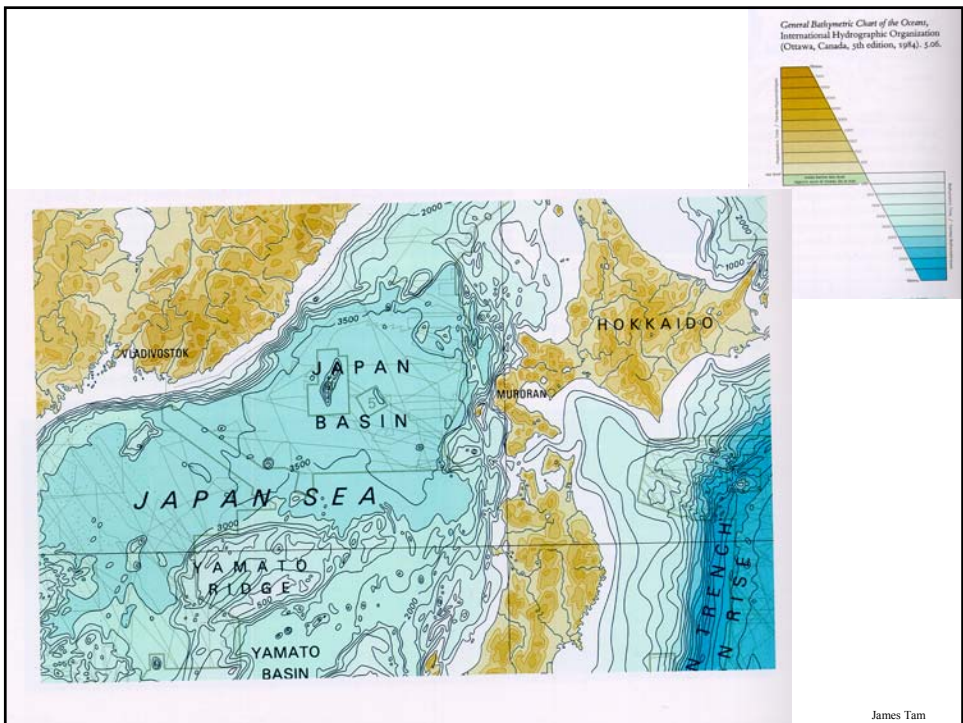
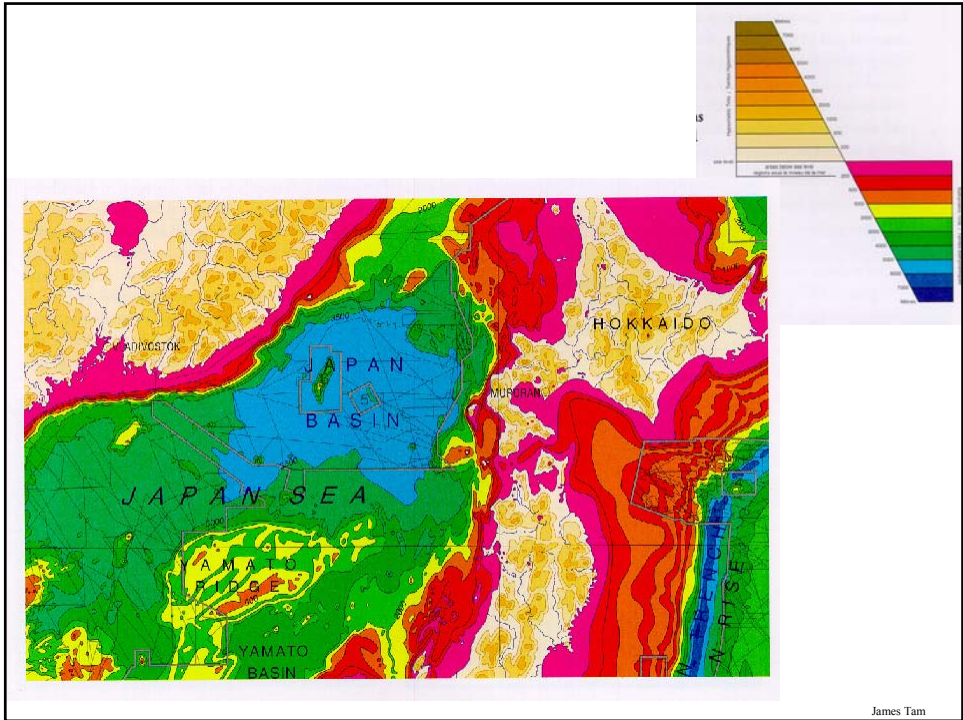
Color Encoding

