



**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
WORK INTEGRATED LEARNING PROGRAMMES**

COURSE HANDOUT

Part A: Content Design

Course Title	Data Visualization and Interpretation
Course No(s)	ZG555
Credit Units	5
Course Author	Febin.A.Vahab
Version No	1.0
Date	

Course Description

The course provides an insight on the best practices used in Data Visualization and also illustrates the best tools used to achieve the same

Course Objectives

No	Description
CO1	To introduce key techniques and theory used in visualization, including data models, graphical perception and techniques for visual encoding and interaction.
CO2	Solving various visualization problem using tools like Tableau, Python (Matplotlib)
CO3	Best Practices of Dashboard Design, Designing dashboards meeting the design principles for various requirements

Text Book(s)	
T1	Storytelling with Data, A data visualization guide for business professionals, by Cole Nussbaumer Knaflic; Wiley
T2	Data Visualisation : A Successful Design Process By Andy Kirk
T3	Visualize This: The Flowing Data Guide to Design, Visualization & Statistics, by Nathan Yau, Wiley
T4	Information Dashboard Design: Displaying data for at-a-glance monitoring, Stephen Few, second edition
T5	Tableau Your Data: Fast and Easy Visual Analysis with Tableau Software, by Daniel G Murray
T6	Matplotlib for Python Developers: Effective techniques for data visualization with Python, by Aldrin Yim, Claire Chung and Allen Yu
T7	Hands on Data Visualization with Bokeh: Interactive web plotting for Python using Bokeh, by Kevin Jolly
R1	Mastering Tableau, by David Baldwin



Learning Outcomes:

No	Learning Outcomes
LO1	Concepts and best practices of Data Visualization
LO2	Best practices of Information Dashboard Design
LO3	Data Visualization using Tableau
LO4	Data Visualization using Python (Matplotlib)



Part B: Content Development Plan

Academic Term	First Semester 2019-20
Course Title	Data Visualization and Interpretation
Course No	DSECL ZG555
Credit	5
Content Developer	Febin.A.Vahab

Glossary of Terms

Module	M	Module is a standalone quantum of designed content. A typical course is delivered using a string of modules. M2 means module 2.
Contact Session	CS	Contact Session (CS) stands for a 2 hour long live session with students conducted either in a physical classroom or enabled through technology. In this model of instruction, instructor led sessions will be for 16 CS.
Recorded Lecture	RL	RL stands for Recorded Lecture or Recorded Lesson. It is presented to the student through an online portal. A given RL unfolds as a sequences of video segments interleaved with exercises.
Lab Exercises	LE	Lab exercises associated with various modules
Self-Study	SS	Specific content assigned for self study
Homework	HW	Specific problems/design/lab exercises assigned as homework

Modular Structure

Module Summary

No.	Title of the Module
M1	Data Visualizations and Practices
M2	Effective Dashboard Design
M3	Data Visualization with Tableau
M4	Data Visualization with Python – 1 (Matplotlib)
M5	Data Visualization with Python – 2 (Bokeh, Seaborn)



Detailed Structure

M1: Data Visualizations and Practices Contact Session 1-3

Type	Description/Plan	Reference Text Book/Chapters
CS1	<ul style="list-style-type: none">• Introduction• Exploiting the Digital age• Visualisation as a Discovery tool• Visualisation skills for the masses• The Visualisation methodology• Visualisation design objectives• Exploratory vs. explanatory analysis• Understanding the context for data presentations• 3 minute story• Effective Visuals<ul style="list-style-type: none">◦ Textuals◦ Tabulars◦ Graphicals	T1 Ch 1 and 2, T2 Ch1
	<ul style="list-style-type: none">• Gestalt principles of visual perception• Visual Ordering• Decluttering	T1 Ch 3
CS2	<ul style="list-style-type: none">• Preattentive attributes in text and graphs<ul style="list-style-type: none">◦ Size◦ Color◦ Position• Data Design concepts<ul style="list-style-type: none">◦ Affordances◦ Accessibility◦ Aesthetics	T1 Ch 4
	<ul style="list-style-type: none">• Storytelling• Visualization Design Lessons	T1 Ch 5
CS3	Taxonomy of Data Visualisation Methods <ul style="list-style-type: none">• Comparing Categories of Plots• Dot Plot• Bar Chart• Floating Bar• Histogram• Radial Chart• Glyph Chart	T2 Ch 5
	<ul style="list-style-type: none">• Case Studies<ul style="list-style-type: none">◦ Visualizing Pattern Over time◦ Visualizing Proportions◦ Visualizing Relationships	T3 , Ch 4, 5, 6
<u>SELF STUDY</u>		
<ul style="list-style-type: none">• Data-Driven Documents (D3.js charts)<ul style="list-style-type: none">◦ Exploring visual gallery		



- Simple charts creation
- <https://d3js.org/>
- Explore more D3 charts examples
- Explore Google charts library
- <https://developers.google.com/chart/>
- Good Enough to Great: A Quick Guide for Better Data Visualizations
- <https://www.tableau.com/learn/whitepapers/good-enough-great-quick-guide-better-data-visualizations>

M2: Data Visualization with Tableau

Contact Session 4-7

Type	Description/Plan	Reference
CS4	<ul style="list-style-type: none">• Exploring Tableau<ul style="list-style-type: none">○ User Interface○ Tableau Prep○ Data Connection○ Data Preparation	T5 Ch 1, 2, 3 https://www.tableau.com/learn/training
CS5	<ul style="list-style-type: none">• Visual Analytics<ul style="list-style-type: none">○ Data Analysis○ Visuals	https://www.tableau.com/learn/training T5 Ch 3, 4
CS6	<ul style="list-style-type: none">• Maps	T3 Ch 6
	<ul style="list-style-type: none">• Dashboard and Stories	https://www.tableau.com/learn/training T5 Ch 8
CS7	<ul style="list-style-type: none">• Beyond the Basic Chart Types<ul style="list-style-type: none">○ Bullet graphs○ Pareto charts○ Custom background images	R1 Ch 7
	<ul style="list-style-type: none">• Visualization Best Practices and Dashboard Design	R1 Ch 10

SELF STUDY

- Explore the different types of visuals that can be plotted with Tableau interface

M3: Effective Dashboard Design

Contact Session 8-10

Type	Description/Plan	Reference
CS8	<ul style="list-style-type: none">• Dashboard• Dashboard categorization and typical data• Characteristics of a Well-Designed Dashboard• Key Goals in the Visual Design Process	T4 Ch 2 and 5
	<ul style="list-style-type: none">• Common Mistakes in Dashboard Design	T4 Ch 3
CS9	<ul style="list-style-type: none">• Power of Visual Perception<ul style="list-style-type: none">○ Visually Encoding Data for Rapid Perception○ Applying the Principles of Visual Perception to	T4 Ch 4



	Dashboard Design	
	<ul style="list-style-type: none"> Effective Dashboard Display Media Dashboards design for Usability 	T4 Ch 6 T4 Ch 7
CS10	<ul style="list-style-type: none"> Case Studies <ul style="list-style-type: none"> Sample Sales Dashboard Sample CIO Dashboard Sample Telesales Dashboard Sample Marketing Analysis Dashboard Bringing it all together with Dashboards <ul style="list-style-type: none"> How Dashboard Facilitates Analysis and Understanding How Tableau Improves the Dashboard-building process The right way to build a Dashboard Best Practices for Dashboard building 	T4 Ch 8
		T5 Ch8

SELF STUDY

- Explore any 2 dashboard design tools
<https://dzone.com/articles/20-free-and-open-source-data-visualization-tools>
- Build Your Competitive Edge: 12 Powerful Retail Dashboards
<https://www.tableau.com/learn/whitepapers/powerful-retail-dashboards>
- 10 Best Practices for Building Effective Dashboards
<https://www.tableau.com/learn/whitepapers/10-best-practices-building-effective-dashboards>

M4: Data Visualization with Python – 1 (Matplotlib)

Contact Session 11-14

Type	Description/Plan	Reference
CS11	<ul style="list-style-type: none"> Merits of Matplotlib The Lifecycle of a Plot Pyplot Matplotlib visuals basics 	https://matplotlib.org/tutorials/index.html T6 Ch 1 and Ch2
CS12	<ul style="list-style-type: none"> Plot styles types Visual Decorations 	http://www.labri.fr/perso/nrougier/teaching/matplotlib/ T6 Ch 3
CS13	<ul style="list-style-type: none"> Advanced Matplotlib 	T6 Ch4
CS14	Matplotlib in the real world <ul style="list-style-type: none"> Plotting data from a database Plotting data from a CSV file Plotting extrapolated data using curve fitting Plotting geographical data 	T6 Ch9

SELF STUDY

- Analysis of time series data using matplotlib



- Plotting Univariate Distributions
- Plotting Bivariate Distributions

M5: Data Visualization with Python – 2 (Seaborn and Bokeh)

Contact Session 15-16

Type	Description/Plan	Reference
CS15	<ul style="list-style-type: none">• Seaborn package<ul style="list-style-type: none">○ Seaborn vs Matplotlib○ Data Loading○ Seaborn Basic Plots	https://seaborn.pydata.org/ https://www.datacamp.com/community/tutorials/seaborn-python-tutorial
	<ul style="list-style-type: none">• Statistical plots with Seaborn	https://www.datacamp.com/courses/introduction-to-data-visualization-with-python
CS16	<ul style="list-style-type: none">• Plotting using Glyphs• Plotting with different Data Structures	T7 Ch 1 T7 Ch 2
	<ul style="list-style-type: none">• Using Annotations, Widgets, and Visual Attributes for Visual Enhancement• Building and Hosting Applications Using the Bokeh Server	T7 Ch 4 T7 Ch 5
SELF STUDY		
<ul style="list-style-type: none">• Try out all the statistical plots mentioned in datacamp's tutorial• https://www.datacamp.com/courses/introduction-to-data-visualization-with-python• Try out the Bokeh tutorial• https://www.analyticsvidhya.com/blog/2015/08/interactive-data-visualization-library-python-bokeh/		

Evaluation Scheme:

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

No	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Quiz	Online	-	5%	Dec
EC-1	Assignment	Online	-	25%	Dec, Feb/March
EC-2	Mid-Semester Test	Closed Book	1.5 hours	30%	Dec
EC-3	Comprehensive Exam	Open Book	2.5 hours	40%	March

Note: Assignment can be replaced by QUIZ also.

Syllabus for Mid-Semester Test (Closed Book): Topics in Session Nos. 1 to 7

Syllabus for Comprehensive Exam (Open Book): All topics (Session Nos. 1 to 16)



Important links and information:

CANVAS(LMS)

Students are expected to visit the CANVAS course page on a regular basis and stay up to date with the latest announcements and deadlines.

Contact sessions: Students should attend the online lectures as per the schedule provided on CANVAS.

Evaluation Guidelines:

1. EC1 consists of two assignments(Quiz/Assignment). Announcements will be made on the portal, in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted.
3. For Open Book exams: Use of books and any printed / written reference material (filed or bound) is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam which will be made available in CANVAS. The Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend the online lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.

CONTACT SESSION 1 -PLAN



Contact Sessions(#)	List of Topic Title	Text/Ref Book/external resource
1	<ul style="list-style-type: none"> • Introduction • Exploiting the Digital age • Visualisation as a Discovery tool • Visualisation skills for the masses • The Visualisation methodology • Visualisation design objectives • Exploratory vs. explanatory analysis • Understanding the context for data presentations • 3 minute story • Effective Visuals • Gestalt principles of visual perception • Visual Ordering • Decluttering 	T1 Ch 1 and 2, T2 Ch1

1

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Bad graphs are everywhere



- We learn a lot about language and math.
- We learn how to put words together into sentences and into stories.
- We learn to make sense of numbers.

2

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Bad graphs are everywhere

- Often end up relying on our tools to understand best practices
- Tool defaults and general practices tend to leave our data and the stories we want to tell with that data sorely lacking.
- There is a story in your data. But your tools don't know what that story is.
- That's where it takes you to bring that story visually and contextually to life.

3

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Bad graphs are everywhere

- The following are a few examples before-and-afters to give you a visual sense of what is story telling.(will learn in detail in later sessions)

4

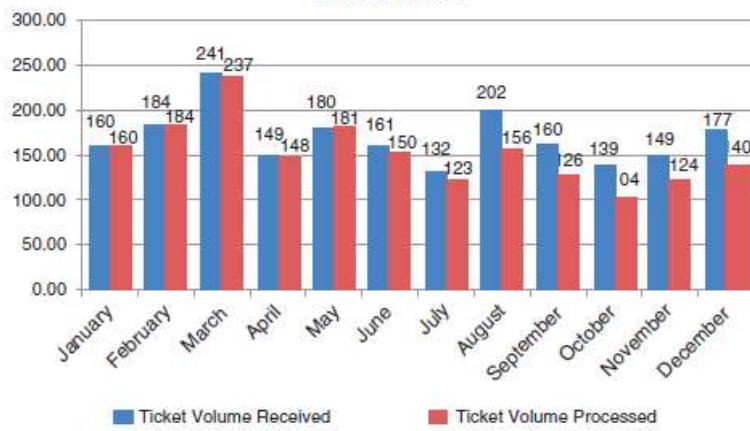
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4

Ticket trend-Showing data



Ticket Trend



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5

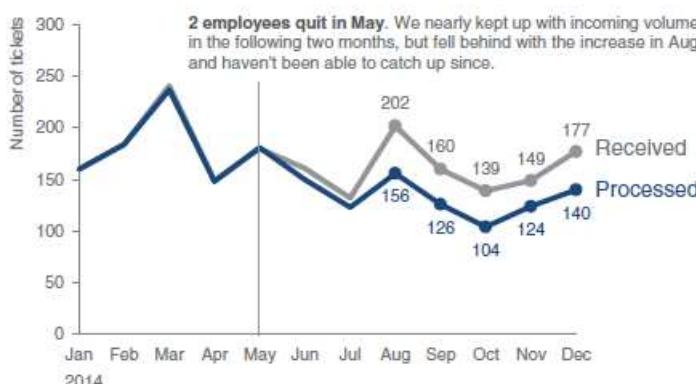
Ticket trend-storytelling with data



Please approve the hire of 2 FTEs

to backfill those who quit in the past year

Ticket volume over time



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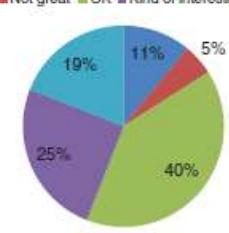
6

Survey Results-Showing data

innovate achieve lead

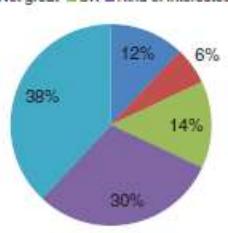
Survey Results

PRE: How do you feel about doing science?



Feeling	Percentage
Bored	5%
Not great	11%
OK	40%
Kind of interested	25%
Excited	19%

POST: How do you feel about doing science?



Feeling	Percentage
Bored	12%
Not great	6%
OK	14%
Kind of interested	30%
Excited	38%

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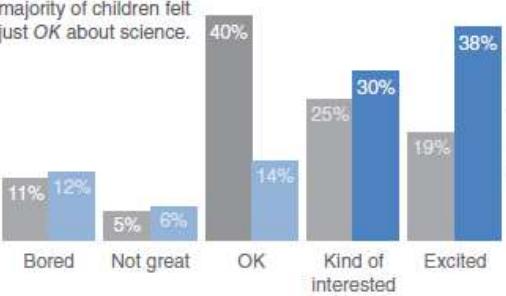
Survey Results-Story Telling with data

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Pilot program was a success

How do you feel about science?

BEFORE program, the majority of children felt just **OK** about science.



Feeling	PRE (%)	POST (%)
Bored	11%	12%
Not great	5%	6%
OK	40%	14%
Kind of interested	25%	30%
Excited	19%	38%

AFTER program, more children were *Kind of interested* & *Excited* about science.

Based on survey of 100 students conducted before and after pilot program (100% response rate on both surveys).

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Story telling with Data

- Being able to tell stories with data is a skill that's becoming ever more important in our world of increasing data and desire for data driven decision making.

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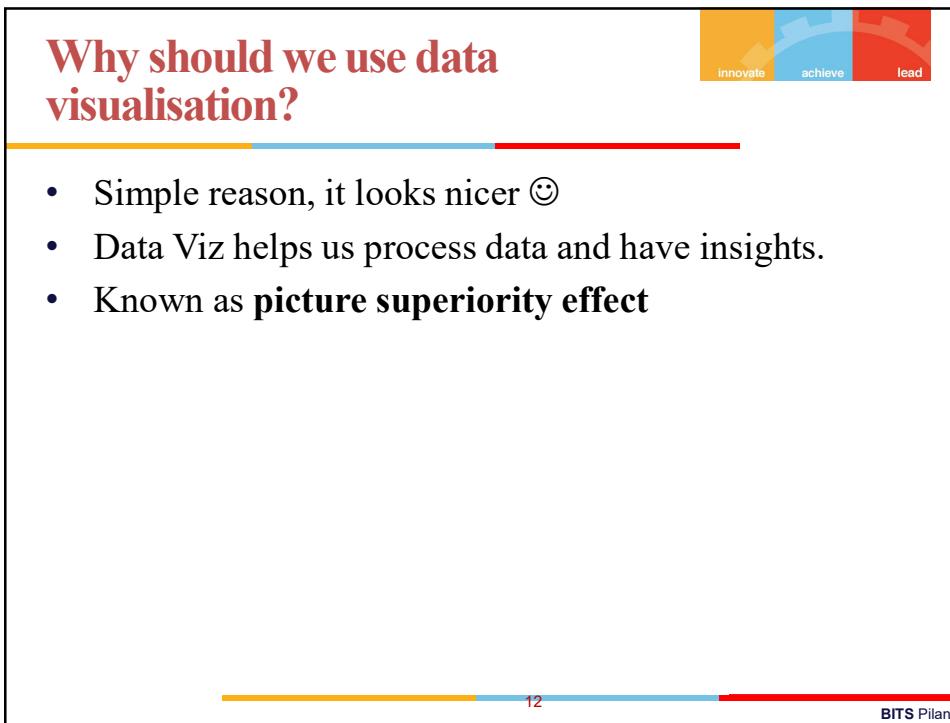
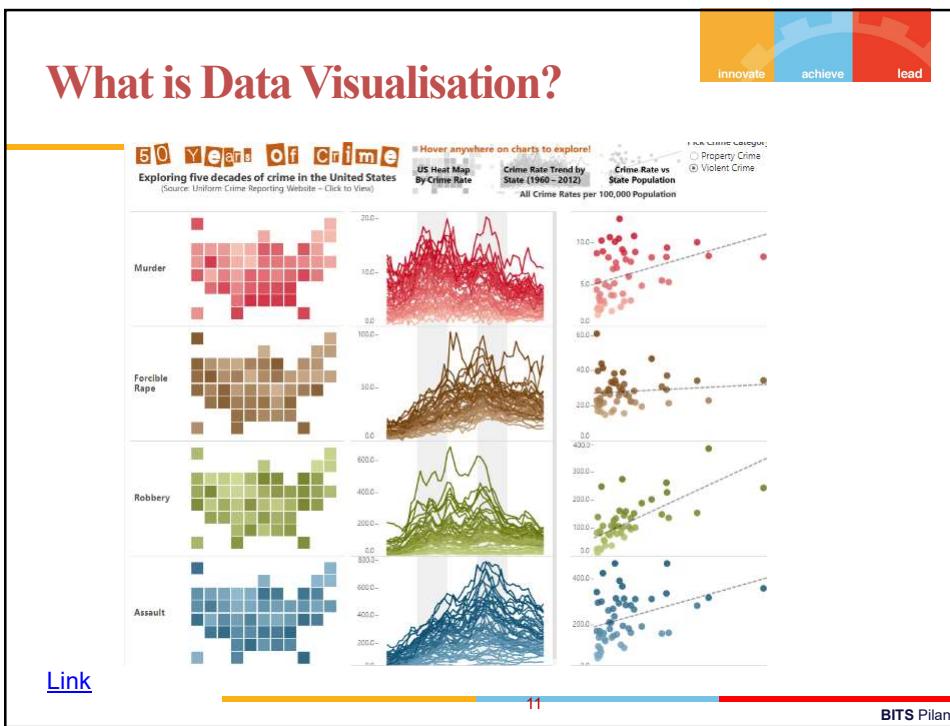
What is Data Visualisation?

- Simply put,
- **Data Viz is using pictures to represent data.**
- It has been there for many years but the recent technological advancements have made it easy to summarize large volumes of data very quickly.

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Why should we use data visualisation?



	Product A	Product B	Product C	Product D	Product E	Product F	Product G	Product H
Northeast	\$ 15,749.00	\$ 40,195.00	\$ 15,472.00	\$ 63,029.00	\$ 8,509.00	\$ 42,987.00	\$ 27,778.00	\$ 12,510.00
Southeast	\$ 48,044.00	\$ 20,741.00	\$ 40,643.00	\$ 15,687.00	\$ 12,342.00	\$ 23,297.00	\$ 10,401.00	\$ 10,522.00
Central	\$ 5,240.00	\$ 45,296.00	\$ 16,114.00	\$ 63,359.00	\$ 58,198.00	\$ 24,191.00	\$ 46,826.00	\$ 50,278.00
Northwest	\$ 12,860.00	\$ 11,548.00	\$ 43,134.00	\$ 19,331.00	\$ 60,563.00	\$ 51,475.00	\$ 28,954.00	\$ 14,405.00
Southwest	\$ 37,087.00	\$ 61,506.00	\$ 54,084.00	\$ 14,715.00	\$ 17,811.00	\$ 32,814.00	\$ 47,853.00	\$ 44,639.00

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Why should we use data visualisation?



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Central	\$ 5,240.00	\$ 45,296.00	\$ 16,114.00	\$ 63,359.00	\$ 58,198.00	\$ 24,191.00	\$ 46,826.00	\$ 50,278.00
Northwest	\$ 12,860.00	\$ 11,548.00	\$ 43,134.00	\$ 19,331.00	\$ 60,563.00	\$ 51,475.00	\$ 28,954.00	\$ 14,405.00
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Why should we use data visualisation?

Big data

- Wind map
<http://hint.fm/wind/>
- Real time credit card monitoring

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Data Visualization



What?

Graphical / Visual representation of data

Why?

- Way to identify patterns, trends and outliers in data
- Helps in making data-driven decisions

How?

- *That is what we will learn in this course!*

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Purpose

"The ability to take data—to be able to understand it, to process it, to extract value from it, to visualize it, to communicate it—that's going to be a hugely important skill in the next decades" –

Hal Varian, Google's chief economist

"The purpose of visualization is insight, not just picture. " –

Ben Shneiderman, Data visualization pioneer

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Exploiting the digital age



- Data is now rightly seen as an invaluable asset.
- "Data is the new oil"

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Visualization as a discovery tool




"The greatest value of a picture is when it forces us to notice what we never expected to see" - John W Tukey

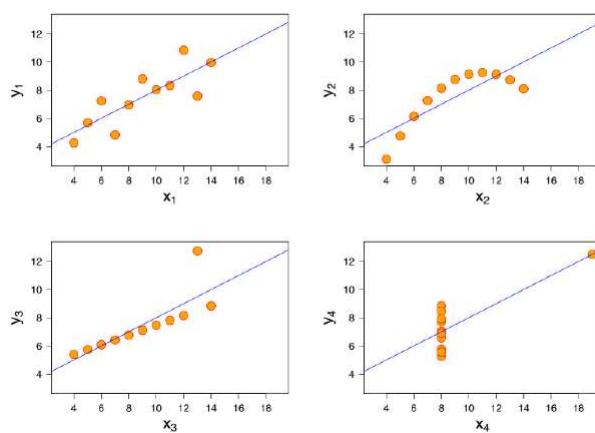
x1	y1	x2	y2	x3	y3	x4	y4
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.1	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.1	4	5.39	19	12.5
12	10.84	12	9.13	12	8.15	8	5.56
7	4.82	7	7.26	7	6.42	8	7.91
5	5.68	5	4.74	5	5.73	8	6.89

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Visualization as a discovery tool

- the general tendency about a trend line in **X1, Y1**
- the curvature pattern of **X2, Y2**
- the strong linear pattern with single outlier in **X3, Y3**
- the similarly strong linear pattern with an outlier for **X4, Y4**

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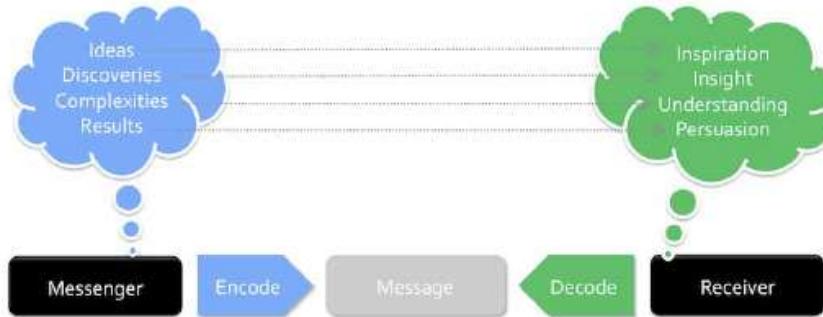
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Definition



“ Data visualization is the use of visual representations to explore, make sense of, and communicate data.” - Data visualization expert, Stephen Few



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Definition



- The representation and presentation of data that exploits our visual perception abilities in order to amplify cognition.

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Human Brain and Data Visualisation



“The purpose of visualization is insight, not just picture.” – Ben Shneiderman, Data visualization pioneer

- This means the most important transformation that you can make as a designer is not turning data into charts
- But turning data into something clear and meaningful in the minds of your audiences

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Human Brain and Data Visualisation



“The purpose of visualization is insight, not just picture.” – Ben Shneiderman, Data visualization pioneer

Visual Processing

- 30-60% of Human Brains capacity is used for visual processing
- By comparison, touch is about 8% for example and hearing is only about 2%.
- Processes 10 million bits per second
- Fastest mode of processing
- Our brains are wired for **fast** visual processing

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Human Brain and Data Visualisation



For our ancestors this need for speed could tip the balance between life and death.

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Human Brain and Data Visualisation



- The impulse to detect, match, and make sense of patterns is so strong that many of us do it not only for practical purposes, but also as a form of pure play in many games.

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WHAT DO YOU SEE?



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Human Brain and Data Visualisation



- A core part of data visualization design involves repurposing our innate visual abilities to adapt to a world that's flooding with data.
- And the more you become aware of people's visual processing strengths and limitations, the better your designs will become

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Human Brain and Data Visualisation



Child vaccination rates

Measles, % of children, 1980 – 2013

Source: OECD Health Statistics : OECD Health Data: Health care utilisation

Show: Chart

Table

full

share

download

add to pinboard

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1'
France	15.0	26.0	35.0	39.0	45.0	51.0	58.0	71.0	74.0	76.0	78.0	80.0	83.0	84.0	83.0	82.0	81.0	81.0	81.0	
Turkey	27.0	52.0	64.0	63.0	62.0	61.0	64.0	67.0	82.0	71.0	78.0	73.0	78.0	72.0	76.0	65.0	72.0	79.0	81.0	8
United States	86.0	97.0	97.0	98.0	98.0	97.0	97.0	82.0	98.0	94.0	90.0	87.0	83.0	84.0	89.0	88.0	91.0	91.0	92.0	5

Information on data for Israel: <http://oe.cd/israel-disclaimer>

Not available; Break in series; Confidential data; Estimated value; Forecast value; Not applicable



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Human Brain and Data Visualisation



- In some instances, data sets can consist of thousands or even millions of rows and columns
- So the direct use of only tables becomes impossible

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Visualization skills for the masses



"The skills required for most effectively displaying information are not intuitive and rely largely on principles that must be learned." – Stephen Few from his book Show Me the Numbers

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Visualization skills for the masses



- You have a certain design style based on personal taste
- You just play around until something emerges that you instinctively like the look of
- You trust software defaults and don't go beyond that in terms of modifying the design
- You have limited software capabilities, so you don't know how to modify a design
- You just do as the boss tells you—"can you do me some fancy charts?"

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Visualization skills for the masses



Citizen Data Scientists

- Required skill set in data driven world
- Modern world needs both technical analysis and creative storytelling
- Data visualization sits exactly in middle of both
- Increasingly valuable asset

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Visualization methodology



- A more organized and sequenced way
- To reduce inefficiency and wasted resource
- Require the assistance of a variety of applications and programs (the focus of this methodology is intended to be technology-neutral, placing an emphasis on the conceiving, reasoning, and decision-making)
- Reasoned decision-making
- Rarely, if ever, a single right answer or single best solution

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Visualization Design Objectives



- 1. Strive for form and function (*style over substance*)**
- 2. Justifying the selection of everything we do**
- 3. Creating accessibility through intuitive design**
- 4. Never deceive the receiver**

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Visualization Design Objectives



- 1. Strive for form and function (*style over substance*)**
 - Wind map

<http://hint.fm/wind/>

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Visualization Design Objectives



1. Strive for form and function (*style over substance*)

Cognitive vs Perceptual Design Distinction

- Help people make clear, accurate interpretations
- Gain useful insights based on what they see.

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Visualization Design Objectives



1. Strive for form and function (*style over substance*)

Cognitive vs Perceptual Design Distinction

- Nobel prize winning psychologist Daniel Kahneman suggested that **there are two fundamental systems that drive how we think and make judgments**.
- As a data visualization designer, your job is to leverage both of them

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Visualization Design Objectives



1. Strive for form and function (*style over substance*)

Cognitive vs Perceptual Design Distinction

- The **first system** involves more automatic and immediate perception, such as noticing an unusual pattern of movement in the bushes. This is where visual encoding and things like Gestalt Principles come into play.
- The **second system** is about slower and more deliberate cognition. That is thinking about the meaning of certain sensory cues.

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Visualization Design Objectives



1. Strive for form and function (*style over substance*)

Cognitive vs Perceptual Design Distinction

- The **first system** involves more automatic and immediate perception, such as noticing an unusual pattern of movement in the bushes. This is where visual encoding and things like Gestalt Principles come into play.
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Visualization Design Objectives



1. Strive for form and function (*style over substance*)

Cognitive vs Perceptual Design Distinction

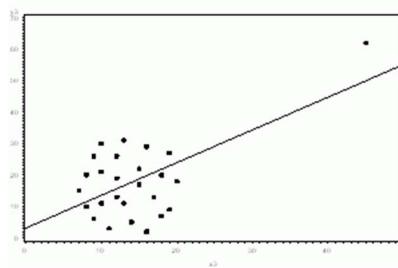
- The **first system** involves more automatic and immediate perception, such as noticing an unusual pattern of movement in the bushes. This is where visual encoding and things like Gestalt Principles come into play.
- The **second system** is about slower and more deliberate cognition. That is thinking about the meaning of certain sensory cues.

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Visualization Design Objectives



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Visualization Design Objectives

- The brain relies on some shortcuts and assumptions to help make our perception rapid, and that's a key to good data visualizations.
- But some of the same mental shortcuts can also create false interpretations and provide challenges and present challenges for visualization designs

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Visualization Design Objectives



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Visualization Design Objectives



- 1. Strive for form and function (*style over substance*)**
- 2. Justifying the selection of everything we do**
- 3. Creating accessibility through intuitive design**
- 4. Never deceive the receiver**

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Visualization Design Objectives



- 2. Justifying the selection of everything we do**

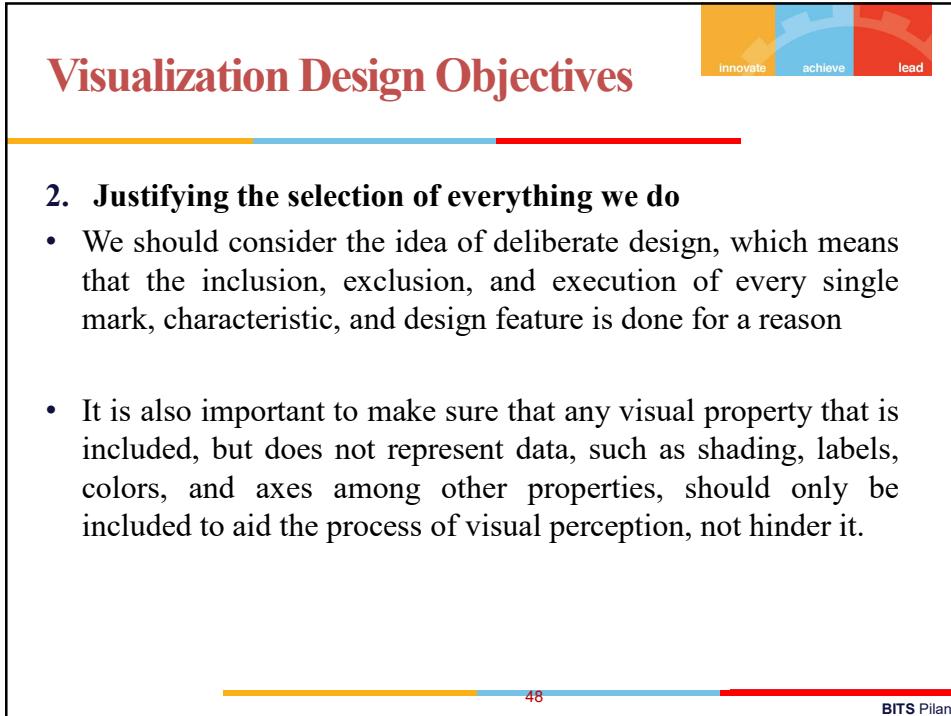
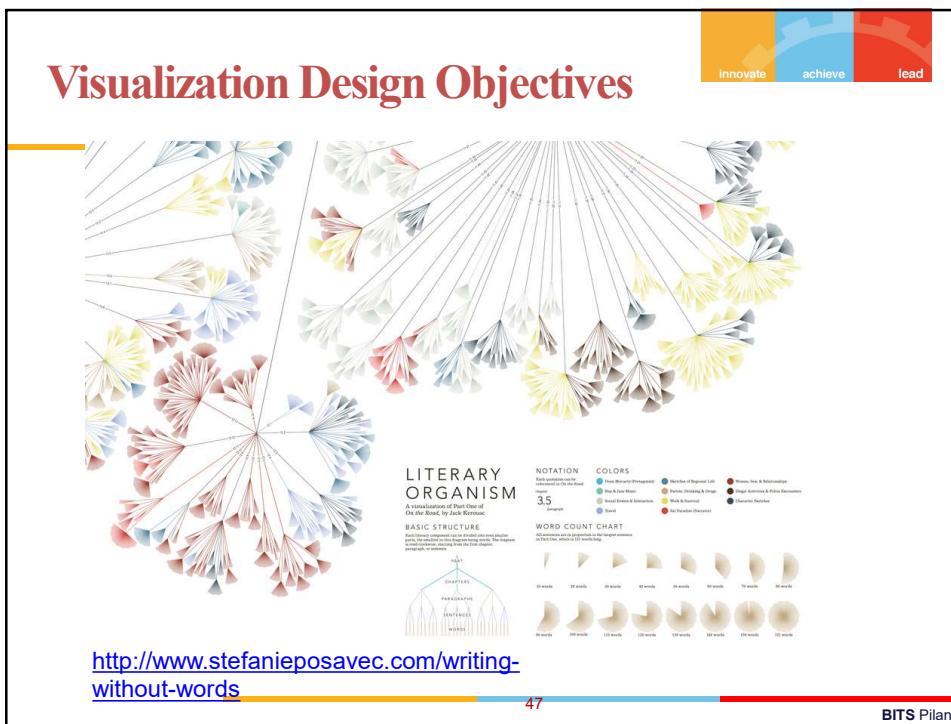
"We're so busy thinking about if we can do things, we forget to consider whether we should."

- Everything you do must be thoroughly planned, understood, and reasoned

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Visualization Design Objectives



- 1. Strive for form and function (*style over substance*)**
- 2. Justifying the selection of everything we do**
- 3. Creating accessibility through intuitive design**
- 4. Never deceive the receiver**

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Visualization Design Objectives



3. Creating accessibility through intuitive design

"Overload, clutter, and confusion are not attributes of information, they are failures of design."

- It is important to create a distinction between accessibility and immediacy. The speed with which you are able to read or interpret a visualization should be determined by the complexity of the subject and the purpose of the project, not by the ineffectiveness of design

50

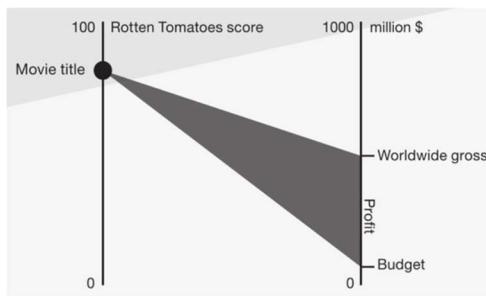
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Visualization Design Objectives



3. Creating accessibility through intuitive design



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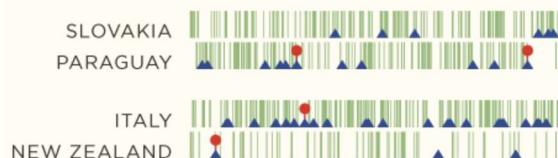
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Visualization Design Objectives



3. Creating accessibility through intuitive design



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Visualization Design Objectives

1. Strive for form and function (*style over substance*)
2. Justifying the selection of everything we do
3. Creating accessibility through intuitive design
4. Never deceive the receiver

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Visualization Design Objectives

4. Never deceive the receiver

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Visualization Design Objectives



4. Never deceive the receiver



Avoid any significant distortion of the truth.

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Usage of Data Visualization



Exploratory Analysis

- Explore data to become familiar with data
- Dig through the data
- Find trends and relationships w.r.t. specific goals
- Helps determine analyses to apply to data

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Usage of Data Visualization



Explanatory Analysis

- Explain outcomes or results of analysis
- Tell a story with data

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Exploratory and Explanatory Analysis



- Exploratory: Try different variables and look for patterns.
- Explanatory: Explain the patterns discovered.

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Exploratory and Explanatory Analysis-Qn



- With your data you need to show which district in your region is not meeting its sales goals. Is this an example of exploratory or explanatory analysis?
- Explanatory Analysis
- As this is a specific question you need to answer and you already recognize the patterns and need to explain it.

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CONTACT SESSION 2 -PLAN



Contact Sessions(#)	List of Topic Title	Text Book
CS2	<ul style="list-style-type: none"> Understanding the context for data presentations 3 minute story Effective Visuals Gestalt principles of visual perception Visual Ordering Decluttering 	T1 Ch 1,2,3

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Visualization Context

“Success in data visualization does not start with data visualization itself.”

-- Cole Knaflic

...understanding context sets solid foundation for data visualization creation

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Visualization Context

Context includes :

❖ Who

To whom you are communicating?

❖ What

What do you want your audience to know or to do?

❖ How

How can you use data to help make your point?

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Identifying Audience



Who?

- Who is audience? To whom you are communicating?
- How they perceive you?
- Help to find common ground that helps to convey your message

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Identifying Audience



Who?

- ❖ Your audience
 - Knowing them place you in better position for communication
 - Be specific while identifying audience
 - Different content for different set of audience

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Identifying Audience



Who?

❖ You

- How your audience perceive you?
- First time interaction or established relationship?
- Know you as expert or need to set credibility?

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Know or Act



What?

❖ What do you want your audience to know or to do?

- Action
- Mechanism
- Tone

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Know or Act

What?

❖ Action

- Make sure audience care about what you say
- You are subject matter expert – unique position to interpret the data and help lead people to understanding and take action
- If no action recommendation possible / feasible, then encourage discussion towards one

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Know or Act

What?



❖ Mechanism

- How will you communicate to your audience?
- Determines level of control and level of detail
 - ✓ Live presentation
 - ✓ Written document
 - ✓ Slideument

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Know or Act (cont...)

What? Mechanism

LIVE PRESENTATION WRITTEN DOC or EMAIL

amount of CONTROL you have

level of DETAIL needed

The "SLIDEUMENT"

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Know or Act (cont...)

What?

- ❖ Tone
 - ❑ What tone do you want your communication to set?
 - ✓ Celebrating success?
 - ✓ Lighting a fire to drive action?
 - ✓ Is topic light-hearted or serious?

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Data



How?

- ❖ How can you use data to help make your point?
- ❖ What data is available?
 - Supporting evidence of the story

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Context by Example



You are the advertising media analyst who is made responsible for providing recommendation on media spend of product

- Who : The marketing team that allocates funding for media advertisement for a product
- What : The current advertising campaign went well on TV but find very limited success in print media
- How : Illustrate success with data available through analysis of spends and product revenues(Can use live presentation)

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3-minute Story

- Able to boil the “so-what” down to a paragraph and, ultimately, to a single, concise statement.
- If you had only three minutes to tell your audience what they need to know, what would you say?

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Case Study

Imagine you are a fourth grade science teacher. You just wrapped up an experimental pilot summer learning program on science that was aimed at giving kids exposure to the unpopular subject. You surveyed the children at the onset and end of the program to understand whether and how perceptions toward science changed. You believe the data shows a great success story. You would like to continue to offer the summer learning program on science going forward.

Identify the Visualisation Context.(WHO,WHAT and HOW)

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WHO

We want to communicate to is **THE BUDGET COMMITTEE**, which controls the funding we need, to continue the program.

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WHAT

Demonstrate the success of the program and ask for a specific funding amount to continue to offer it

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HOW

Use the data collected via survey at the onset and end of the program to illustrate the increase in positive perceptions of science before and after the pilot summer learning program.

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Summary

Who: The budget committee that can approve funding for continuation of the summer learning program.

What: The summer learning program on science was a success; please approve budget of \$X to continue.

How: Illustrate success with data collected through the survey conducted before and after the pilot program.

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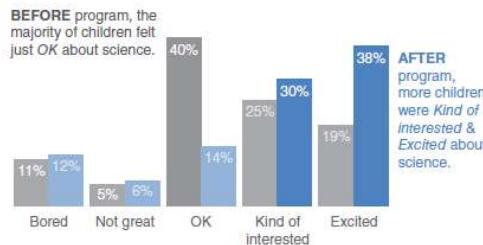
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Summary



Pilot program was a success

How do you feel about science?



Based on survey of 100 students conducted before and after pilot program (100% response rate on both surveys).

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3 -minute Story



3-minute story: A group of us in the science department were brainstorming about how to resolve an ongoing issue we have with incoming fourth-graders. It seems that when kids get to their first science class, they come in with this attitude that it's going to be difficult and they aren't going to like it. It takes a good amount of time at the beginning of the school year to get beyond that. So we thought, what if we try to give kids exposure to science sooner? Can we influence their perception? We piloted a learning program last summer aimed at doing just that. We invited elementary school students and ended up with a large group of second- and third-graders. Our goal was to give them earlier exposure to science in hopes of forming positive perception. To test whether we were successful, we surveyed the students before and after the program. We found that, going into the program, the biggest segment of students, 40%, felt just "OK" about science, whereas after the program, most of these shifted into positive perceptions, with nearly 70% of total students expressing some level of interest toward science. We feel that this demonstrates the success of the program and that we should not only continue to offer it, but also to expand our reach with it going forward.

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BIG IDEA



The pilot summer learning program was successful at improving students' perceptions of science and, because of this success, we recommend continuing to offer it going forward; please approve our budget for this program.

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Effective and Ineffective visuals



- The types of visualizations that are available
- **Textuals**
 - Just a simple text visualization
 - High Level Information
 - Conveys exactly what you need
 - KPI or key performance indicator

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Textuals

Page Views:

10,267

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Tables

- The types of visualizations that are available
- **Tables**
 - Conveys a lot of information
 - Conveys comparison across categories
 - Too big=less effective
 - A 2 X 2 table has a lot of power.

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Tables



	Right Handed	Left Handed
Male	67	8
Female	65	14

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Tables



Heavy borders

Group	Metric A	Metric B	Metric C
Group 1	S.X.	Y%	Z.ZZZ
Group 2	S.X.	Y%	Z.ZZZ
Group 3	S.X.	Y%	Z.ZZZ
Group 4	S.X.	Y%	Z.ZZZ
Group 5	S.X.	Y%	Z.ZZZ

Light borders

Group	Metric A	Metric B	Metric C
Group 1	S.X.	Y%	Z.ZZZ
Group 2	S.X.	Y%	Z.ZZZ
Group 3	S.X.	Y%	Z.ZZZ
Group 4	S.X.	Y%	Z.ZZZ
Group 5	S.X.	Y%	Z.ZZZ

Minimal borders

Group	Metric A	Metric B	Metric C
Group 1	S.X.	Y%	Z.ZZZ
Group 2	S.X.	Y%	Z.ZZZ
Group 3	S.X.	Y%	Z.ZZZ
Group 4	S.X.	Y%	Z.ZZZ
Group 5	S.X.	Y%	Z.ZZZ

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Heat Maps



- The types of visualizations that are available
- Tables-Heat Maps**
 - Colorful version of a table,
 - It takes information that you have in a table and then colors it based on a certain set of parameters.
 - Use color to visually emphasize information

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Heat Maps



CUSTOMER CONTACTS PER EMPLOYEE PER WEEKDAY

	Charles	Toby	Amanda	Troy	Sam	Tammy	Matt	Jason	Amy	Alice	
Friday	67	48	52	16	115	120	96	30	84	91	
Thursday	24	117	64	19	117	6	98	32	64	48	
Wednesday	8	78	123	114	8	12	88	82	123	31	
Tuesday	19	58	15	132	5	32	44	1	97	114	
Monday	10	92	35	72	38	88	13	31	85	47	

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Effective and Ineffective visuals

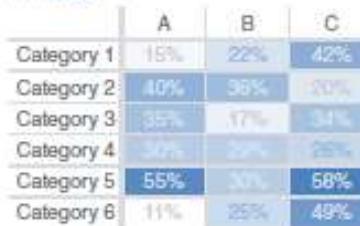


Table

	A	B	C
Category 1	15%	22%	42%
Category 2	40%	36%	20%
Category 3	35%	17%	34%
Category 4	30%	29%	26%
Category 5	55%	30%	58%
Category 6	11%	25%	49%

Heatmap

LOW HIGH



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GRAPHS



- Graphs interact with our visual system
- Faster at processing information

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Gestalt Principles of Visual Perception

Gestaltism



- Identifying which elements in our visuals are **signal**
- Which might be **noise**
- **How individuals perceive order in the world around them**

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Gestalt Principles of Visual Perception



- The human brain loves simplicity and it tends to process simple patterns — patterns that are regular, even, and orderly — faster than patterns that are more complex

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Gestalt Principles of Visual Perception



Principles

- Proximity
- Similarity
- Enclosure
- Closure
- Continuity
- Connection.
- Focal point
- Figure and ground

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Gestalt Principles of Visual Perception



- Gestalt Law of Proximity



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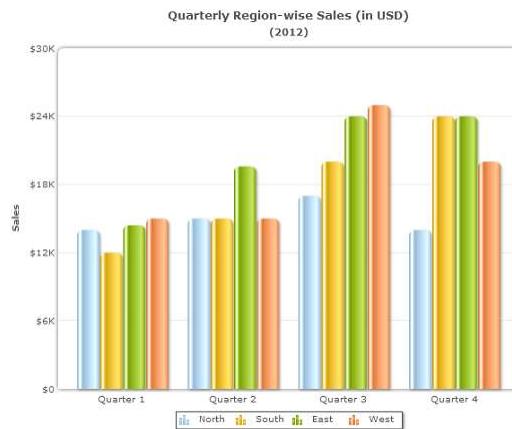
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Gestalt Principles of Visual Perception



Gestalt Law of Proximity (example)



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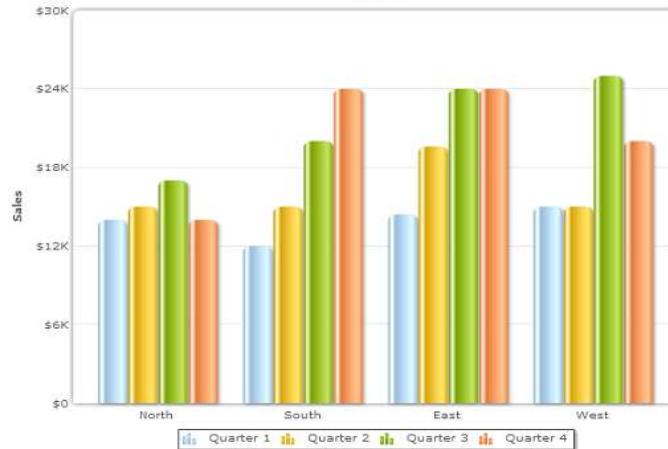
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Gestalt Principles of Visual Perception



Quarterly Regionwise Sales (in USD)
(2012)



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Gestalt Principles of Visual Perception



- Gestalt Law of Similarity



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Gestalt Principles of Visual Perception



- Gestalt Law of Similarity



98

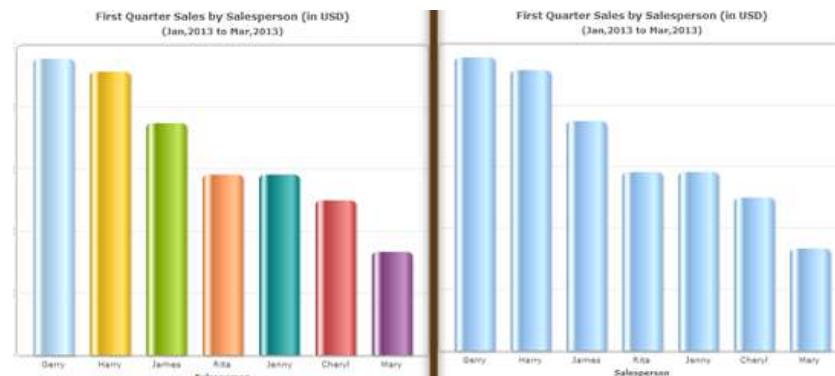
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Gestalt Principles of Visual Perception