Common advice says use a rainbow scale

- Marcus, Murch, Healey
- There are problems with rainbows



James Tam

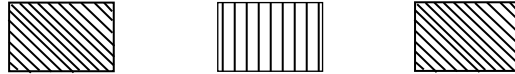


Visual Variable: Orientation

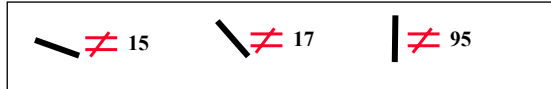
✓ Selective



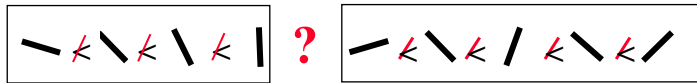
✓ Associative



≠ Quantitative



≠ Order



✓ Length

~5 in 2D

? in 3D

James Tam

Visual Variable: Texture

✓ Selective



✓ Associative



≠ Quantitative



≠ Order



✓ Length

• Theoretically infinite

James Tam

Visual Variable: Motion

✓ **Selective** - motion is one of our most powerful attention grabbers



✓ **Associative** – objects moving in unison groups them effectively



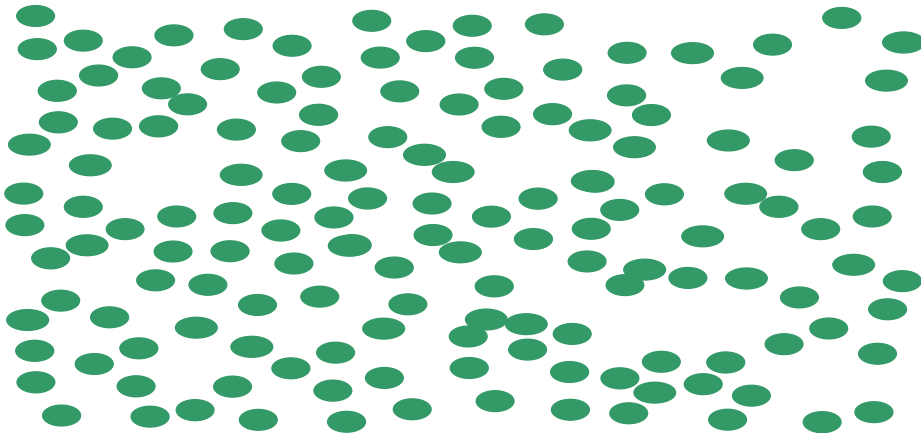
≠ **Quantitative** - subjective perception

≠ **Order**

? **Length** - distinguishable types of motion?