- Gestalt Law of Similarity (example)



99

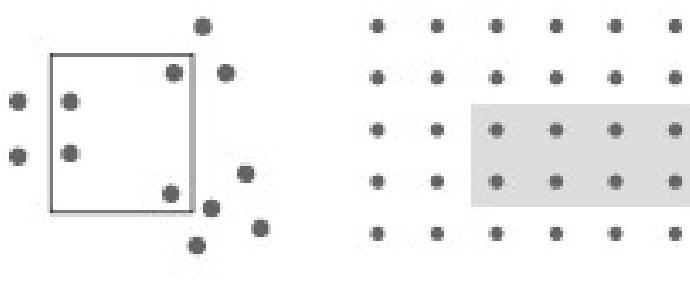
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Gestalt Principles of Visual Perception



- Gestalt Law of Enclosure

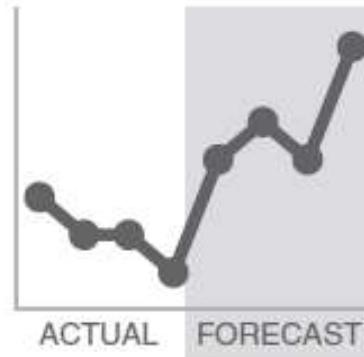


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Gestalt Principles of Visual Perception



101

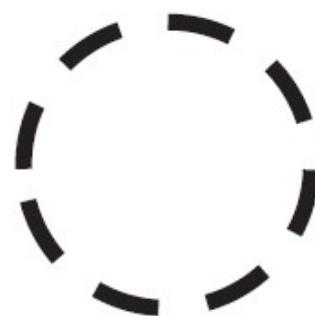
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Gestalt Principles of Visual Perception



- Gestalt Law of Closure



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Gestalt Principles of Visual Perception



- Gestalt Law of Closure



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Gestalt Principles of Visual Perception



- Gestalt Law of Continuity



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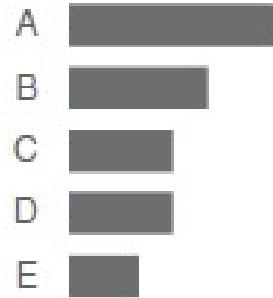
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Gestalt Principles of Visual Perception



- Gestalt Law of Continuity



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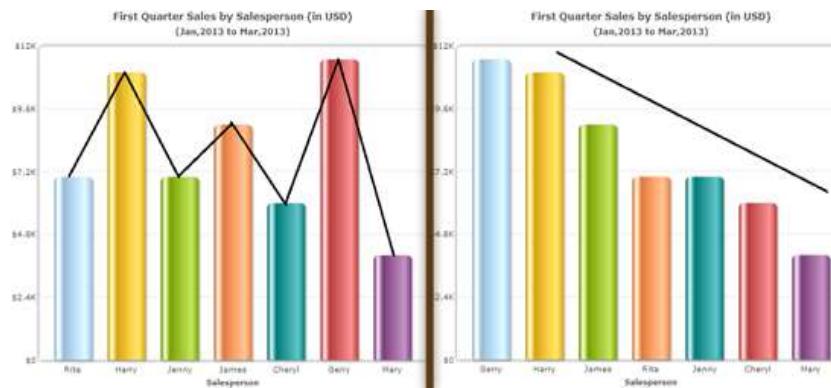
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Gestalt Principles of Visual Perception



Gestalt Law of Continuity (example)



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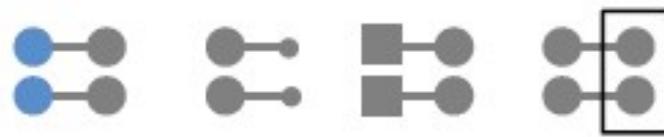
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Gestalt Principles of Visual Perception



- Gestalt Law of Connection



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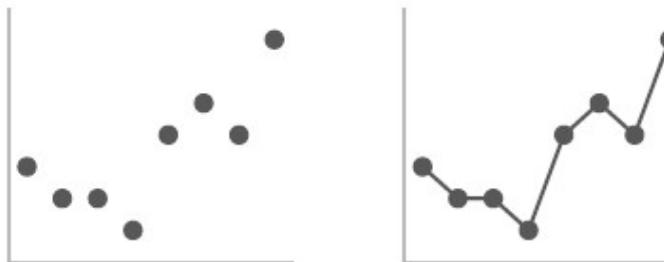
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Gestalt Principles of Visual Perception



- Gestalt Law of Connection



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Gestalt Principles of Visual Perception



- Gestalt Law of Focal Point



109

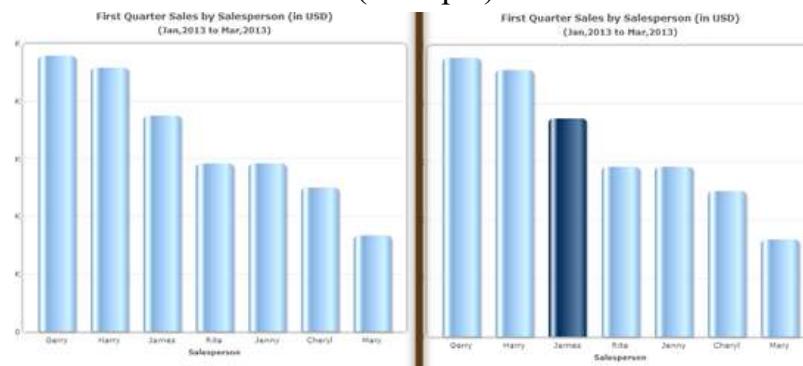
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Gestalt Principles of Visual Perception



Gestalt Law of Focal Point (example)



110

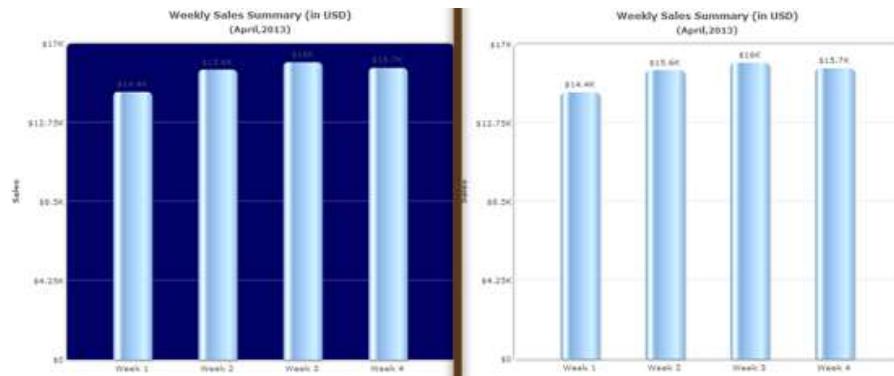
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Gestalt Principles of Visual Perception



- Gestalt Law of Figure/Ground

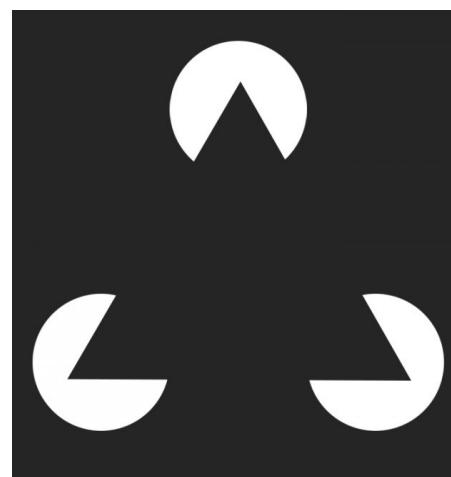


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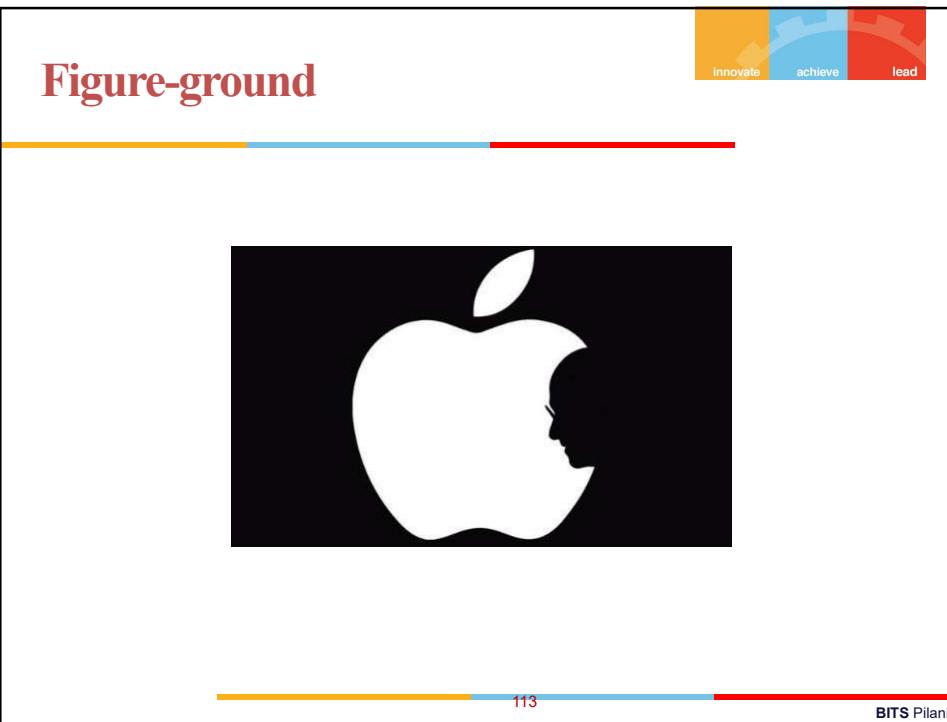
WHAT DO YOU SEE?



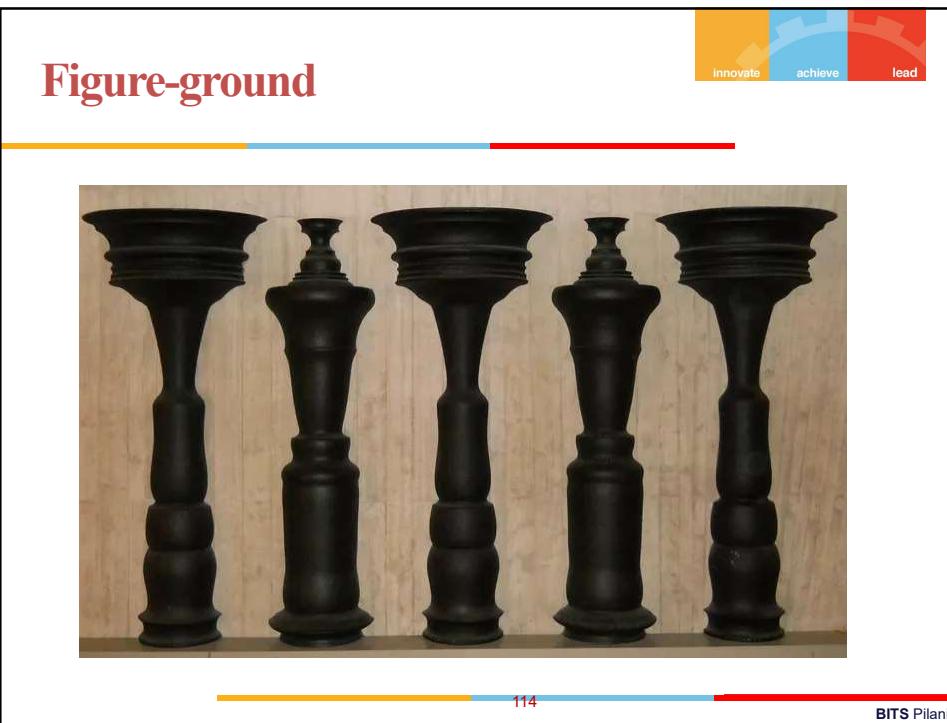
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113



114



Figure AND Ground

- Blurriness
- Size
- Separation

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Question

Which of the following Gestalt principles that we've discussed thus far deal with the contrast of information?

- Proximity
- Closure
- Similarity
- Enclosure

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Question

Which of the following Gestalt principles that we've discussed thus far deal with the contrast of information?

- Proximity
- Closure
- Similarity
- **Enclosure**

- Enclosure is about using contrast in order to differentiate between information

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Cognitive Load

- **It is the amount of mental effort that we use to get the information that we need.**
- signal-to-noise ratio

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Cognitive Load

- There are three types of cognitive load
 - Intrinsic,
 - Extraneous, and
 - Germane.
- Different tasks need different amount of thoughts and attention

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Cognitive Load

- **Intrinsic Cognitive Load**
- The amount of memory that we need to understand something.
- **Extraneous cognitive load**
- Refers to the amount of **extra** brain power required to analyze and process information.
- **Germane cognitive load**
- A way for the brain to look for patterns to develop context.

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Question



- Which type of the cognitive loads just discussed pertains to the baseline level amount of brain power needed to understand an idea?
- Germane Cognitive Load
- Intrinsic Cognitive Load
- Extraneous Cognitive Load

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Question



- Which type of the cognitive loads just discussed pertains to the baseline level amount of brain power needed to understand an idea?
- Germane Cognitive Load
- **Intrinsic Cognitive Load**
- Extraneous Cognitive Load

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Clutter



- Presence of unnecessary elements on the screen/page that
 - Occupies space
 - Reduces understanding
 - Increases complexity
 - *KNOW IT WHEN YOU SEE IT*

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Declutter



- How to eliminate clutter?
 - Gestalt Principles of Visual Perception
 - Identify signal (what needs to be communicated)
 - Identify noise (what needs to be eliminated)

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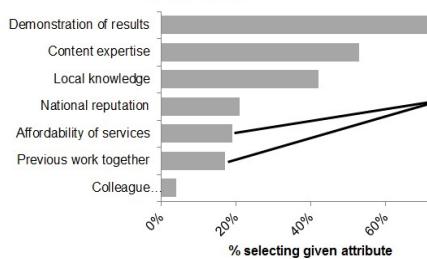


Declutter-Visual Ordering

Lack of Visual Order (Example)

Demonstrating effectiveness is most important consideration when selecting a provider

In general, what attributes are the most important to you in selecting a service provider?
(Choose up to 3)



Survey shows that demonstration of results is the single most important dimension when choosing a service provider.

Affordability and experience working together previously, which were hypothesized to be very important in the decision making process, were both cited less frequently as important attributes.

Data source: xyz; includes N number of survey respondents. Note that respondents were able to choose up to 3 options.

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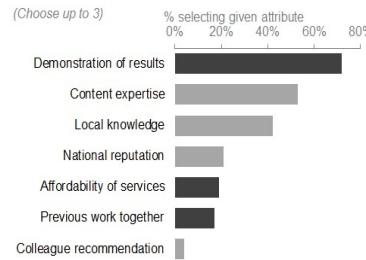


Declutter-Visual Ordering

Lack of Visual Order (Example Improved)

Demonstrating effectiveness is most important consideration when selecting a provider

In general, what attributes are the most important to you in selecting a service provider?
(Choose up to 3)



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Data source: xyz; includes N number of survey respondents.
Note that respondents were able to choose up to 3 options.

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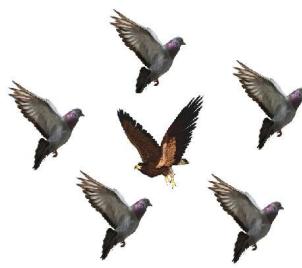
126



Visual Ordering

Contrast

"It's easy to spot a hawk in a sky full of pigeons, but as the variety of birds increases, that hawk becomes harder and harder to pick out." - Colin Ware, Information Visualization : Perception for Design



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Visual Ordering-Contrast



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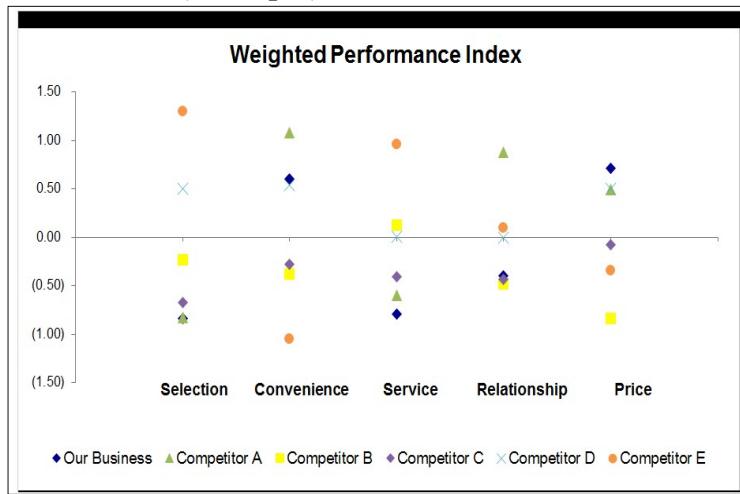
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Visual Ordering

Lack of Contrast (Example)



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Visual Ordering

- Lack of Contrast (Example)



- What's going on?
 - Lot of elements
 - Each one trying to grab attention
 - Difficult to focus attention

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Visual Ordering (cont...)



Lack of Contrast (Example Improved)

Performance overview



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Case Study-Strategic use of contrast Study



The question that we're going to answer today is whether or not “profit and sales go hand in hand.”

The question was asked by the CFO of the company. She doesn't have time to try to understand complex visualizations. She understands data very well, but is now in meetings all day, and really isn't in a position to do a deep dive on the data. What she needs is the ability to quickly get at what the issue is, if there is an issue with profit and sales from a list of people

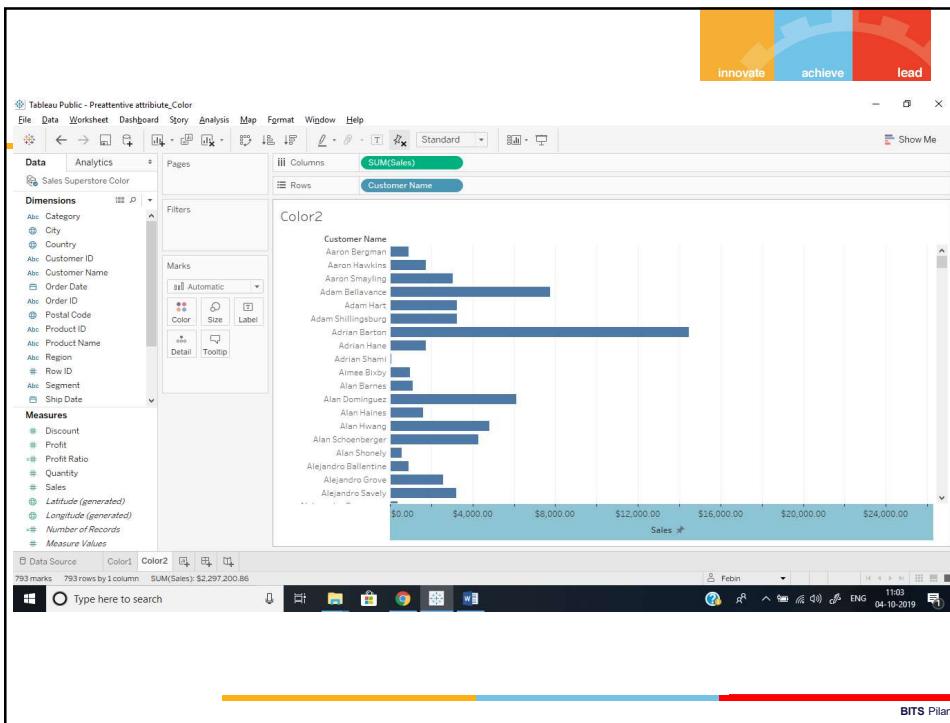
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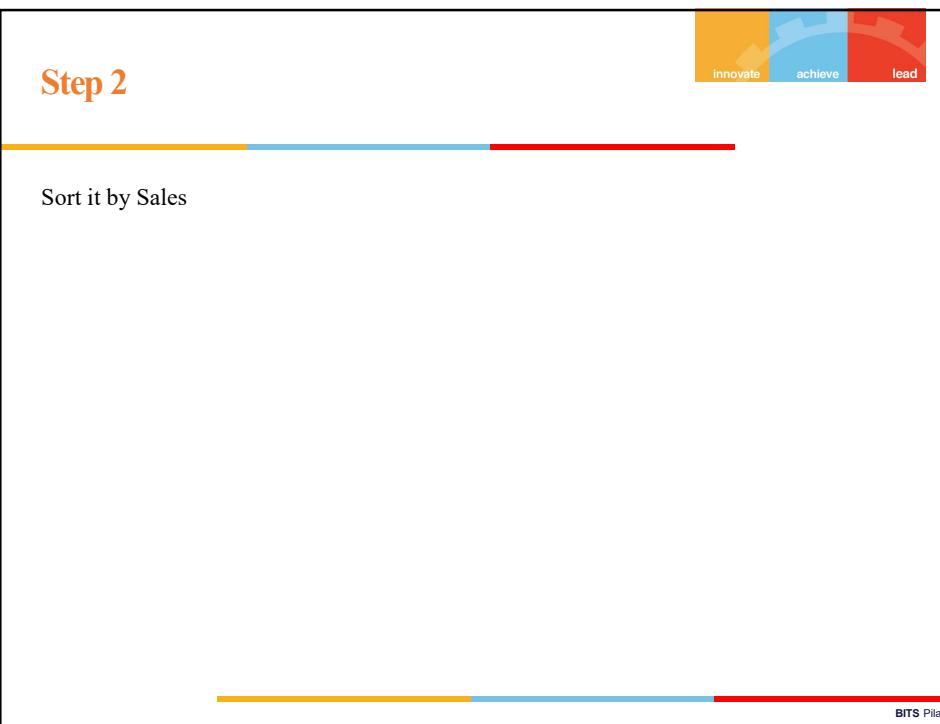
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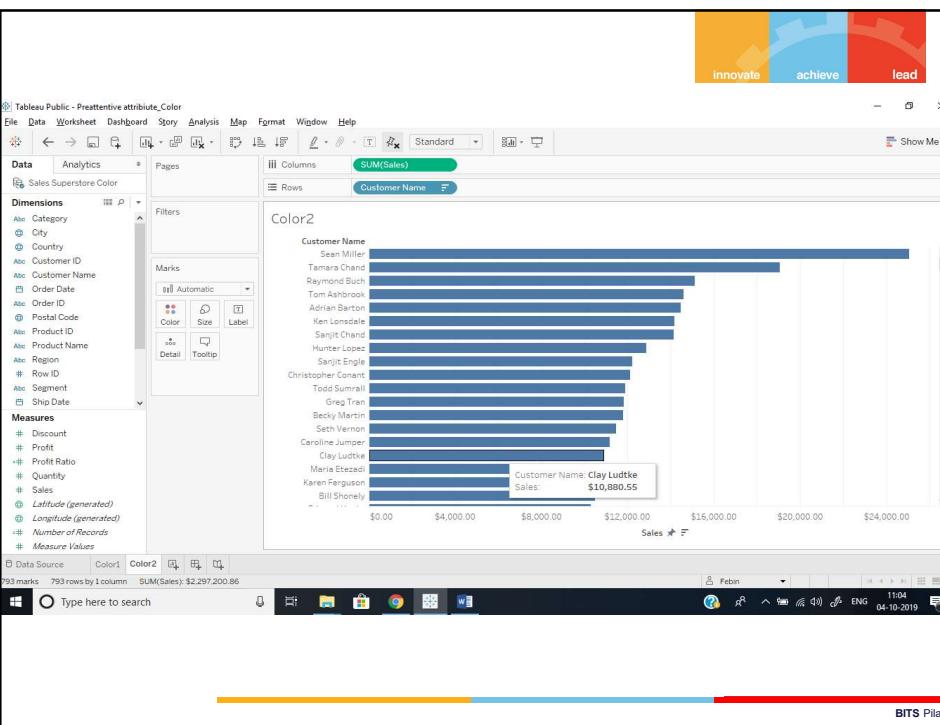
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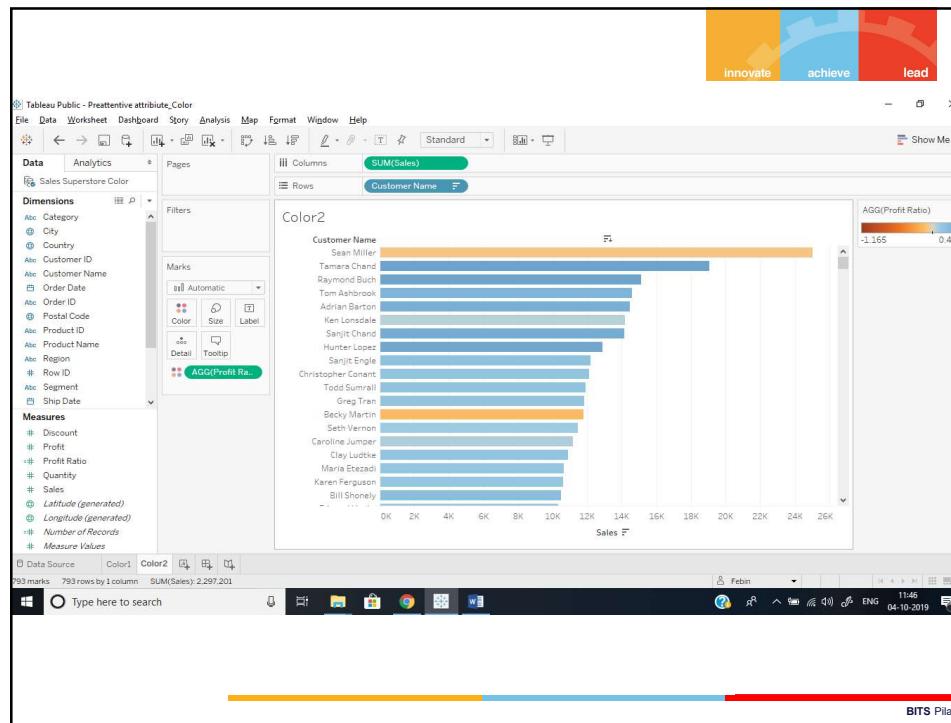
Step 3



Add Profit Ratio to the graph with Color Mark

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137



138

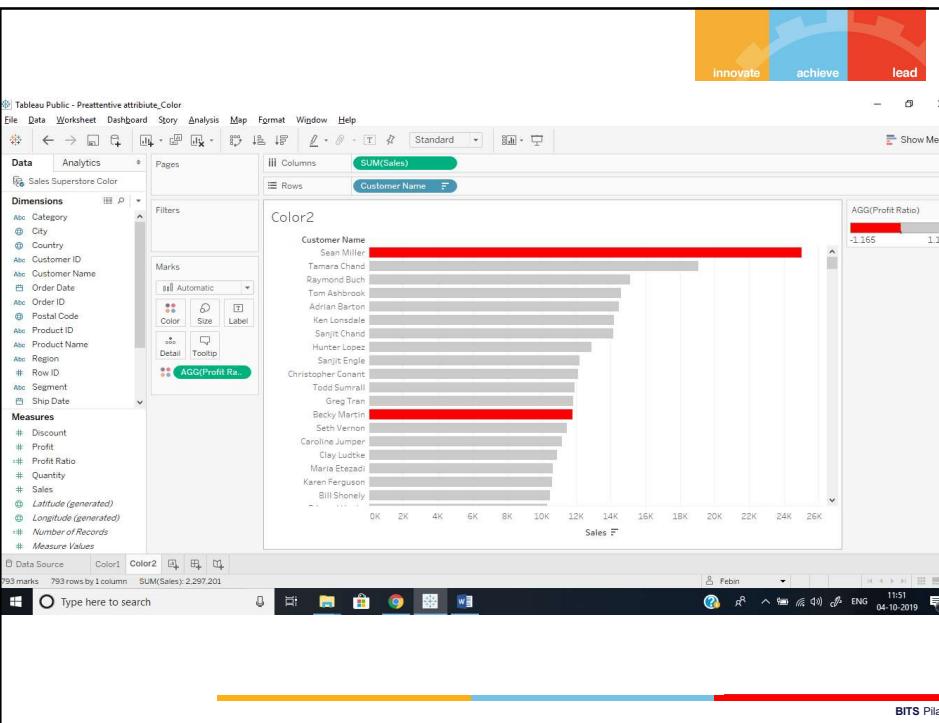
Step 4

Since It needs to be clear to the CFO whose profits are less than zero. In other words, who is not making money? ,we need only 2 Colors.

The color is red if the profit was less than zero, gray, a very light gray, if they made money.

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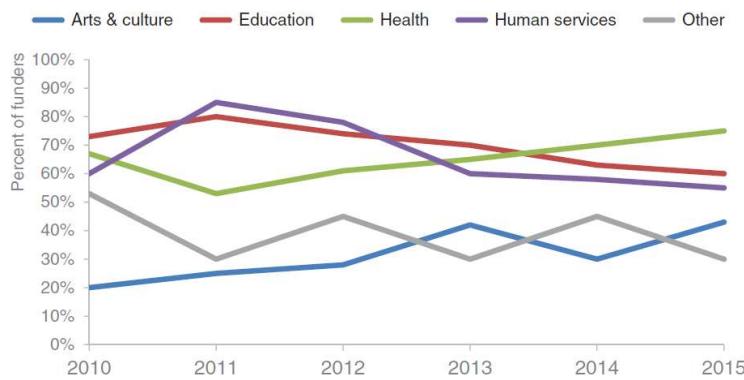


140

Case Study -Clutter



Types of non-profits supported by the corporate workforce



Data is self-reported by funders; percents sum to greater than 100 because respondents can make multiple selections.

- **To Do:** You are a Data Science Consultant. Convey to your CSR leadership team where they should plan to focus the organization's CSR activity in the future

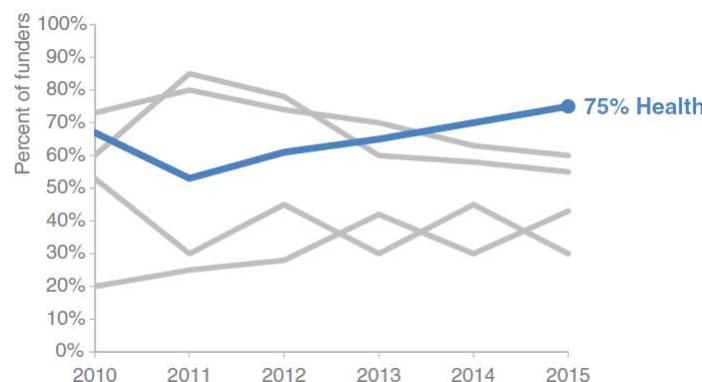
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Case Study – probable solutions

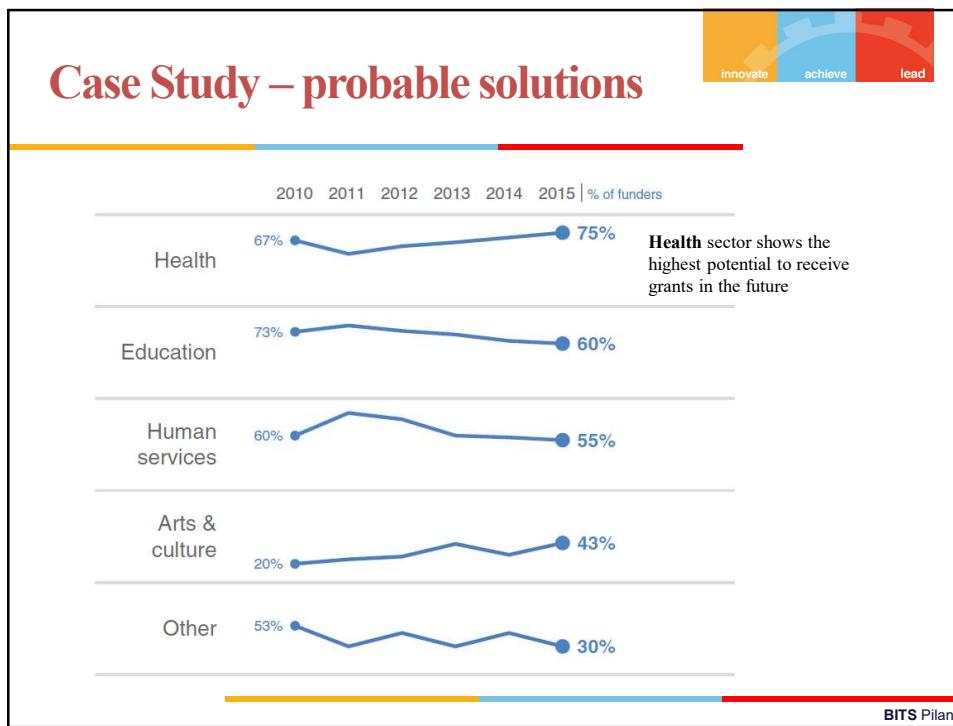


Health sector shows the highest potential to receive grants in the future

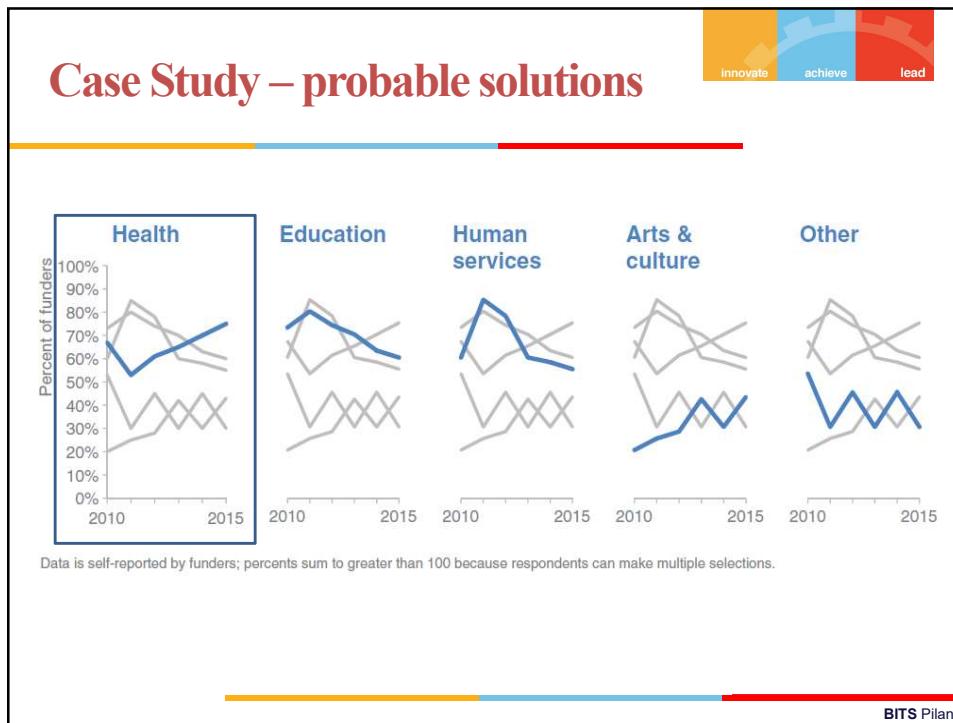


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144



Case Study - Clutter

The visualization that we're going to de-clutter is from the United States Department of Agriculture or USDA.

Because the information that the USDA has is generally public, we happen to have the underlying data set for this visualization

www.ers.usda.gov/mediaImport/1706918/msagroceryinflation.xls

In the next slide is the image from the US Department of Agriculture

145

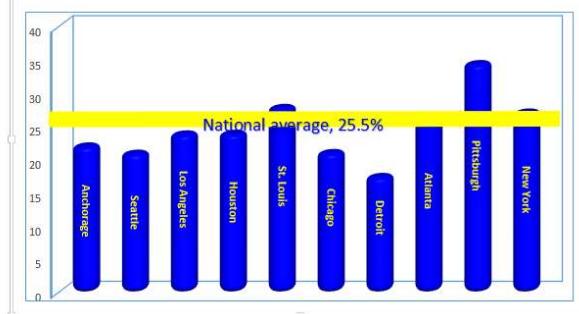
BITS Pilani

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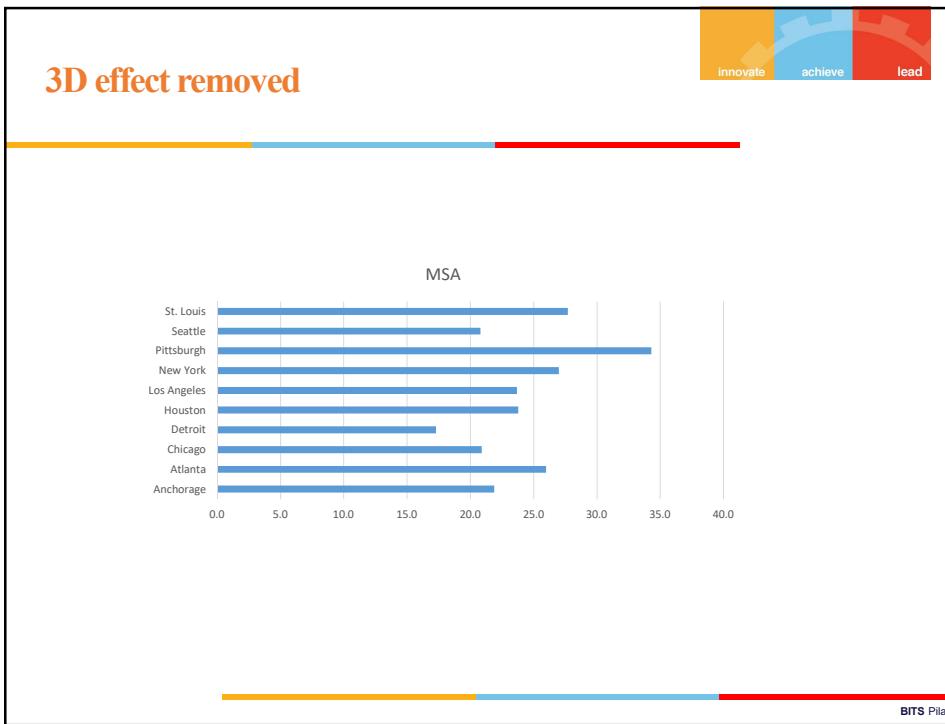
Case study

Retail food price inflation by MSA



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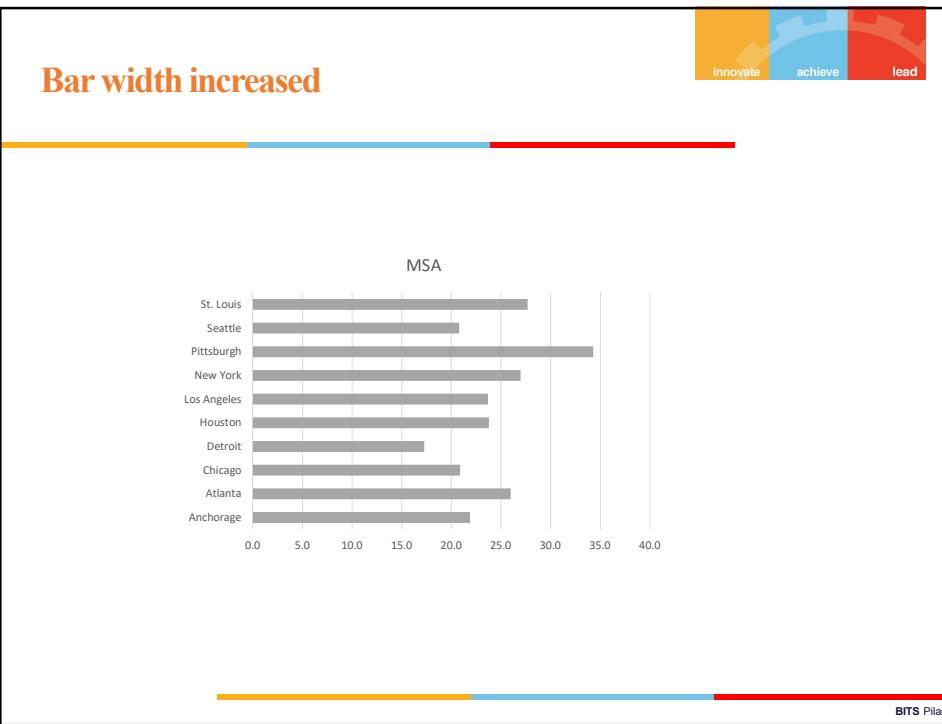
146



147



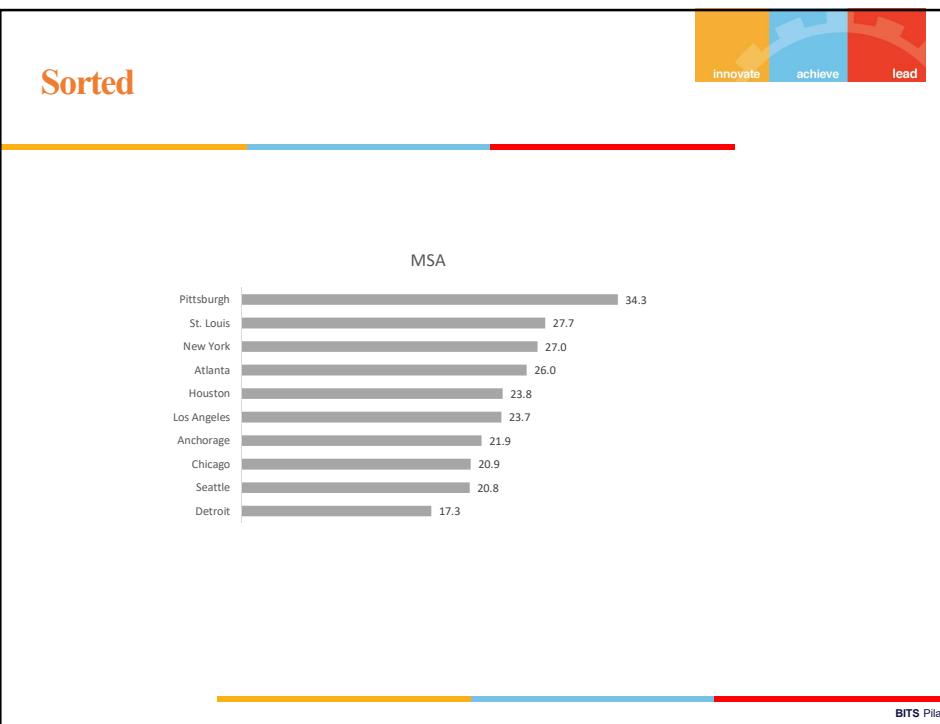
148



149



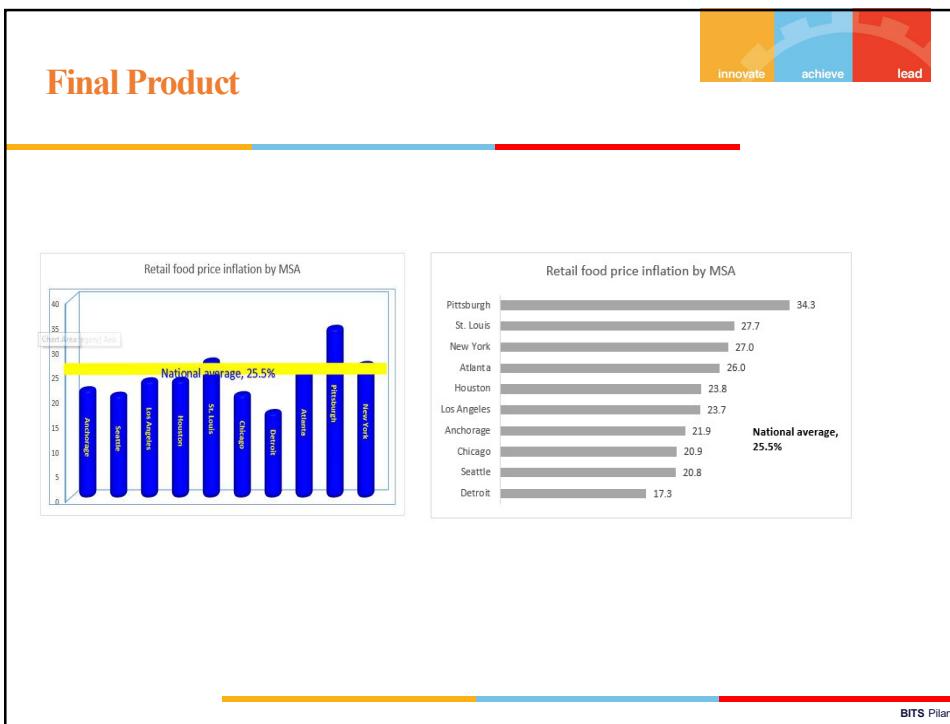
150



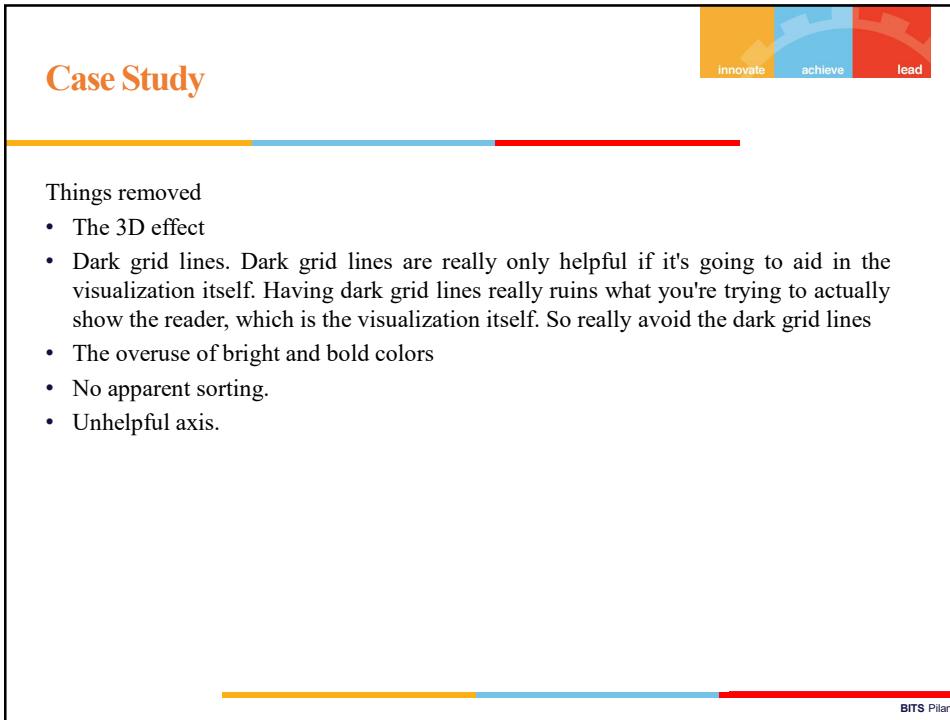
151



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CASE STUDY 3 - Scenario



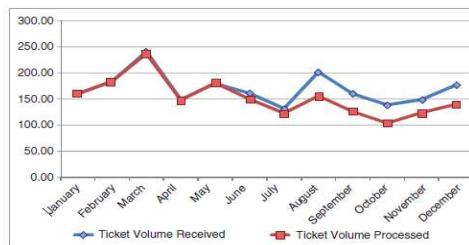
Imagine that you manage an information technology (IT) team. Your team receives tickets, or technical issues, from employees. In the past year, you've had a couple of people leave and decided at the time not to replace them. You have heard a rumbling of complaints from the remaining employees about having to "pick up the slack." You've just been asked about your hiring needs for the coming year and are wondering if you should hire a couple more people. First, you want to understand what impact the departure of individuals over the past year has had on your team's overall productivity. You plot the monthly trend of incoming tickets and those processed over the past calendar year. You see that there is some evidence your team's productivity is suffering from being short-staffed and now want to turn the quick-and-dirty visual you created into the basis for your hiring request

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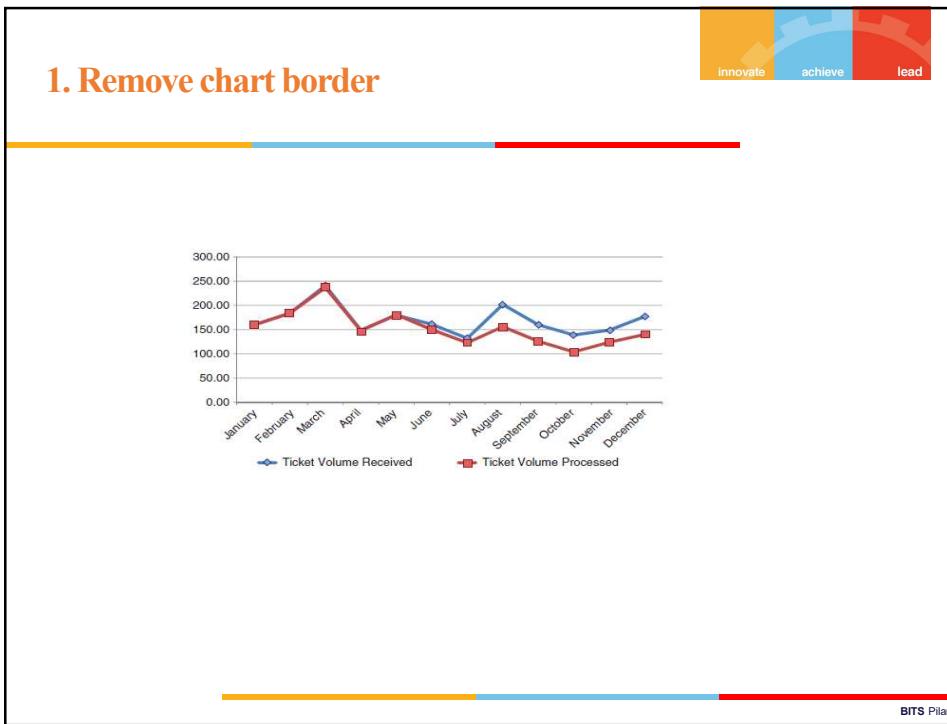
155