James Tam

Motion

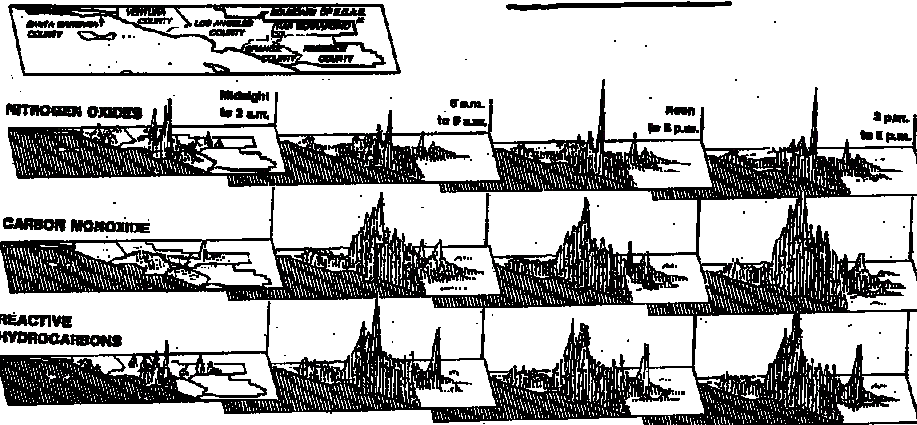


James Tam

Small Multiples: General Principles

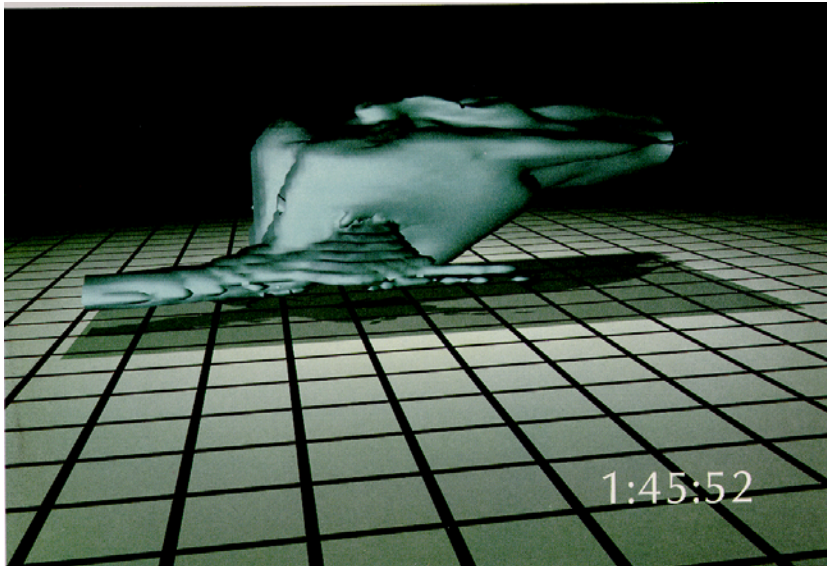
Learn once

Invite comparisons



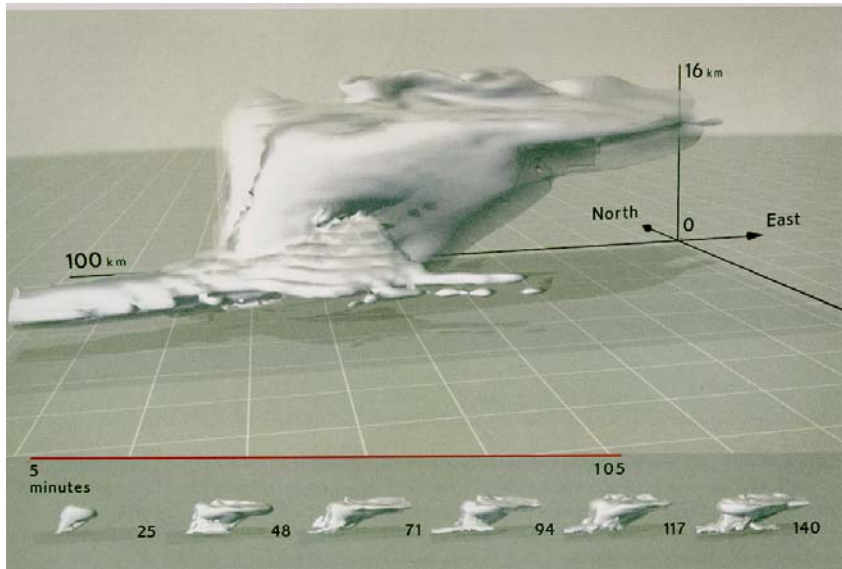
James Tam

Small Multiples: Showing Time And Change



James Tam

Small Multiples: Showing Time And Change



James Tam

Metaphors

Definition of a Metaphor

- One kind of object or idea is used in place of another to suggest a likeness or analogy between them
- Application of name or descriptive term to an object to which it is not literally applicable

James Tam

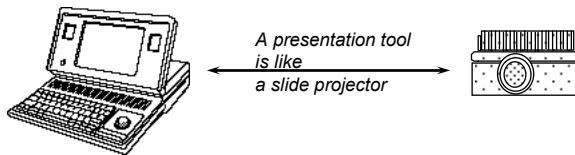
Interface Metaphors

Purpose

- Function as natural models
- Leverages our knowledge of familiar, concrete objects/experiences to understand abstract computer and task concepts

Problem

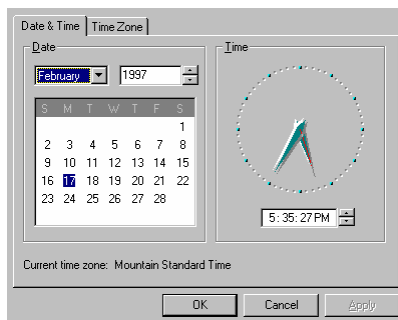
- Metaphor may portray inaccurate or naive conceptual model of the system



James Tam

Interface Metaphors

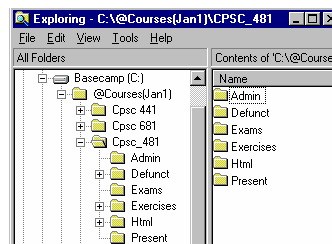
Pervade excellent interfaces



Control Panels with familiar controls

Name: _____
Address: _____
City: _____
Province: _____
Postal Code: _____

Forms



Hierarchical Folders

James Tam

A Real Life Metaphor: Life!



The Sims House Party © Maxis

James Tam

Creating Interface Metaphors

Generating metaphors

- Use metaphors that matches user's conceptual task
 - Desktop metaphor for office workers
 - Paintbrush metaphor for artists...
- Given a choice, choose the metaphor close to the way the system works
- Ensure emotional tone is appropriate to users
 - e.g., file deletion metaphors
 - Trashcan
 - Black hole
 - Paper shredder
 - Pit bull terrier
 - Nuclear disposal unit...

James Tam

Evaluating Metaphors

Potential problems:

- The metaphor has attributes that the system does not have.
- The system has attributes that are not suggested by the metaphor.
- An attribute exists both in the metaphor and in the system but works differently in each.

James Tam

The Metaphor Is More Powerful Than The System

Will the metaphor make people believe that the system can do more than it currently can?

```
West of House          Score: 0/0
ZORK I: The Great Underground Empire
Copyright 1982 by Infocom, Inc.
All rights reserved.
ZORK is a trademark of Infocom, Inc.
Release 30 / Serial number 830330

West of House
You are standing in an open field west
of a white house, with a boarded front
door.
There is a small mailbox here.

>■
```

Zork © Infocom

James Tam

The System Is More Powerful Than The Metaphor Implies

Will the metaphor restrict how people will try to use the system?

- e.g., file folders



James Tam

An Attribute Differs Between The Metaphor And The System

e.g., The trash can



Real trashcan



Desk top trashcan

James Tam

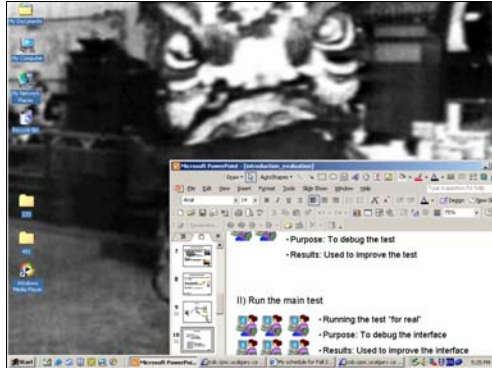
Metaphors Should Not Be Static

Evolve metaphors

- Is metaphor extensible to new features?
- When is the metaphor no longer useful?