Case study

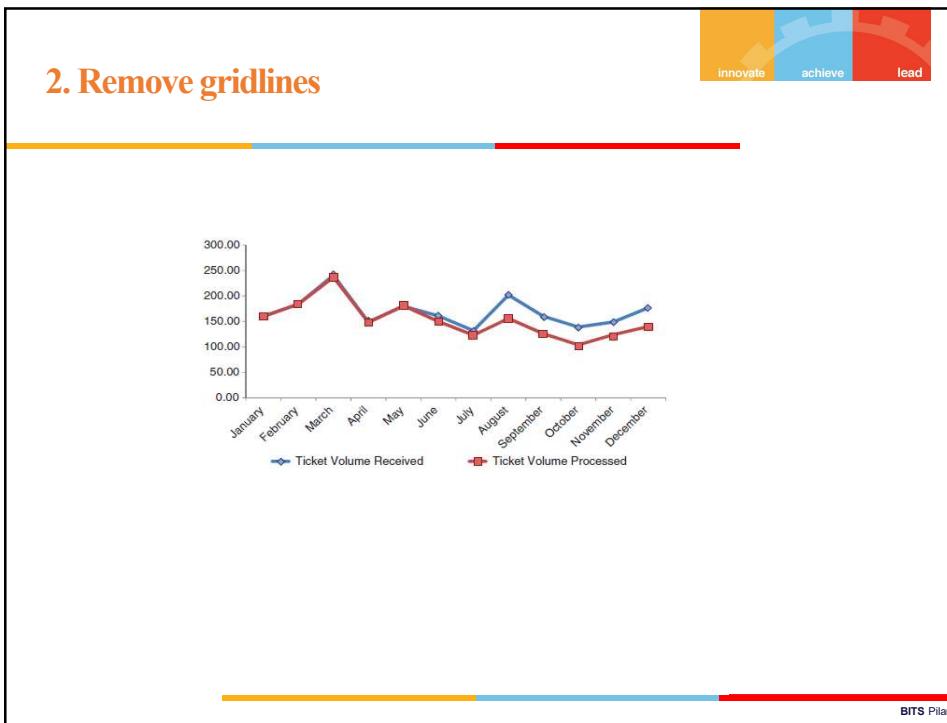


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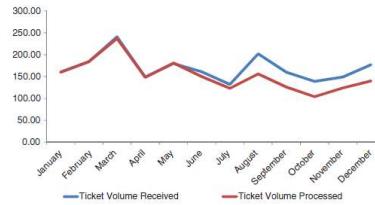


157



158

3. Remove data markers



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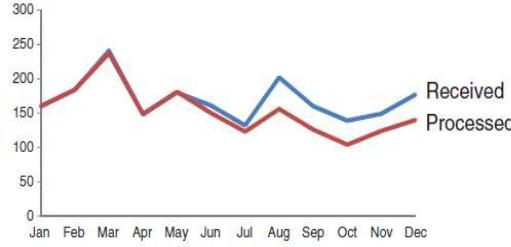
4. Clean up axis labels



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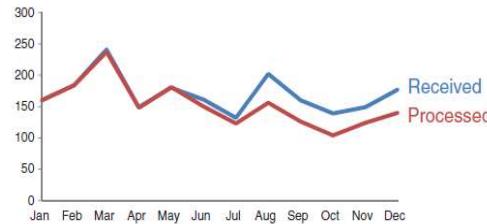
5. Label data directly



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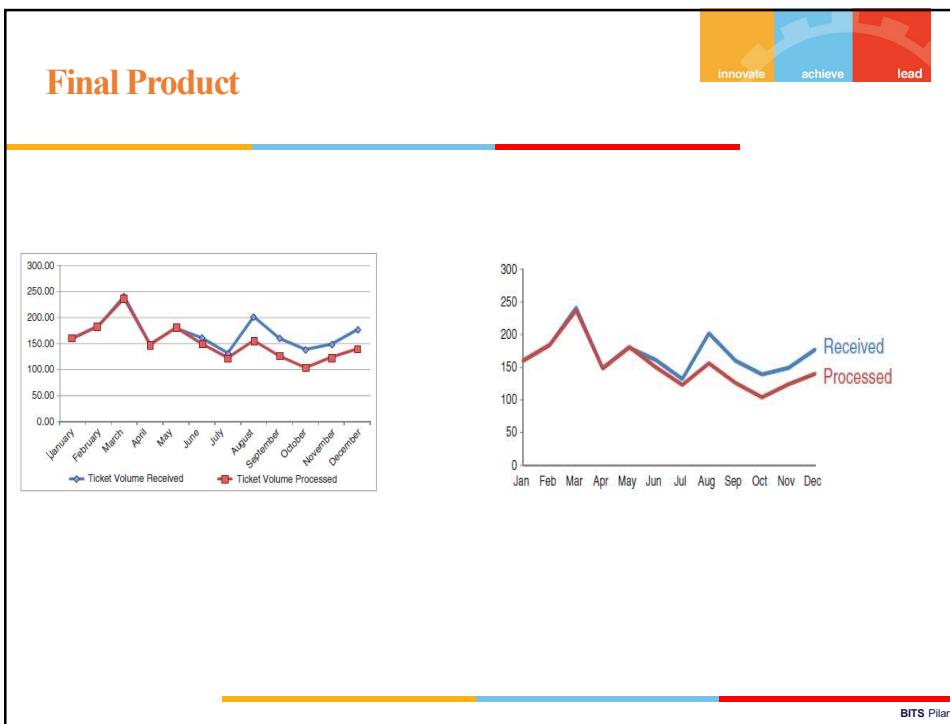
161

6. Leverage consistent color



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163

The slide features a title "CONTACT SESSION 3 -PLAN" in red at the top left. At the top right is a decorative bar divided into three colored segments: yellow (innovate), light blue (achieve), and red (lead). Below the title is a table with three columns: Contact Sessions(#), List of Topic Title, and Text Book.

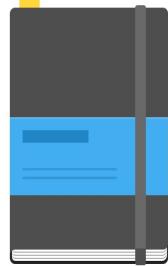
Contact Sessions(#)	List of Topic Title	Text Book
CS3	<ul style="list-style-type: none"> • Decluttering • Pre-attentive attributes in text and graphs • Visualisation Design concepts 	T1 Ch 3 T1 Ch 4 T1 Ch 5

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Design Concepts



Traditional Design Concepts

- Affordances
- Accessibility
- Aesthetics
- Acceptance

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Form Follows Function



Function

- Think about what our audience be able to do with data

Form

- Create a visualization

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Affordances



“A situation where an object’s sensory characteristics intuitively imply its functionality and use”

-- CrowdCube

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Affordances



Affordances

- ❑ Inherent usability aspect in the product
- ❑ How to interact with or operate the product?
- ❑ With sufficient presence of affordance, good design fades into background
- ❑ Example, teapot has a handle, door has a handle

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Affordances

Lessons

- Highlight the important stuff
- Eliminate distractions
- Create clear hierarchy of information

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Affordances

Highlighting

- Focus on a fraction of overall visual (10% highlighting)
- Guidelines
 - Bold, italics, underlining :
 - ✓ Use for titles, labels, captions and short word sequences
 - ✓ Bolding preferred as it adds little noise
 - ✓ Use underlining sparingly as it add lot of noise
 - Case, typeface :
 - ✓ for short word sequences use uppercase
 - ✓ Can be used for titles, labels, keywords
 - ✓ Avoid different fonts as it disrupts aesthetics

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innovate achieve lead

Affordances

Highlighting

- Guidelines
 - Color :
 - ✓ Effective highlighting technique
 - ✓ Use sparingly
 - Size :
 - ✓ Way to attract attention
 - ✓ Signals relative importance
 - Blinking / Flashing:
 - ✓ Avoid or
 - ✓ Use only to indicate highly critical information that requires immediate response

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Affordances

Highlighting (example)

“New census data show more Americans are tying the knot, but mostly it’s the college educated.”

New Marriage Rate by Education

Number of newly married adults per 1,000 marriage eligible adults

Education Level	'08	'09	'10	'11	'12
All	41.4	36.7	36.7	36.7	36.7
Less than high school	26.8	23.4	23.4	23.4	23.4
High school graduate	35.9	30.1	30.1	30.1	30.1
Some college	42.5	36.5	36.5	36.5	36.5
Bachelor's degree or more	61.5	56.7	56.7	56.7	56.7

Note: Marriage eligible includes the newly married plus those widowed, divorced or never married at interview.
Source: US Census
Adapted from PEW RESEARCH CENTER

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Affordances

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Highlighting (example)
Changing the use of color completely redirect the focus

New Marriage Rate by Education
Number of newly married adults per 1,000 marriage eligible adults

Education Level	2008	2009	2010	2011
All	41.4	36.7	26.8	23.4
Less than high school				
High school graduate			35.9	30.1
Some college			42.5	36.5
Bachelor's degree or more				61.5
				56.7

Note: Marriage eligible includes the newly married plus those widowed, divorced or never married at interview.
Source: US Census
Adapted from PEW RESEARCH CENTER

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Affordances

innovate achieve lead

Eliminate Distractions

“You know you have achieved perfection, not when have nothing to add, but when you have nothing to take away.”
--Antoine de Saint-Exupery,
Airman’s Odyssey

... what to cut or de-emphasize can be more important than what to include

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Affordances

Eliminate Distractions

- Focus on clutter and context
- Considerations
 - ✓ Not all data are equally important
 - ✓ When detail is not needed, summarize
 - ✓ Ask: would eliminating this change anything?
 - ✓ Push necessary, but non-message conveying items to background

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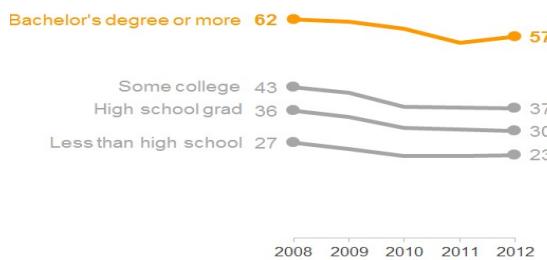
175



Affordances

Eliminate Distractions (example)

New marriage rate by education
Number of newly married adults per 1,000 marriage eligible adults



2008 2009 2010 2011 2012

Note: Marriage eligible includes the newly married plus those widowed, divorced or never married at interview.

Source: US Census
Adapted from PEW RESEARCH CENTER

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Affordances

Eliminate Distractions (example)

- What's improved?
 - ✓ Change from bar to line
 - ✓ Reduced bars from 25 to 4 lines
 - ✓ Same x –axis instead of legends
 - ✓ “All” category removed
 - ✓ Decimal points rounded to whole digits
 - ✓ Italics in font changed in subtitle
 - ✓ Highlighting of “Bachelors degree or more” category

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Affordances

Visual Hierarchy of information

- Preattentive attributes can be used for focusing
- Pull some item foreground, push some items to background indicating the order in which to process the information

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Affordances

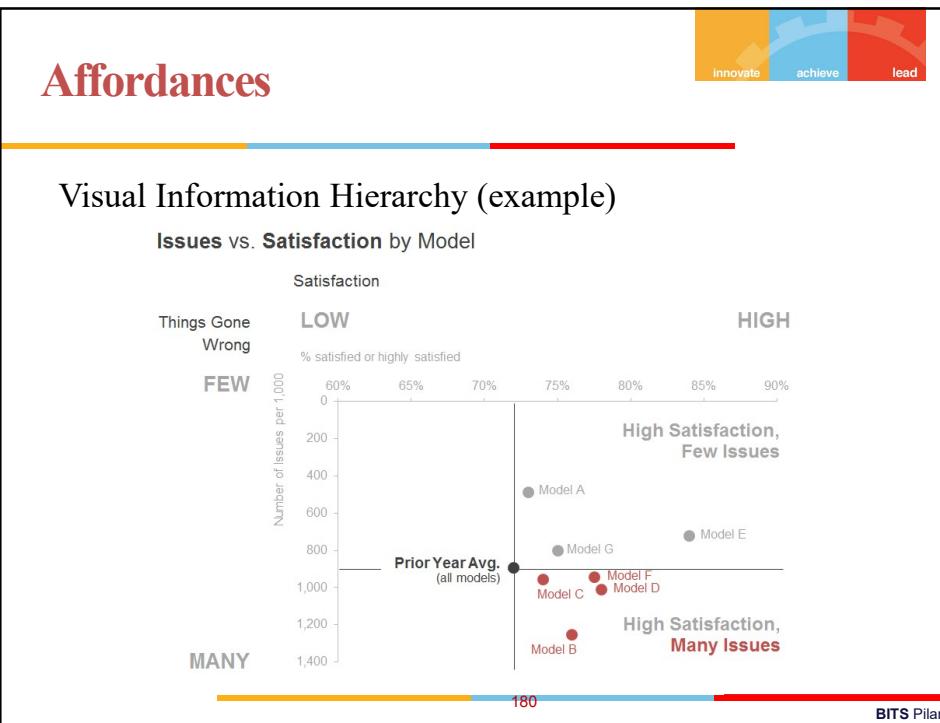
Visual Information Hierarchy (example)

Car manufacturer

- ❑ Dimensions used for determining success of make and model
 - ✓ Customer satisfaction
 - ✓ Frequency of car issues

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Affordances



Visual Information Hierarchy (example)

Hierarchy components

- ✓ Graph title: Bolding of words used
- ✓ y-axis label: Issues scale visible
- ✓ x-axis label: Satisfaction scale visible
- ✓ Dark point in visual: Last years average
- ✓ Red points in last quadrant: highlighting used

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Accessibility



Accessibility

Designs should be usable by people of diverse abilities

- ✓ Example, mobile phone screens

Work to make your data visualizations similarly straightforward and easy to use

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Accessibility



Accessibility strategies

- Don't overcomplicate
- Use text to label, introduce, explain, reinforce, highlight, recommend, and tell a story

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Accessibility



Don't overcomplicate

"If it's hard to read, it's hard to do it."

"The more complicated the visual looks, the more time audience perceives it will take to understand and less likely they are to spend time to understand it."

-- Cole Knaflic

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Accessibility

Don't overcomplicate

Guidelines

- ✓ Make it legible
 - ❖ use consistent, easy to read font
- ✓ Keep it clean
 - ❖ use visual affordance, remove clutter
- ✓ Use straightforward language
 - ❖ over complex one
- ✓ Remove unnecessary complexity

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Accessibility

Text is your Friend

Accessible visual

Use text to label, introduce, explain, reinforce, highlight, recommend, and tell a story

Must have text for chart titles, axis titles

Use text for conclusion or suggestion or recommended action

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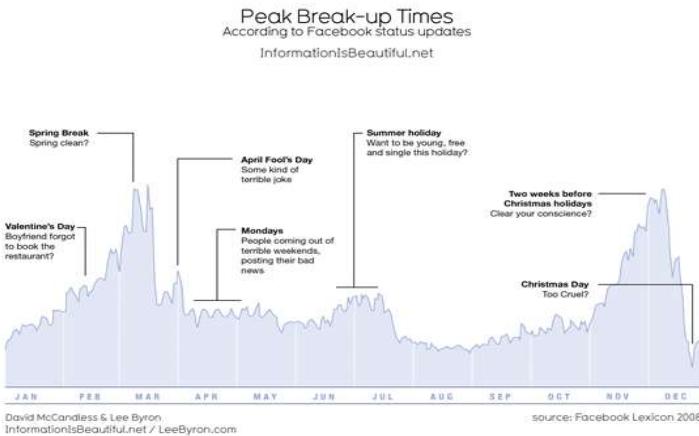
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Accessibility



Text is your friend (example: annotations)



187

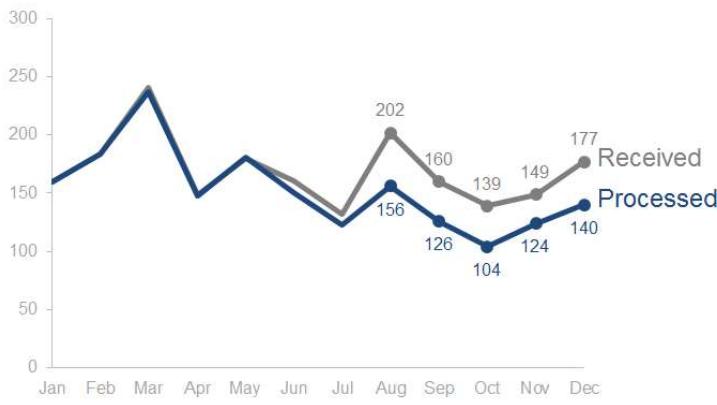
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Accessibility



Text is your friend (example)



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Accessibility

The chart displays two data series: 'Received' (blue line with circles) and 'Processed' (grey line with circles). The y-axis represents the 'Number of tickets' from 0 to 300. The x-axis shows the months from Jan to Dec 2014. A vertical grey line is drawn at May.

Month	Received	Processed
Jan	158	158
Feb	180	180
Mar	235	235
Apr	150	150
May	180	180
Jun	160	160
Jul	120	120
Aug	202	156
Sep	160	126
Oct	139	104
Nov	149	124
Dec	177	140

Data source: XYZ Dashboard, as of 12/31/2014

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Accessibility

Text is your friend (example)

Please approve the hire of 2 FTE
to backfill those who quit in the past year

The chart displays two data series: 'Received' (blue line with circles) and 'Processed' (grey line with circles). The y-axis represents the 'Number of tickets' from 0 to 300. The x-axis shows the months from Jan to Dec 2014. A vertical grey line is drawn at May.

Month	Received	Processed
Jan	158	158
Feb	180	180
Mar	235	235
Apr	150	150
May	180	180
Jun	160	160
Jul	120	120
Aug	202	156
Sep	160	126
Oct	139	104
Nov	149	124
Dec	177	140

2 employees quit in May. We nearly kept up with incoming volume in the following two months, but fell behind with the increase in Aug and haven't been able to

Data source: XYZ Dashboard, as of 12/31/2014 | A detailed analysis on tickets processed per person and time to resolve issues was undertaken to inform this request and can be provided if needed.

190

Aesthetics



“People perceive more aesthetic designs as easier to use than less aesthetics designs – whether they actually are or not.”

- Cole, Storytelling with data

.... Increases our chance of success for getting our message across

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Aesthetics



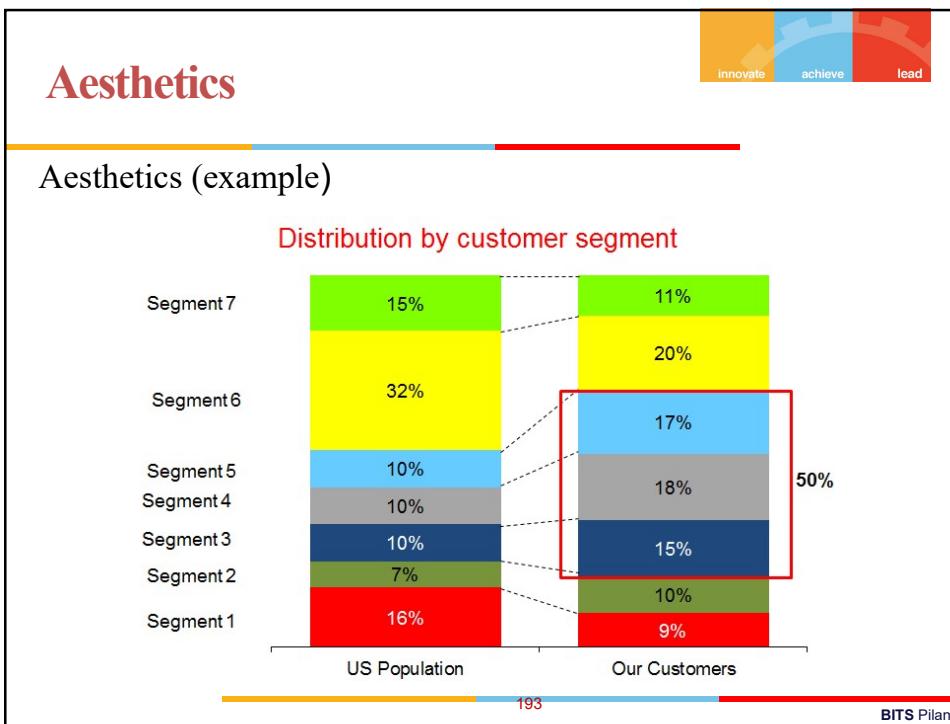
❑ Considerations

- Be smart with color
 - ✓ Use it sparingly and strategically
- Pay attention to alignment
 - ✓ Create sense of unity and cohesion
- Leverage white space
 - ✓ Preserve margins
 - ✓ Don't stretch graphics or add things

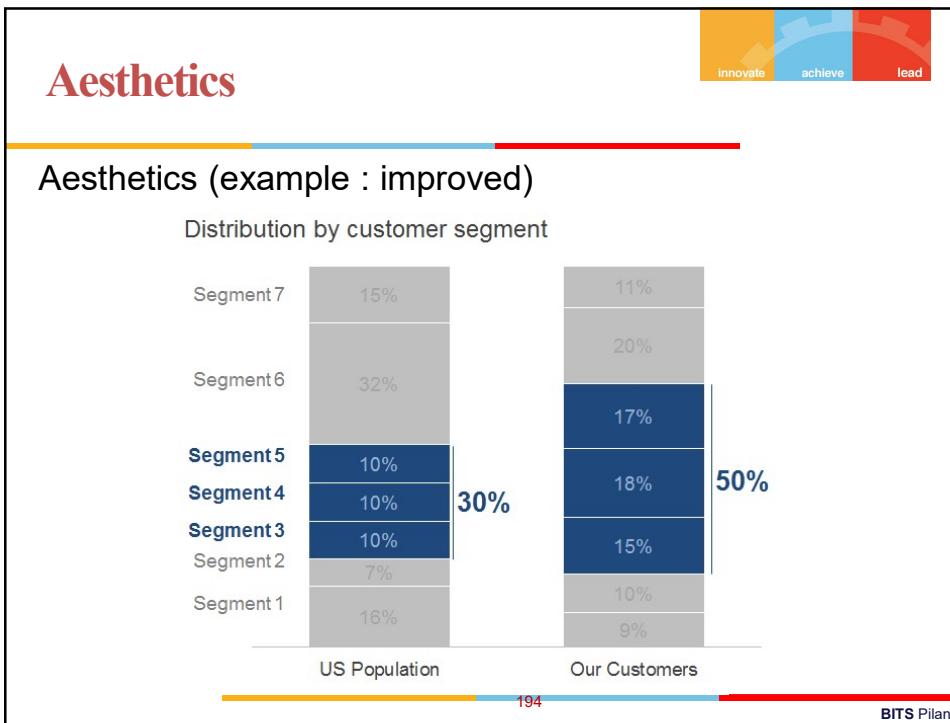
192

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193

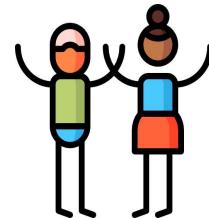


194



Acceptance

“For a design to be effective, it must be accepted by its intended audience.”



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Acceptance



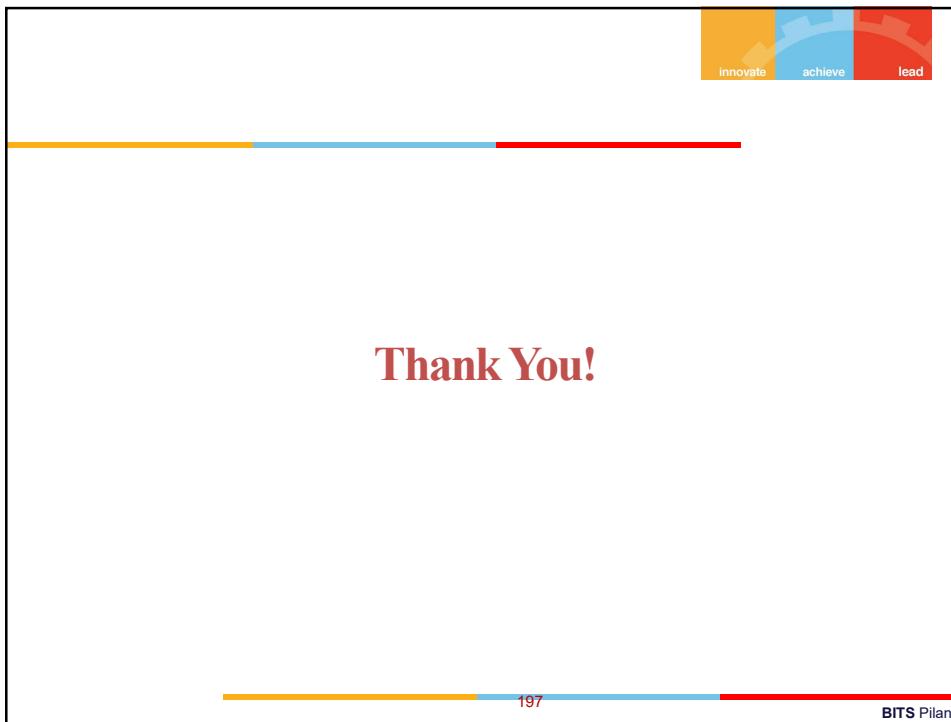
Strategies for gaining acceptance

- Articulate the benefits of the new or different approach
- Show the side-by-side
- Provide multiple options and seek input
- Get a vocal member of your audience on board

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CONTACT SESSION 3 -PLAN		
Contact Sessions(#)	List of Topic Title	Text Book
CS3	<ul style="list-style-type: none"> • Decluttering • Pre-attentive attributes in text and graphs • Data Design concepts 	T1 Ch 3 T1 Ch 4 T1 Ch 5

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Cognitive Load

- It is the amount of mental effort that we use to get the information that we need.
- signal-to-noise ratio

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Cognitive Load

- There are three types of cognitive load
 - Intrinsic,
 - Extraneous, and
 - Germane.
- Different tasks need different amount of thoughts and attention

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Cognitive Load

- **Intrinsic Cognitive Load**
- The amount of memory that we need to understand something.
- **Extraneous cognitive load**
- Refers to the amount of **extra** brain power required to analyze and process information.
- **Germane cognitive load**
- A way for the brain to look for patterns to develop context.