Dilbert © United Features Syndicate

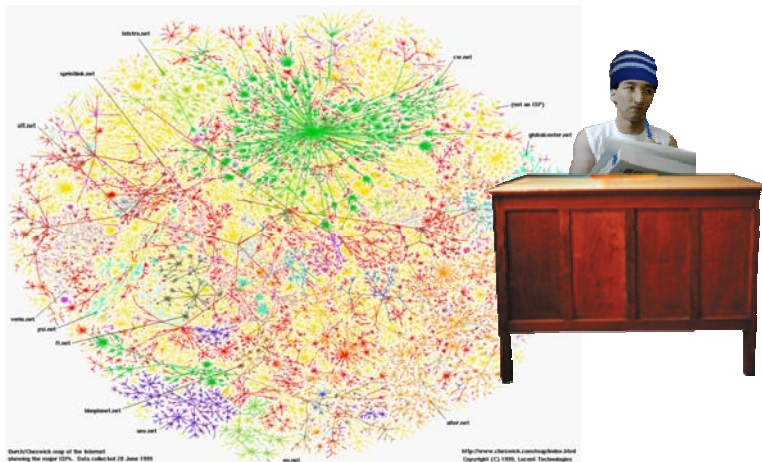


James Tam

Metaphors Should Not Be Static (2)

Evolve metaphors

- Is metaphor extensible to new features?
- When is the metaphor no longer useful?



James Tam

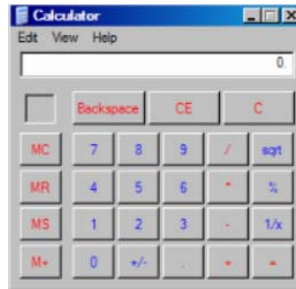
Misuse Of Metaphors

Caveat

- Metaphors can be overdone!

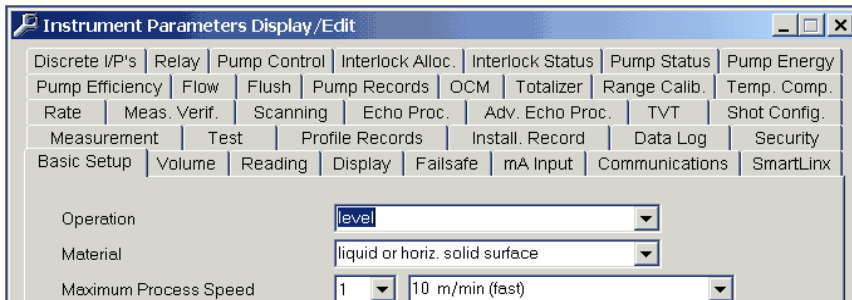
Common pitfalls

- Overly literal
 - Unnecessary fidelity
 - Excessive interactions
- Overly cute
 - Novelty quickly wears off
- Overly restrictive
 - Cannot move beyond
- Mismatched
 - Does not match user's task and/or thinking



James Tam

Misuse Of Metaphors (2)



Milltronics' *Dolphin Plus* a configuration package for industrial level and flow sensors

James Tam

A Example System That Applies A Metaphor: The Data Mountain



Robertson / Czerwinski / Larson / Robbins / Thiel / van Dantzich
Data Mountain: Using Spatial Memory for Document Management Proc ACM UIST'98

James Tam

A Example System That Applies A Metaphor: The Data Mountain

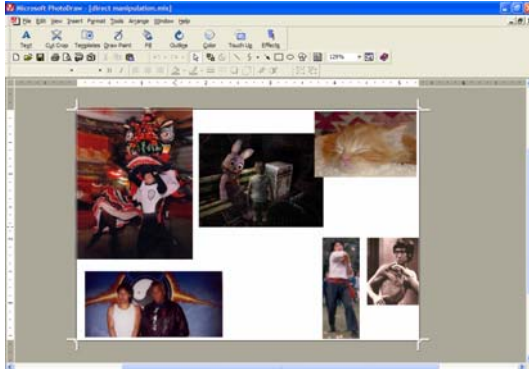


Robertson / Czerwinski / Larson / Robbins / Thiel / van Dantzich
Data Mountain: Using Spatial Memory for Document Management Proc ACM UIST'98

James Tam

Direct Manipulation

- **An interface that behaves as though the interaction was with a real-world object rather than with an abstract system**
- **Almost always based on a metaphor**
 - Mapped onto some facet of the real world task semantics



PhotoDraw © Microsoft

James Tam

Characteristics Of Direct Manipulation

Objects of interest are visible

Visible objects can be manipulated

Manipulation occurs by pointing and moving

James Tam

Indirect Interaction: Writing Java GUI's



James Tam

Indirect Interaction: Changing The Java Code

```
ContactsTracker.java - WordPad
File Edit View Insert Format Help

private Button add;
private Button remove;
private FileIO f;
private Button load;
private Button save;

public ContactsTracker ()
{
    gbc = new GridBagConstraints ();
    setLayout(gbc);
    list = new List(5);
    addWidget(this, list, 0, 1, 2, 3, GridBagConstraints.BOTH, GridBagConstraints.WEST);
    inputOne = new TextField();
    inputOne.addActionListener(new TextFieldListener());
    emailLabel = new Label ("Enter new email below");
    add = new Button ("<- Add");
    remove = new Button ("Rem ->");
    load = new Button ("Load");
    save = new Button ("Save");
    f = new FileIO();
}

public List getList () { return list; }

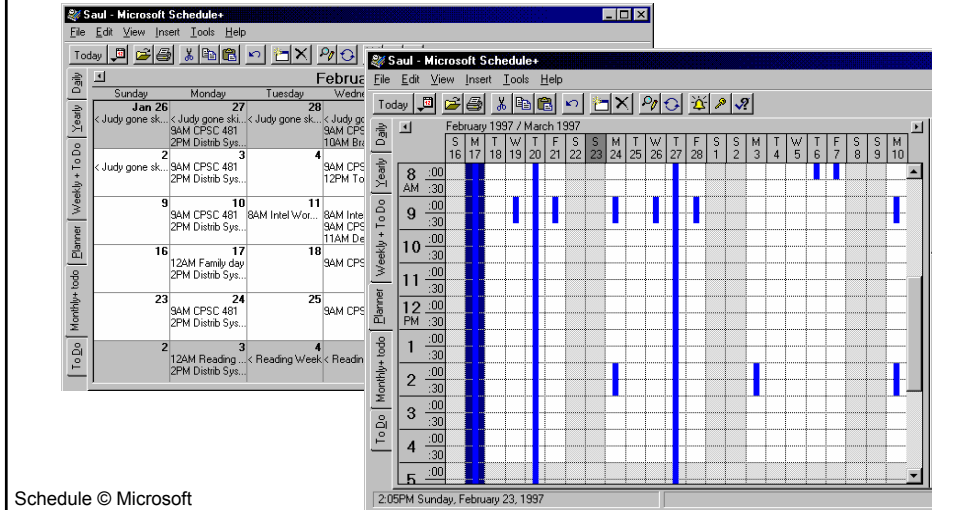
public void addWidget(Container container, Component widget,
    int x, int y, int w, int h, int fill, int anchor)
{
    LayoutManager lm = container.getLayout();
    GridBagConstraints gbc = new GridBagConstraints();

    gbc.gridx = x;
    gbc.gridy = y;
    gbc.gridwidth = w;
    gbc.gridheight = h;
    gbc.fill = fill;
    gbc.anchor = anchor;
    gbc.setConstraints(widget,gbc);
    container.add(widget);
}
```

James Tam

Direct Manipulation

Representation directly affects what can be directly manipulated



Is Direct Manipulation The Way To Go?