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Question

- Which type of the cognitive loads just discussed pertains to the baseline level amount of brain power needed to understand an idea?
- Germane Cognitive Load
- Intrinsic Cognitive Load
- Extraneous Cognitive Load

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Question



- Which type of the cognitive loads just discussed pertains to the baseline level amount of brain power needed to understand an idea?
- Germane Cognitive Load
- **Intrinsic Cognitive Load**
- Extraneous Cognitive Load

203

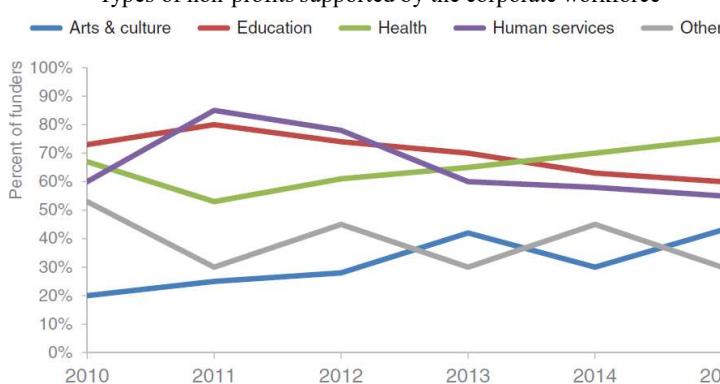
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Case Study -Clutter



Types of non-profits supported by the corporate workforce



Data is self-reported by funders; percents sum to greater than 100 because respondents can make multiple selections.

- **To Do:** You are a Data Science Consultant. Convey to your CSR leadership team where they should plan to focus the organization's CSR activity in the future

204

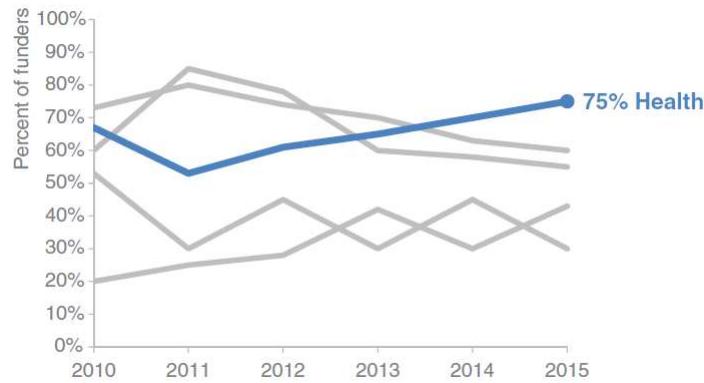
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Case Study – probable solutions



Health sector shows the highest potential to receive grants in the future



205

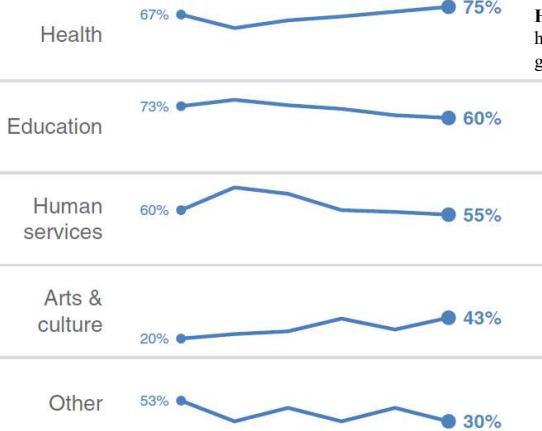
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Case Study – probable solutions



2010 2011 2012 2013 2014 2015 | % of funders



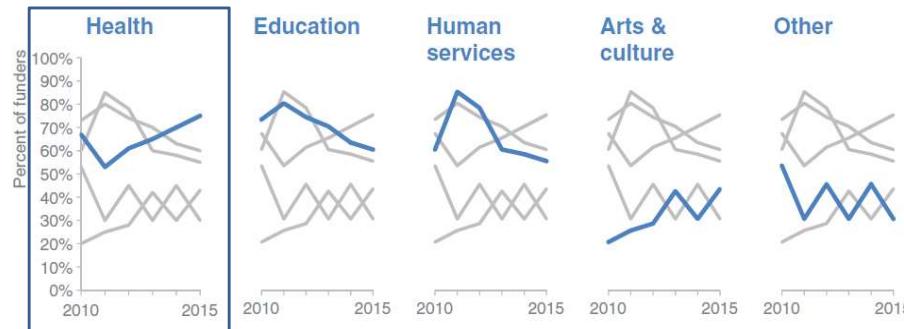
Health sector shows the highest potential to receive grants in the future

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Case Study – probable solutions



Data is self-reported by funders; percents sum to greater than 100 because respondents can make multiple selections.

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Case study 2-Clutter



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Human Memory

1. How human sees?
2. How you can use that to your advantage when creating visuals?

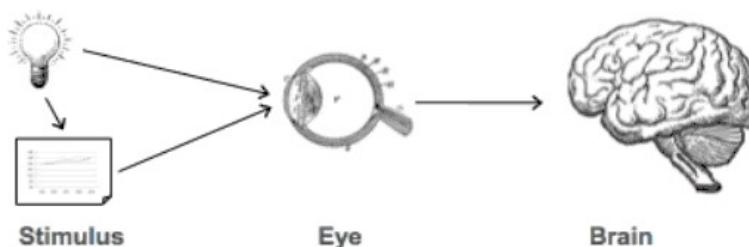
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How Human sees?



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See with Brain

Types of Human Memory

- Iconic
- Short term
- Long term

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See with Brain

```

graph LR
    Stimuli[Stimuli/input] --> ST[Short-term memory  
15 - 30 secs]
    ST --> LT[Long-term memory  
1sec - Lifetime]
    ST --> SM[Sensory memory  
1-3 secs]
    LT --> Forgetting[Forgetting  
Caused by biological factors, or antecedent processes]
    SM --> Forgetting
    Rehearsal[Rehearsal] -.-> ST
    Rehearsal -.-> LT
    
```

Adapted from: <https://www.interaction-design.org/literature/article/the-properties-of-human-memory-and-their-importance-for-information-visualization>

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Types of Human Memory



Iconic

- Stored for tiny time periods
- Originate from our sensory organs such as our eyes
- Typically retained for less than 500 milliseconds
- Raw information that the brain receives from the eye
- Store and process sensory memories automatically – that is without any conscious effort to do so

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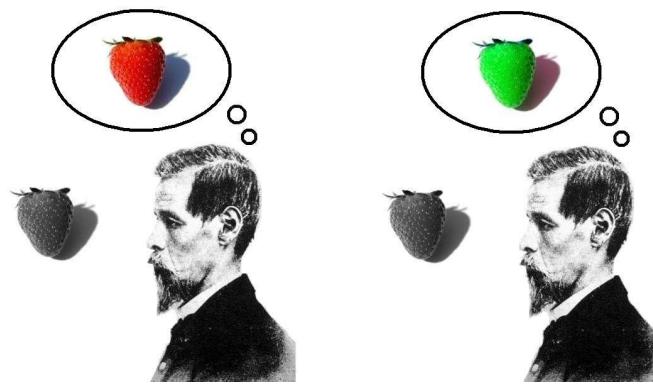
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Types of Human Memory



Iconic Memory (example)



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Types of Human Memory

Short-term memory

- Limited capacity
- Used to process sensory memories which are of interest to us – for whatever reason
- The sensory memory is transferred to the short-term memory where it may be processed for up to a minute

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Types of Human Memory

Long-term memory

- Built up over a lifetime
- Important for pattern recognition and cognitive processing
- Visuals persisted here can have longer lasting impact

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How to use human sight ?

Preattentive Attributes

- Size
- Color
- Position

Help to direct audience's attention to where you want them to focus in the visuals

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Preattentive Signals

Example

756395068473
658663037576
860372658602
846589107830

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218



Preattentive Signals

Example

756395068473
658663037576
860372658602
846589107830

219

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Preattentive Signals

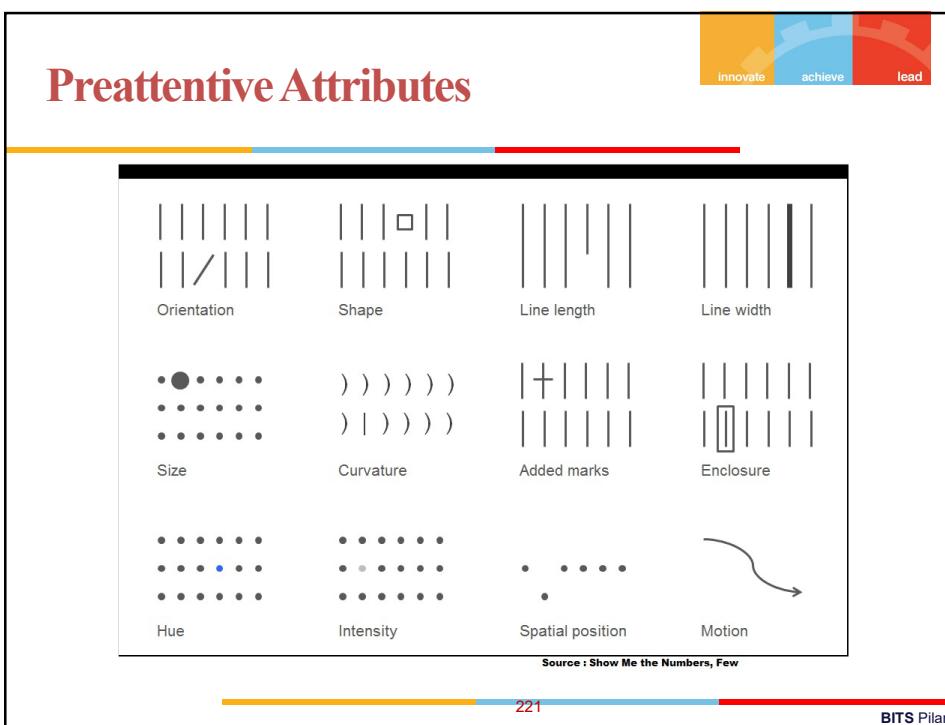
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• • • • •

“Enable our audience to see what we want them to see before they even know they’re seeing it!”

- Cole Knaflic

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Preattentive Attributes

innovate achieve lead

Importance

- ❑ Drawing audience's attention quickly to where you want them to look
- ❑ Creating a visual hierarchy of information

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Preattentive Attributes In text

Example

No preattentive attributes

What are we doing well? Great Products. These products are clearly the best in their class. Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours.

You have a great company – keep up the good work!

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Preattentive Attributes In text

Example (use of color)



Color

What are we doing well? Great Products. **These products are clearly the best in their class.** Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours.

You have a great company – keep up the good work!

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Preattentive Attributes In text

T T

Example (use of Size)

Size

What are we doing well? Great Products. These products are the best in their class. Replacement parts are shipped when needed. You sent gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours. You have a great company – keep up the good work!

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Preattentive Attributes In text

Example (use of enclosure)

Outline (enclosure)

What are we doing well? Great Products. These products are clearly the best in their class. Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours.

You have a great company – keep up the good work!

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Preattentive Attributes In text

Example (information hierarchy)

What are we doing well?

Themes & example comments

- **Great products:** "These products are clearly the best in class."
- **Replacement parts are shipped when needed:**
"You sent me gaskets without me having to ask, and I really needed them, too!"
- **Problems are resolved promptly:** "Bev in the billing office was quick to resolve a billing issue I had."
- **General customer service exceeds expectations:**
"The account manager even called after normal business

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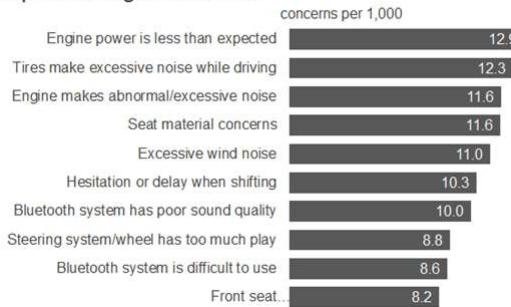
227



Preattentive Attributes In graphs

Example

Top 10 design concerns



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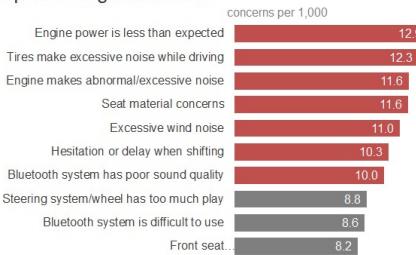
Preattentive Attributes In graphs



Example (use of color and text attributes)

7 of the top 10 design concerns have 10 or more concerns per 1,000.
Discussion: is this an acceptable default rate?

Top 10 design concerns



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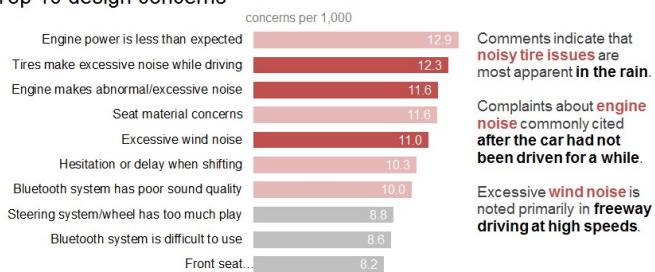
Preattentive Attributes In graphs



Example (Modified focus and text)

Of the top design concerns, three are noise-related.

Top 10 design concerns



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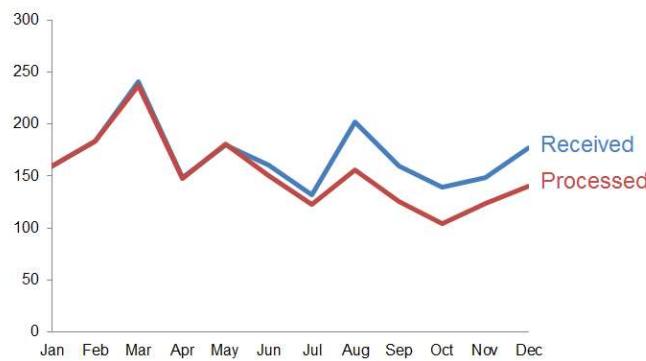
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Preattentive Attributes In graphs



Another example



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Preattentive Attributes In graphs



Another example (everything in background)



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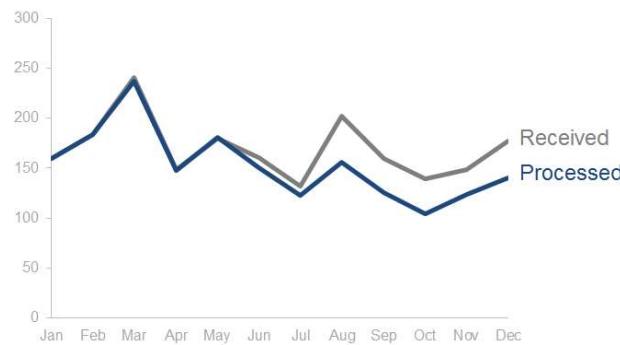
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Preattentive Attributes In graphs



Another example (use color)



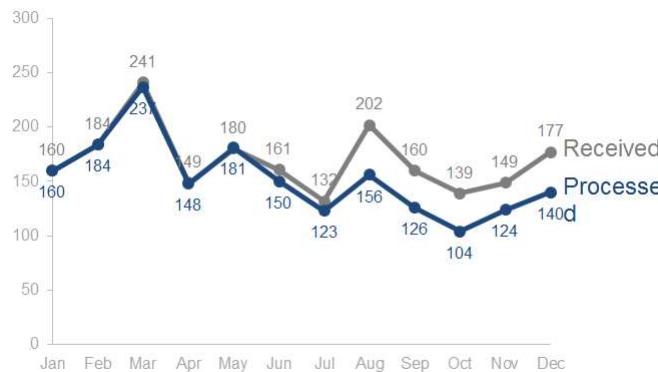
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Preattentive Attributes In graphs



Another example (data labels and clutter)



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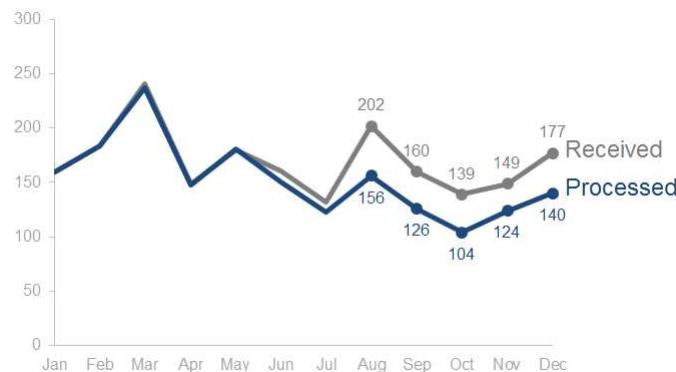
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Preattentive Attributes In graphs



Another example (use labels sparingly)



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Size



Preattentive Attribute – Size

- Size matters!
- Relative Size --→ Relative Importance!
- Similar things -→ Similar Size!

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Color



Preattentive Attribute – Color

- Use sparingly
- Use Consistently
- Design with colorblind in mind
- Be thoughtful of the tone that color conveys
- Use Brand colors

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Use color sparingly



Country Level Sales Rank Top 5 Drugs

Rainbow distribution in color indicates sales rank in given country from #1 (red) to #10 or higher (dark purple)

Country	A	B	C	D	E
AUS	1	2	3	6	7
BRA	1	3	4	5	6
CAN	2	3	6	7	8
CHI	1	2	3	4	7
FRA	3	2	4	8	9
GER	3	1	6	5	4
IND	4	1	3	7	5
ITA	2	4	5	9	8
MEX	1	5	4	6	3
RUS	4	3	7	9	10
SPA	2	3	4	5	11
TUR	7	2	3	4	5
UK	1	2	3	6	7
US	1	2	4	3	5

Top 5 drugs: country-level sales rank

COUNTRY DRUG	RANK				
	A	B	C	D	E
Australia	1	2	3	6	7
Brazil	1	3	4	5	6
Canada	2	3	6	12	8
China	1	2	8	4	7
France	3	2	4	8	10
Germany	5	1	6	5	4
India	4	1	8	10	5
Italy	2	1	10	9	8
Mexico	1	5	4	6	11
Russia	3	7	9	8	12
Spain	2	3	4	5	11
Turkey	7	2	9	4	8
United Kingdom	1	2	3	6	7
United States	1	2	4	3	5

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Brand color

Leverage brand color Draw attention with black Use complementary color

Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7
7	7	7	4	4	4	7
Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7
Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7

ClientLogo *ClientLogo* *ClientLogo*

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Position

Pre-attentive Attribute – Position

- Use top left corner wisely for important stuff
- Be mindful of how you position elements on page
- Aim to do so in way that will feel natural for audience to consume information

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CONTACT SESSION 3 -PLAN		
Contact Sessions(#)	List of Topic Title	Text Book
CS3	<ul style="list-style-type: none"> • Decluttering • Pre-attentive attributes in text and graphs • Data Design concepts • Visualisation Types 	T1 Ch 3 T1 Ch 4 T1 Ch 5 T2 Ch 5

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Data Visualisation Methods		
Textuals		
Text Based Visualizations		
<input type="checkbox"/> Simple Text	<input type="checkbox"/> Tables	<input type="checkbox"/> Heatmap

— 242 —

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Graphs



- Interacts with visual system
- Well designed graph get information across more quickly than well designed table

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Graphicals



- Points
- Lines
- Bars
- Area

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Data Visualisation Methods- Comparing Categories



- Dot Plot
- Bar Chart
- Floating Bar
- Histogram
- Slope Graph
- Radial Chart
- Glyph Chart

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Dot Plots



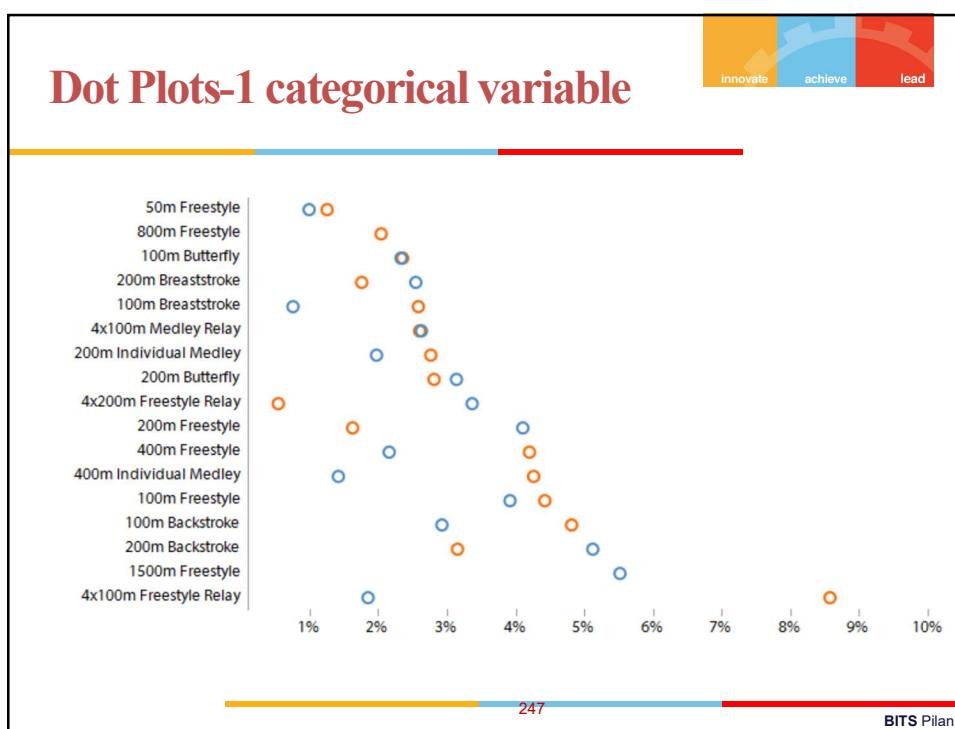
Data variables: 2 x categorical, 1 x quantitative.

Visual variables: Position, color-hue, symbol.

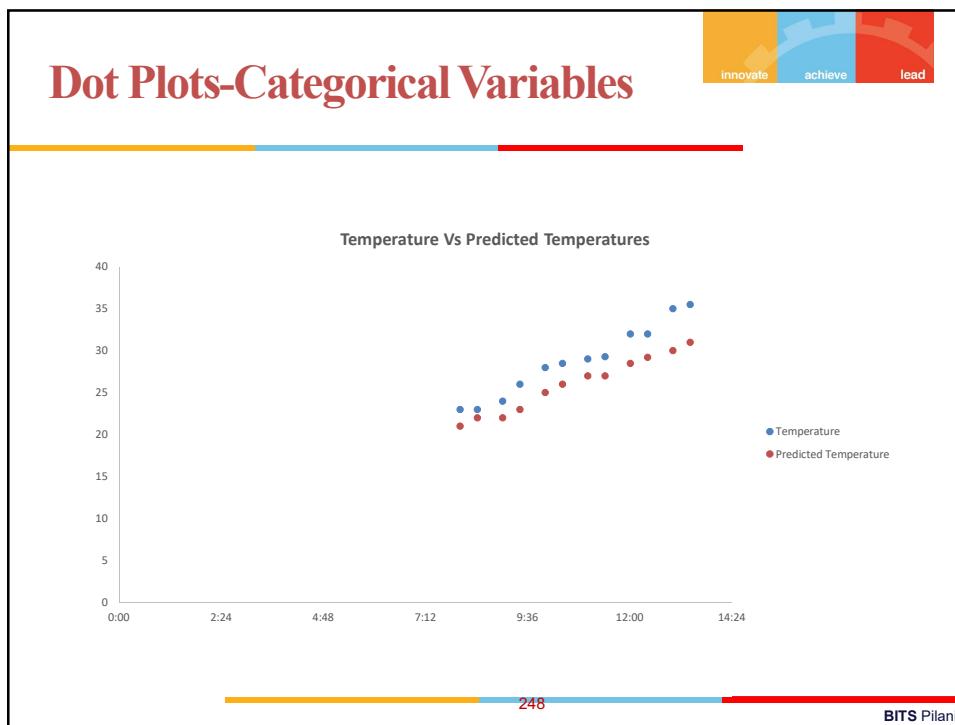
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Bar Charts



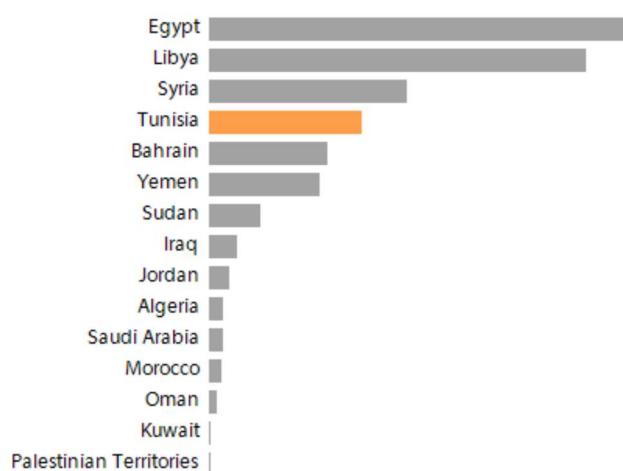
Data variables: 1 x categorical, 1 x quantitative-ratio.