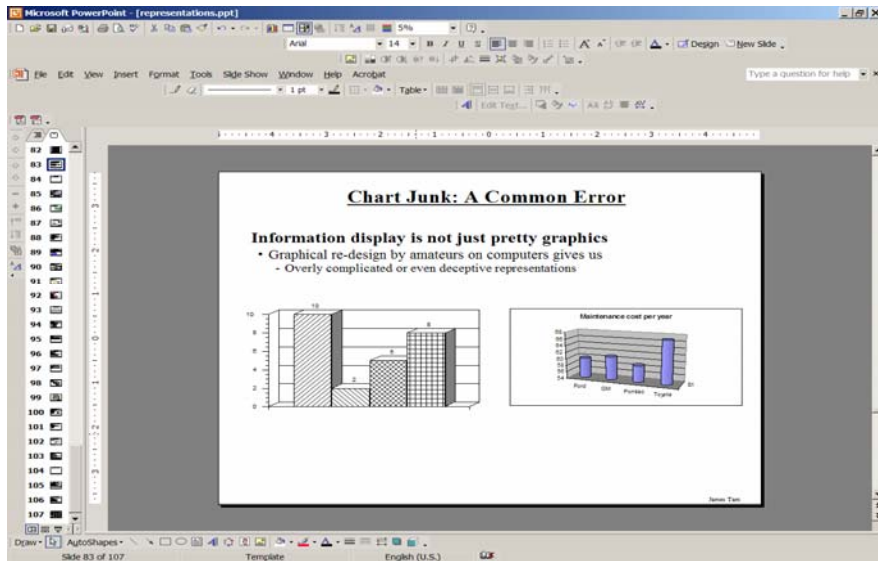
Some Disadvantages

- Ill-suited for abstract operations
 - Spell-checker?
- Tedium
 - Manually search large database vs. query
- Task domain may not have adequate physical/visual metaphor
- Metaphor may be overly-restrictive

Solution

- Most systems combine direct manipulation and abstractions
 - Word processor:
 - WYSIWYG document (direct manipulation)
 - buttons, menus, dialog boxes (abstractions, but direct manipulation “in the small”)

Conventional Applications: A Mix



PowerPoint © Microsoft

James Tam

Direct Engagement

- **The feeling of working directly on the task.**
- **To employ it, you need to consider the user of the system and the tasks that he or she engages in.**
- **Often direct manipulation is an important requirement for direct engagement.**
 - e.g., A drawing program provides tools that are familiar to artists (brushes, palettes etc.)

James Tam

Direct Engagement: A Telephone Database

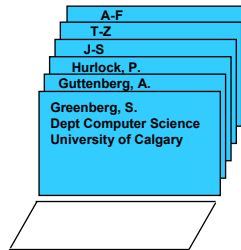
Find "Green"
>S. Greenberg
>Dept Computer Science
>University of Calgary

Command system
no direct manipulation

Search for: Green

Result: S. Greenberg
Dept Computer Science
University of Calgary

Form metaphor:
syntactic direct
manipulation



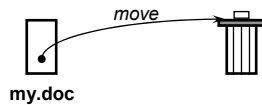
Rolodex metaphor:
full direct manipulation

James Tam

Object-Action vs. Action-Object

Select object, *then* do action

- Interface emphasizes 'nouns' (visible objects) rather than 'verbs' (actions)



The Sims House Party © Maxis

James Tam

Object-Action Vs. Action-Object (2)

Advantages

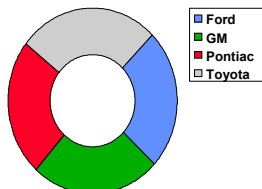
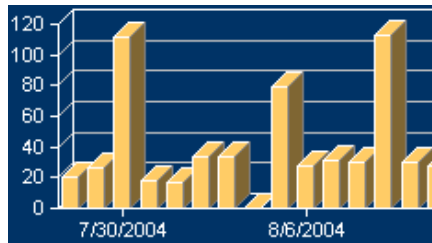
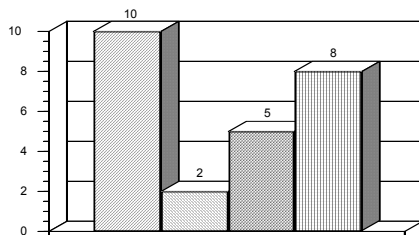
- Closer to real world
- Modeless interaction
- *Actions* always within context of object
 - Inappropriate ones can be hidden
- *Generic commands*
 - The same type of action can be performed on the object
 - e.g., drag 'n drop:
 - folders
 - files
 - paragraphs
 - text
 - numbers...

James Tam

Chart Junk: A Common Error

Information display is not just pretty graphics

- Graphical re-design by amateurs on computers gives us
 - Overly complicated or even deceptive representations



James Tam

What You Now Know

Good Representations

- Captures essential elements of the event / world
- Deliberately leaves out / mutes the irrelevant
- Appropriate for the person, their task, and their interpretation

Information Visualization

- Tufte's principles
- Exploits our knowledge of visual variables
- Many techniques now available (illustrated with research and commercial systems)

James Tam

What You Now Know (2)

Metaphors

- Uses our knowledge of the familiar and concrete to represent abstract concepts
- Need not be literal
- Has limitations that must be understood

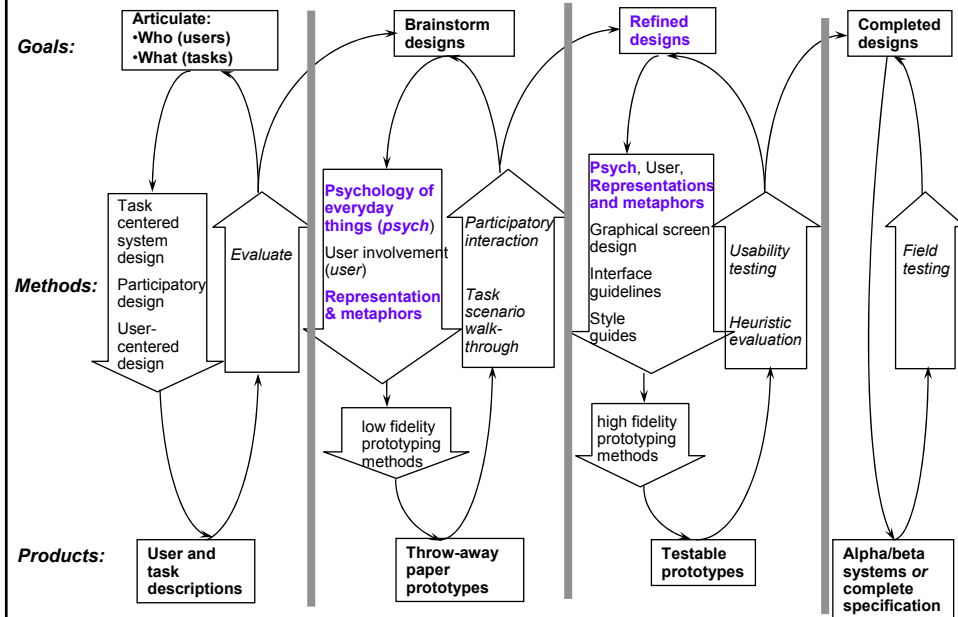
Direct manipulation

- Visibility of the objects of interest
- Manipulation by pointing and moving

These four components are the foundation of a true Visual Interface

James Tam

Interface Design And Usability Engineering



This diagram is a variation of the one presented by Saul Greenberg

James Tam