Visual variables: Length/height, color-hue.

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Bar Charts



5% 10% 15% 20% 25%

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Floating Bars/Gantt Charts



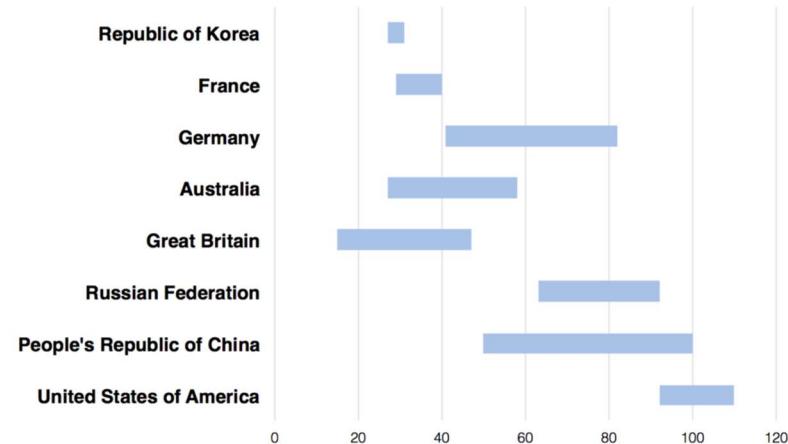
Data variables: 1 x categorical-nominal, 2 x quantitative.

Visual variables: Position, length.

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Data Visualisation Methods - Floating Bars



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Histogram



Data variables: 1 x quantitative-interval, 1 x quantitative-ratio.

Visual variables: Height, width.

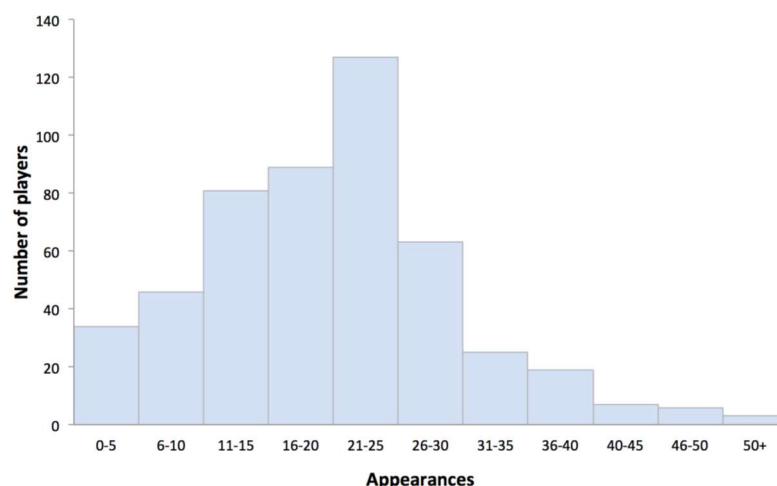
- show distribution through the frequency of quantitative values (y axis) against defined intervals of quantitative values(x axis).

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Data Visualisation Methods Histogram



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Slope Graph



Data variables: 1 x categorical, 2 x quantitative.

Visual variables: Position, connection, color-hue.

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Slope Graph



2010/2011

2011/2012

Manchester United, 80

Chelsea, 71
Manchester City, 71
Arsenal, 68

Tottenham, 62

Liverpool, 58

Everton, 54

Newcastle, 46

Manchester City, 89
Manchester United, 89

Arsenal, 70

Tottenham, 69

Newcastle, 65

Chelsea, 64

Everton, 56

Liverpool, 52

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Slope Graph



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Glyph Chart



Data variables: Multiple x categorical, multiple x quantitative.

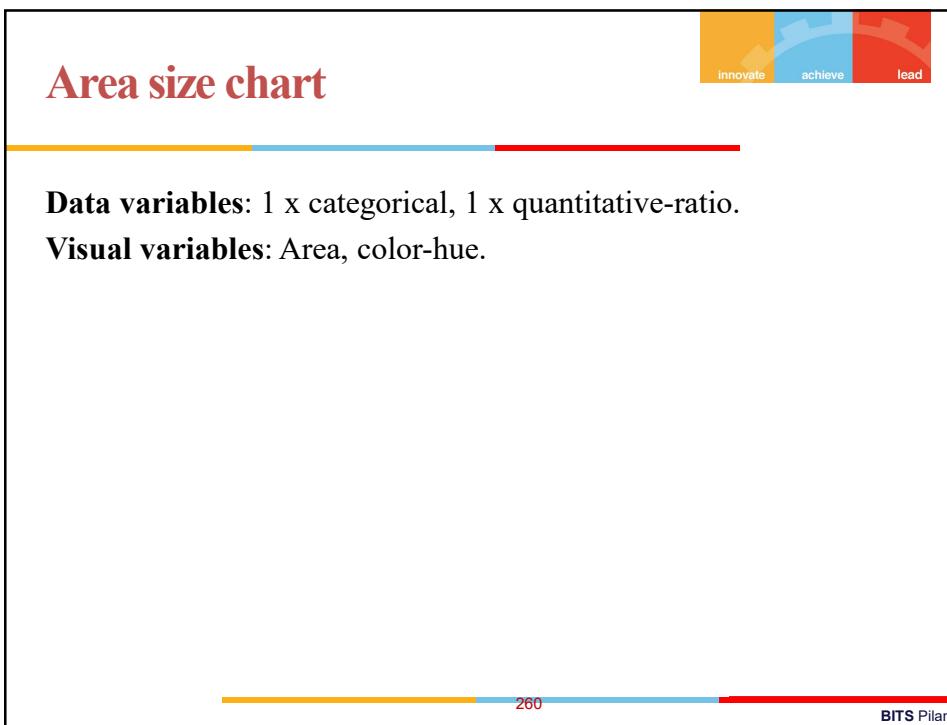
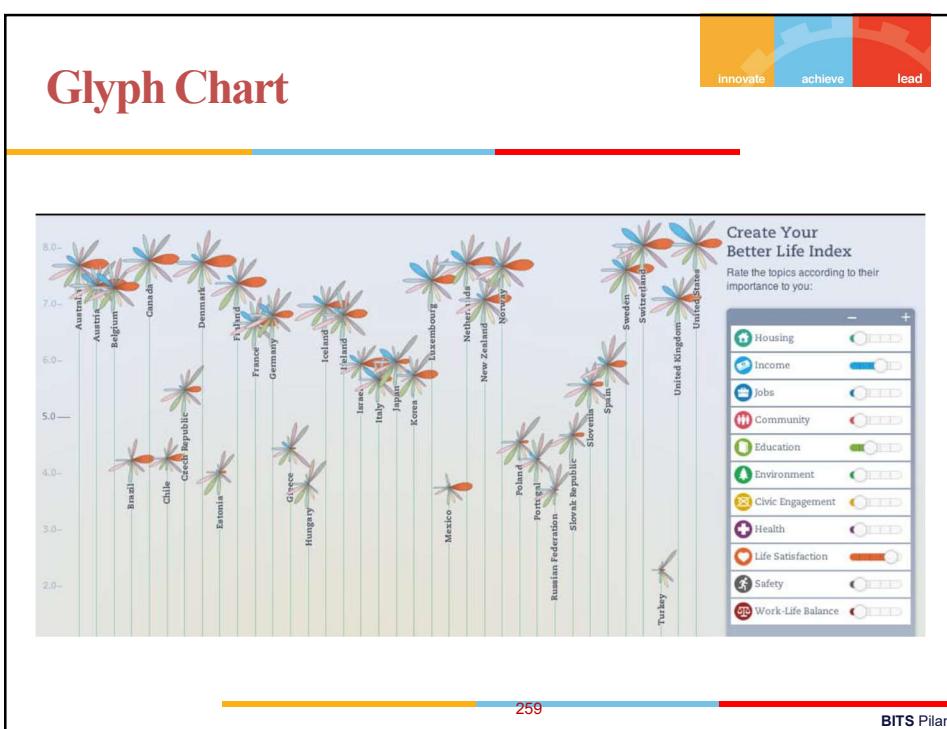
Visual variables: Shape, size, position, color-hue.

Description: A glyph chart is based on a shape (in the following example, a flower) being the main artifact of representation.

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Area size chart



A Tale of Two Leagues: Comparing Transfer Spend (Summer 2012)

English Premier League
£554M

Scottish Premier League
£22M



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Trellis chart



Data variables: Multiple x categorical, multiple x quantitative.

Visual variables: Position, any visual variable.

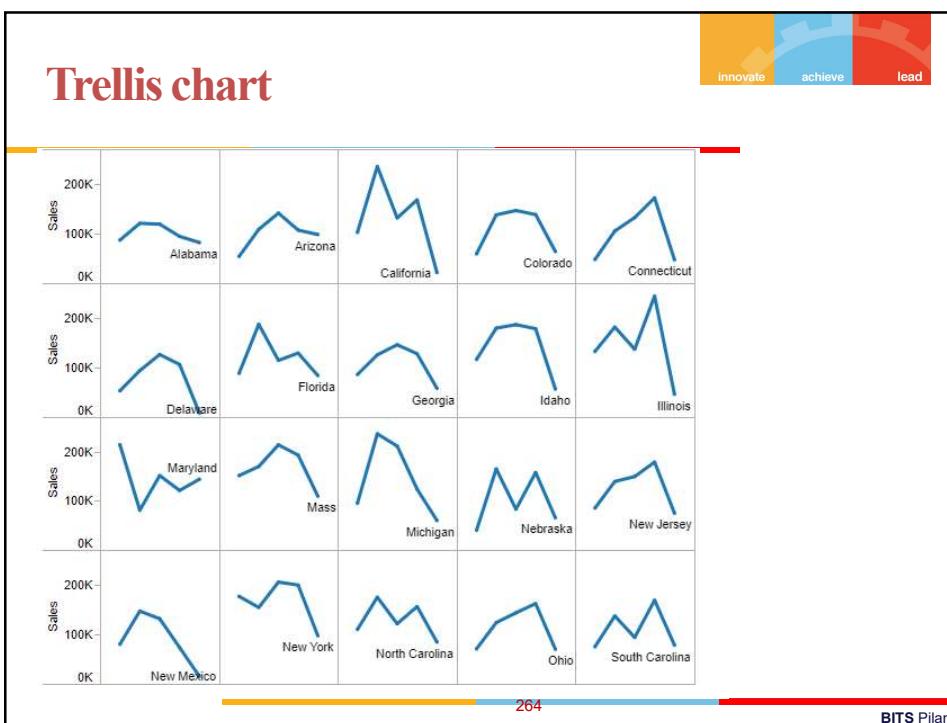
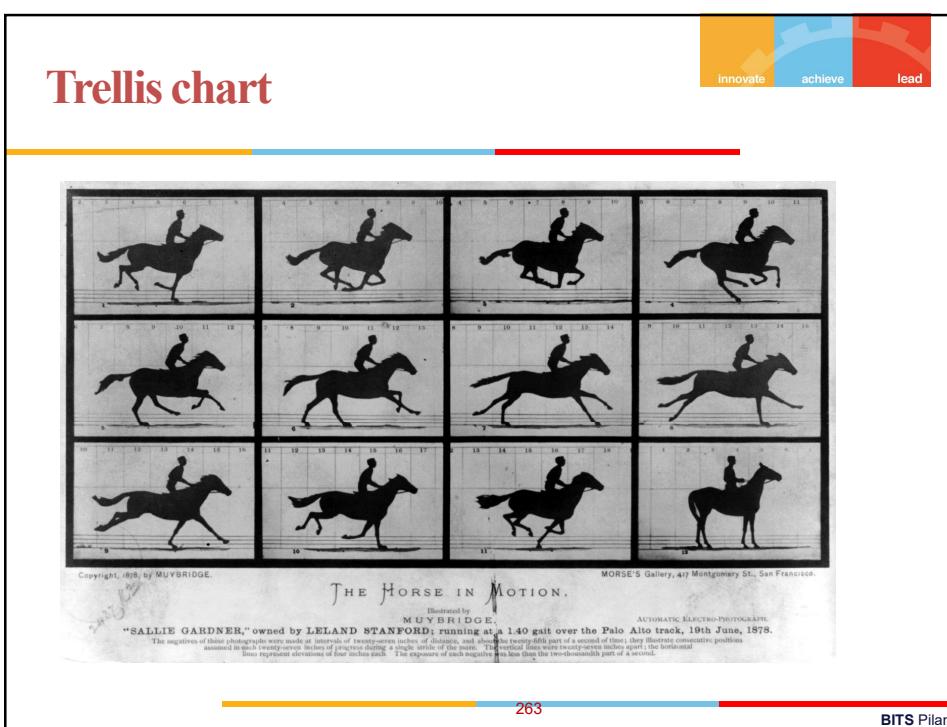
Description:

Small multiples are not really a separate chart type but an arrangement approach that facilitates efficient and effective comparisons to be made across a multipanel display of small chart elements.

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Word cloud

Data variables: 1 x categorical, 1 x quantitative-ratio.

Visual variables: Size.

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Word cloud

design
data
visualization
image

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Assessing hierarchies and part-to-whole Relationships- Pie chart



Data variables: 1 x categorical, 1 x quantitative-ratio.

Visual variables: Angle, area, color-hue.



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Stacked bar chart

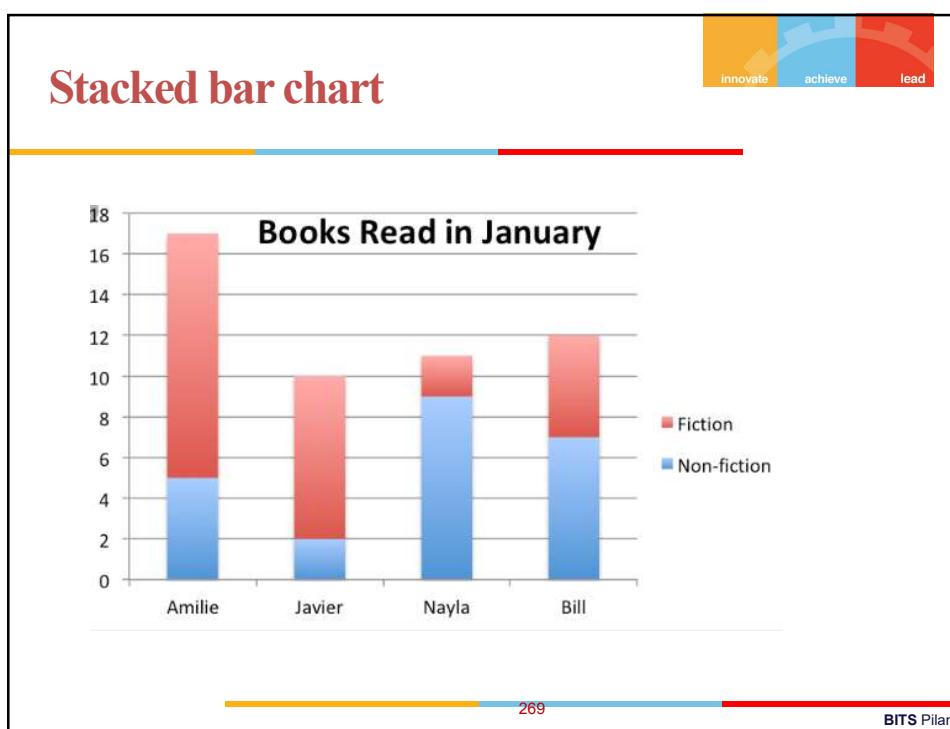


Data variables: 2 x categorical, 1 x quantitative-ratio.

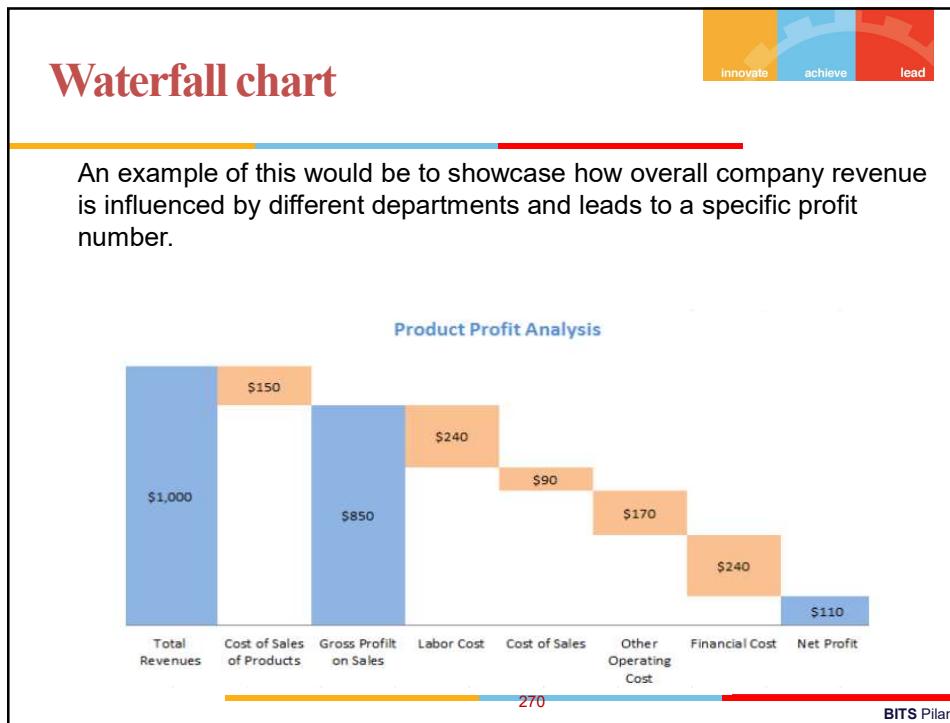
Visual variables: Length, color-hue, position, color-saturation/lightness.

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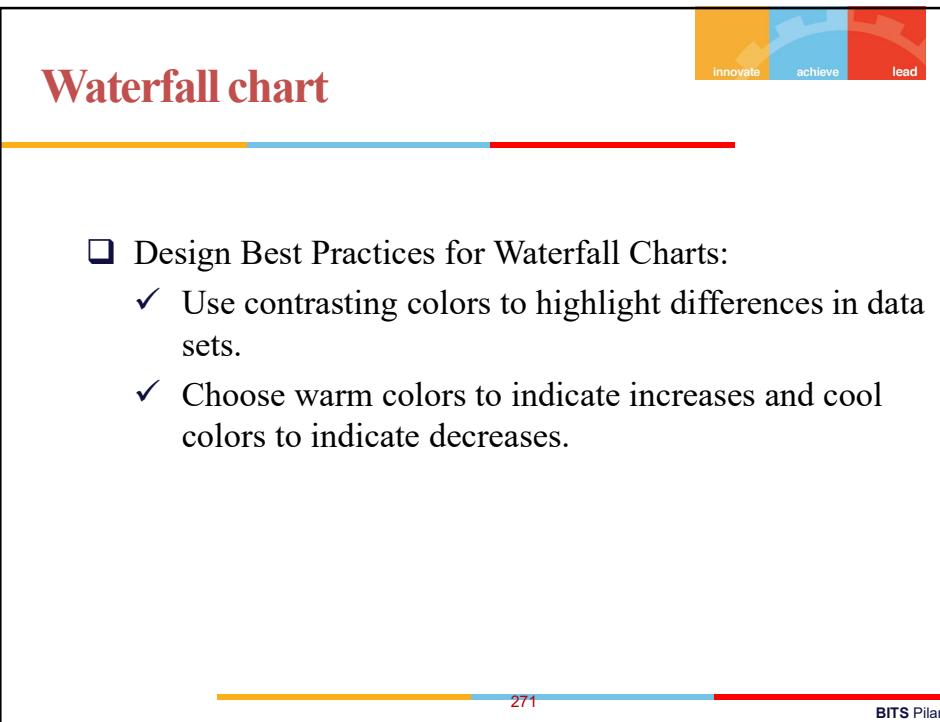
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Waterfall chart

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- ❑ Design Best Practices for Waterfall Charts:
 - ✓ Use contrasting colors to highlight differences in data sets.
 - ✓ Choose warm colors to indicate increases and cool colors to indicate decreases.

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Tree hierarchy

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LITERARY ORGANISM
A visualization of Part One of *On the Road*, by Jack Kerouac

BASIC STRUCTURE
Each literary component can be divided into even smaller parts, the smallest in this diagram being words. The diagram is organized into three levels: chapters, paragraphs, sentences, and words.

NOTATION
Each quotation can be positioned at the first chapter, 3.5 paragraph.

COLORS

- Dean Moriarty (Protagonist)
- Hop & Jean鼠
- Social Events & Interaction
- Travel
- Witches of Regional Life
- Partners, Dressing & Drags
- Work & Survival
- Red Parallel (Dystopia)
- Women, Sex, & Relationships
- Digital Activities & Police Encounters
- Character Backdrops

WORD COUNT CHART
All sentences are in proportion to the longest sentence in Part One, which is 131 words long.

http://www.stefanieposavec.com/writing-without-words

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Showing changes over time-Line Chart



Data variables: 1 x quantitative-interval, 1 x quantitative-ratio, 1 x categorical.

Visual variables: Position, slope, color-hue.

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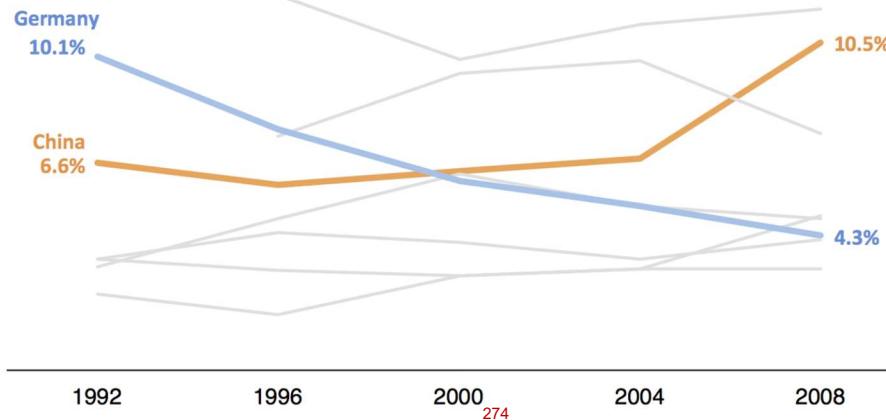
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Showing changes over time-Line Chart



The Contrasting Fortunes of German and Chinese Olympic Success

Percentage of total medals won across past five Olympics (eight countries selected based on ranking at 2008)



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Area Charts



Data variables: 1 x quantitative-interval, 1 x categorical, 1 x quantitative-ratio.

Visual variables: Height, slope, area, color-hue.

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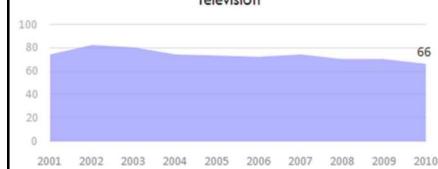
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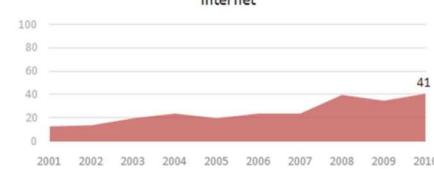
Area chart



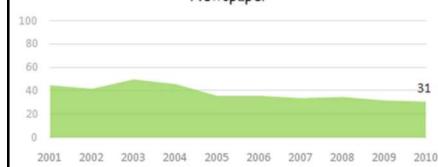
Television



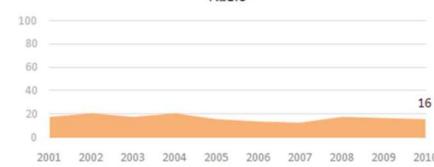
Internet



Newspaper



Radio



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Area chart



Design Best Practices for Area Charts:

- Use transparent colors so information isn't obscured in the background.
- Don't display more than four categories to avoid clutter.
- Organize highly variable data at the top of the chart to make it easy to read.

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Stacked area chart



Data variables: 1 x quantitative-interval, 1 x categorical, 1 x quantitative-ratio.

Visual variables: Height, area, color-hue.

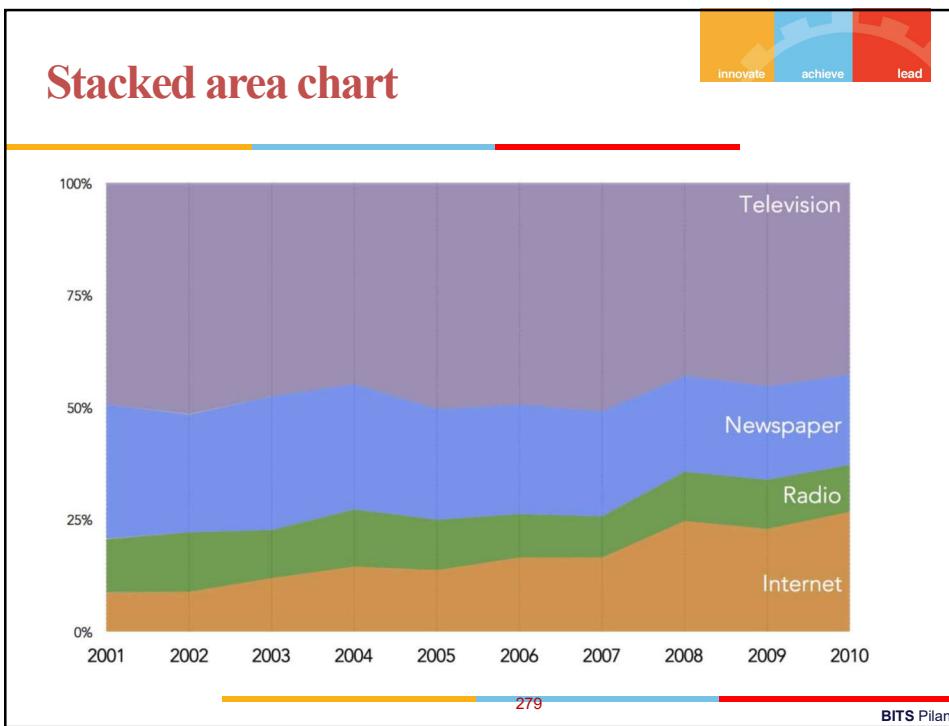
Stacked Area Graphs Are Not Your Friend

<https://everydayanalytics.ca/2014/08/stacked-area-graphs-are-not-your-friend.html>

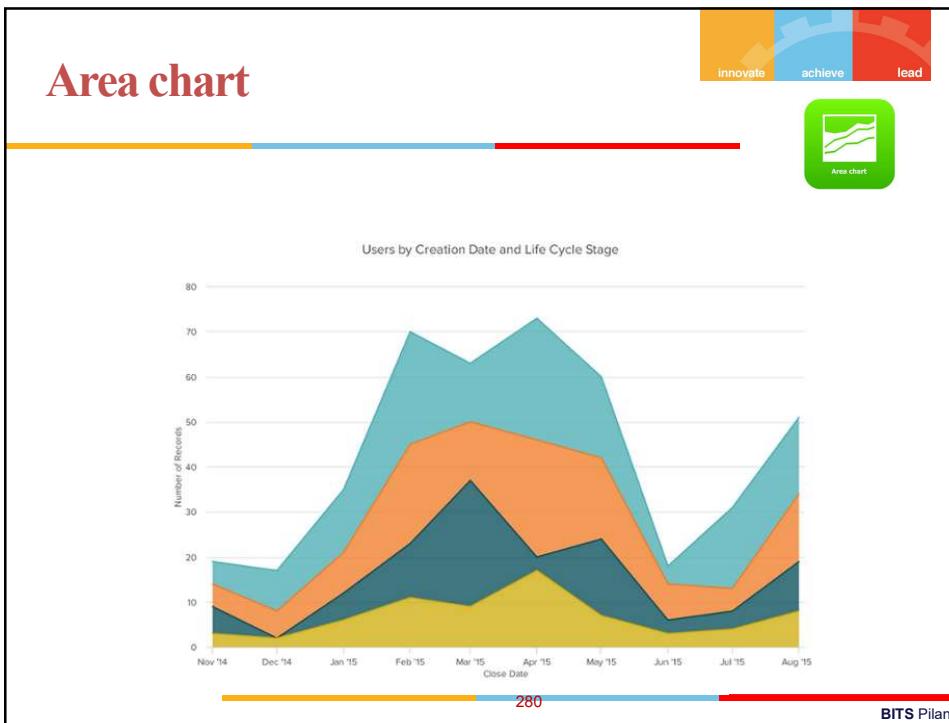
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Candlestick chart



Data variables: 1 x quantitative-interval, 4 x quantitative-ratio.

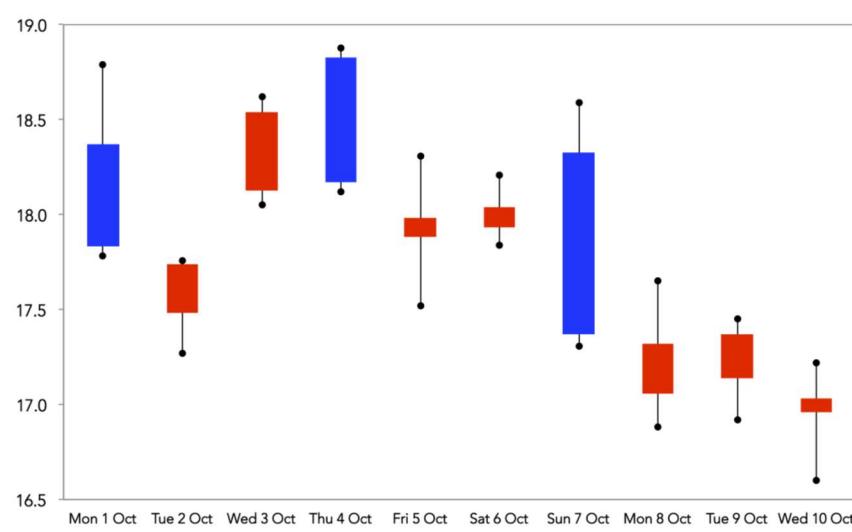
Visual variables: Position, height, color-hue.

Description: The candlestick chart is commonly used in financial contexts to reveal the key statistics about a stock market for a given timeframe (often daily).

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Candlestick chart



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Flow map

Data variables: Multiple x quantitative-interval, 1 x categorical, 1 x quantitative-ratio.

Visual variables: Position, height/width, color-hue.

Description: A flow map portrays the flow of a quantitative value as it is transformed over time and/or space

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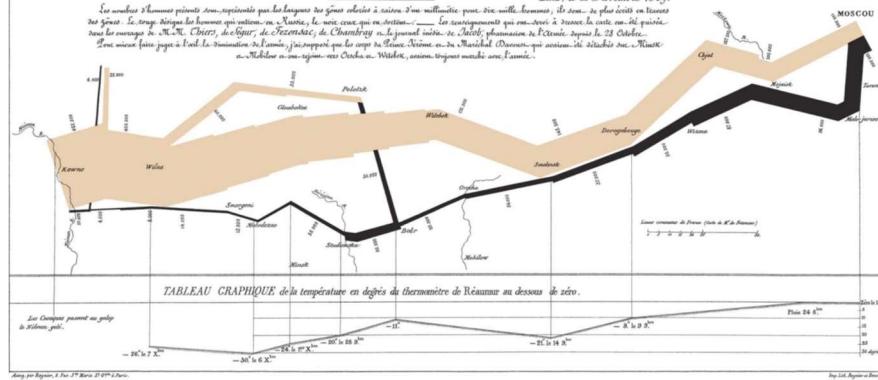
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Flow map

Carte Figurative des pertes subies en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dessiné par M. Minard, Ingénieur Général des Ponts et Chaussées au Ministère
Paris, le 20 Novembre 1869.
Les nombres d'hommes perdus, représentés par les largeurs des traits colorés à raison d'une millième pour être nulle, montrent, de tout, de plus évidemment que toutes les forces. Le temps démontre les batailles qui ont été, le nombre, le moins, qui se déroulent, les combats qui ont eu lieu à diverses dates, mais aussi à diverses périodes qui sont arrivés à diverses dates, ou bien qu'il y ait une progression régulière de l'armée depuis le 23 Octobre. Les routes font également la progression de l'armée, j'ai supposé que les corps de l'armée étaient au Mouvement, qui suivent les déplacements des troupes, mais également avec l'assaut.



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Plotting connections and relationships-Scatter plot



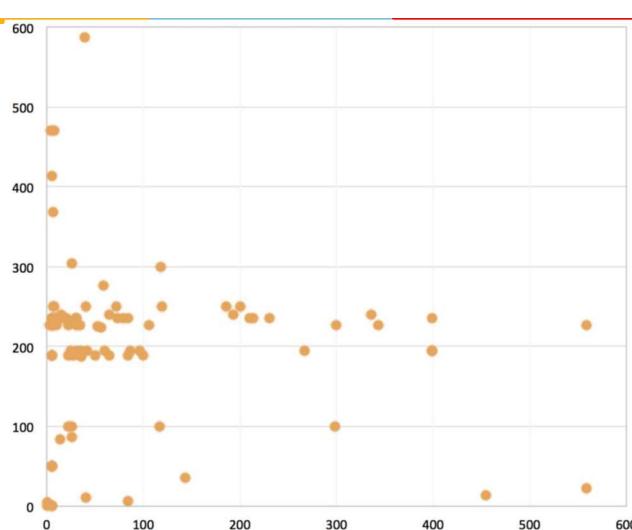
Data variables: 2 x quantitative.

Visual variables: Position, color-hue.

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Scatter plot



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Scatter Plots

- **Best Practices for designing Scatter Plots:**
- Include more variables, such as different sizes, to incorporate more data.
- Start y-axis at 0 to represent data accurately.
- If you use trend lines, only use a maximum of two to make your plot easy to understand.

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Bubble plot

Data variables: 2 x quantitative, 2 x categorical.

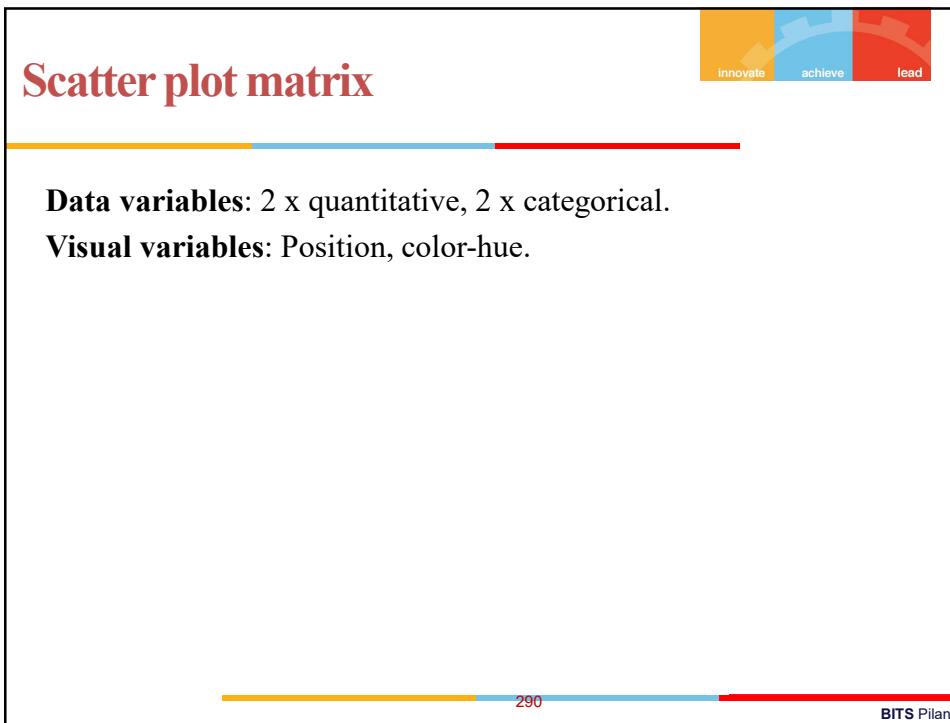
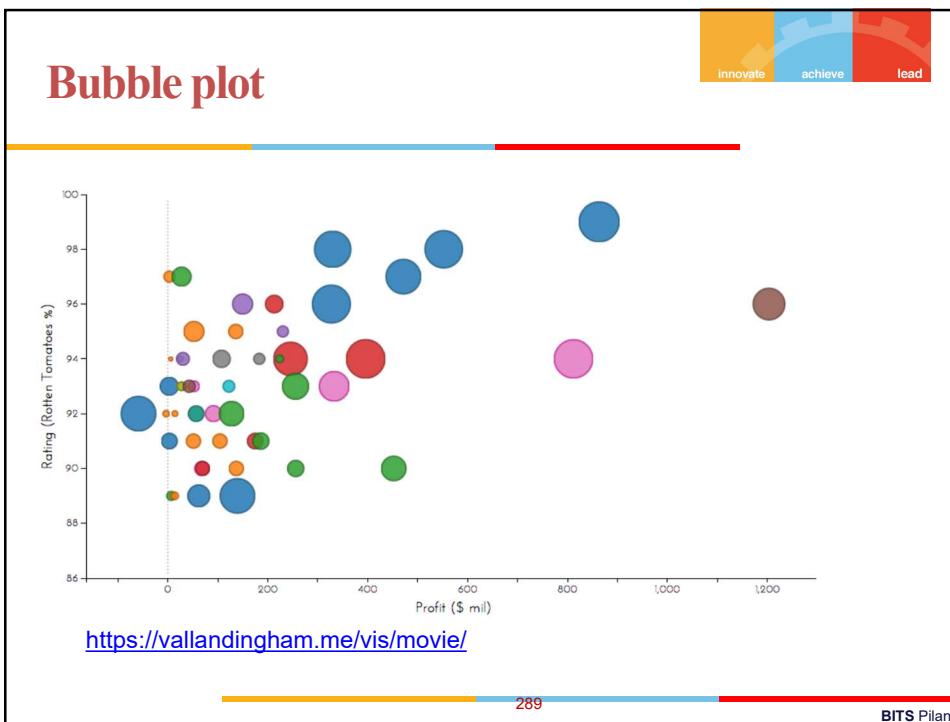
Visual variables: Position, area, color-hue.

Description: A bubble plot extends the potential of a scatter plot through multiple encoding of the data mark

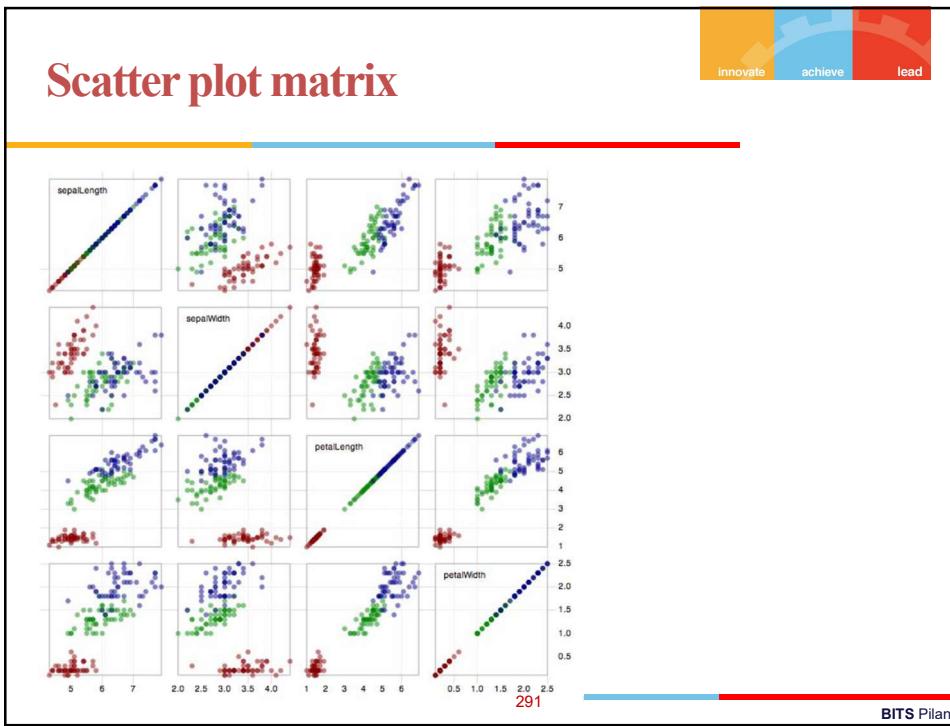
288

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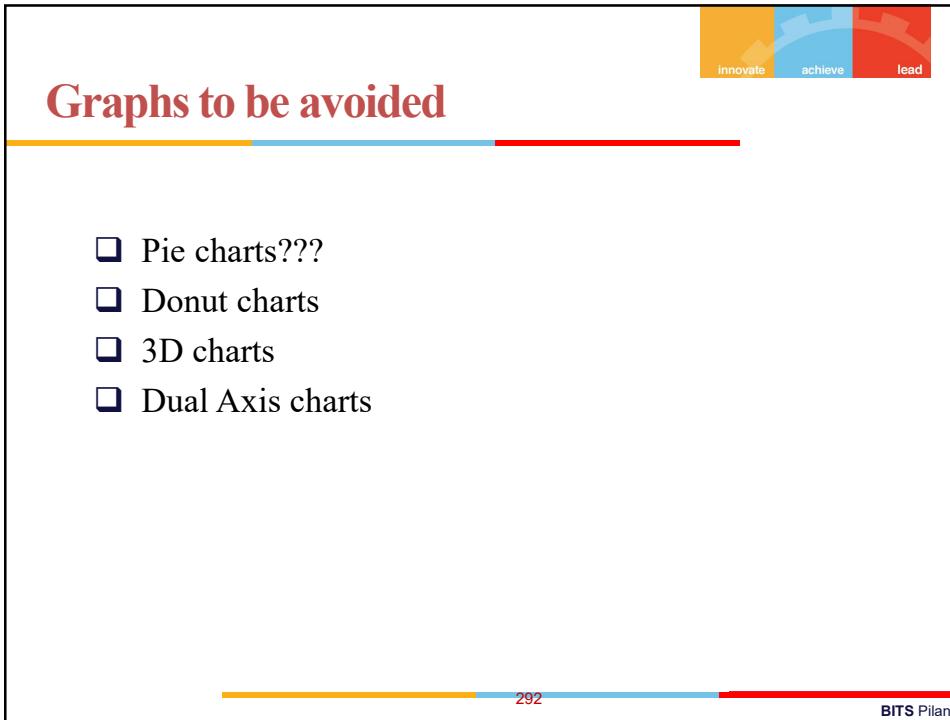
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Graphs to be avoided

Pie and Donut charts

- Most widely used (and misused)
- used to visualize a part to whole relationship or a composition
- typically represents numbers in percentages,

- The human mind thinks linearly but, when it comes to angles and areas, most of us can't judge them well.

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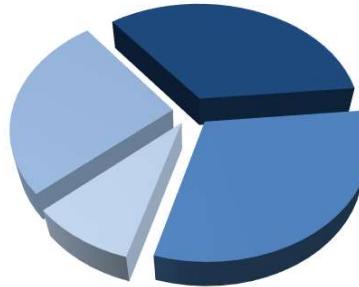
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Graphs to be avoided

Pie chart Example

Supplier Market Share



- Supplier A
- Supplier B
- Supplier C
- Supplier D

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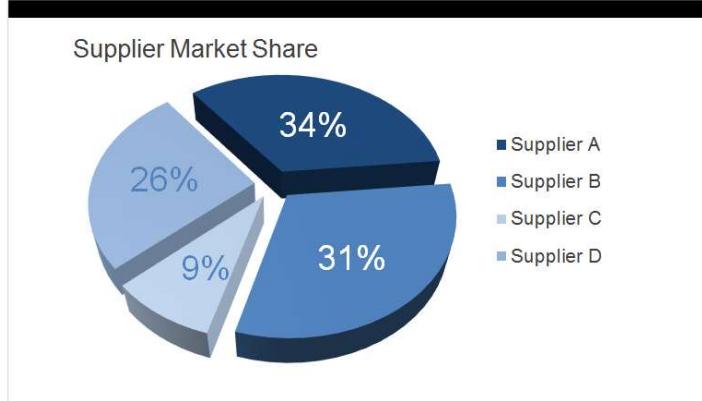
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Graphs to be avoided

Pie chart Example (with numbers)



Supplier Market Share

Supplier	Market Share (%)
Supplier A	34%
Supplier B	31%
Supplier C	26%
Supplier D	9%

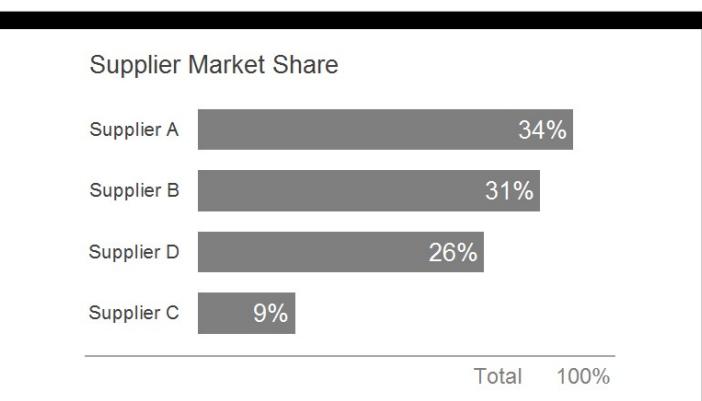
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Graphs to be avoided

Alternative to Pie chart



Supplier Market Share

Supplier	Market Share (%)
Supplier A	34%
Supplier B	31%
Supplier C	26%
Supplier D	9%

Total 100%

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Graphs to be avoided

Pie charts (Dos and Don'ts)

- Make sure that the total sum of all segments equals 100 percent.
- Use pie charts only if you have less than six categories, unless there's a clear winner you want to focus on.
- Ideally, there should be only two categories, like men and women visiting your website, or only one category, like a market share of your company, compared to the whole market.
- Don't use a pie chart if the category values are almost identical or completely different. You could add labels, but that's a patch, not an improvement.
- Don't use 3D or blow apart effects — they reduce comprehension and show incorrect proportions.

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Graphs to be avoided

3D charts

- Never use 3D to plot one or two dimensions
- Only use when really third dimension is needed
- Makes difficult to interpret number
- Makes comparisons impossible

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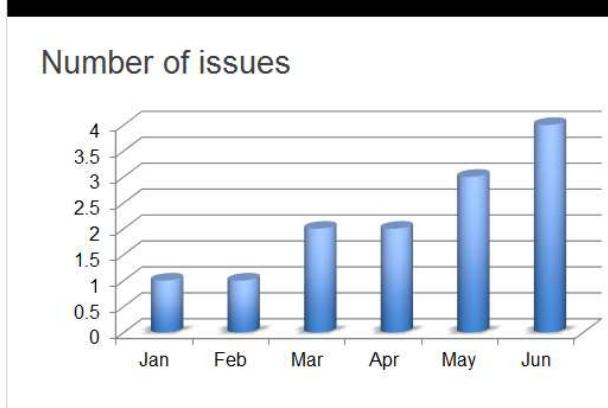
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Graphs to be avoided

3D Chart Example

Number of issues



Month	Number of issues
Jan	1.2
Feb	1.2
Mar	2.2
Apr	2.2
May	3.2
Jun	4.2

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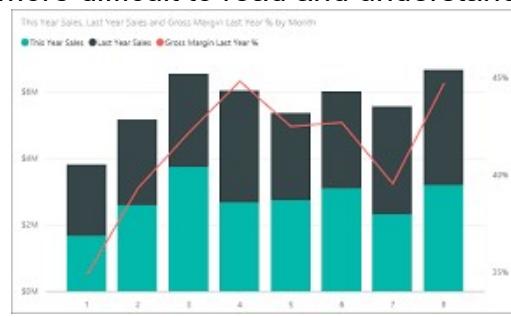
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Graphs to be avoided

Dual Axis charts

- Used when to show relationships and compare variables on vastly different scales
- Plot data using two y-axes and one shared x-axis
- Much more difficult to read and understand



This Year Sales, Last Year Sales and Gross Margin Last Year % by Month

Legend: This Year Sales (Teal), Last Year Sales (Dark Grey/Black), Gross Margin Last Year % (Pink/Red)

Month	This Year Sales (\$M)	Last Year Sales (\$M)	Gross Margin Last Year %
1	10	10	40%
2	12	12	42%
3	15	15	45%
4	14	14	43%
5	13	13	41%
6	14	14	42%
7	12	12	39%
8	16	16	44%

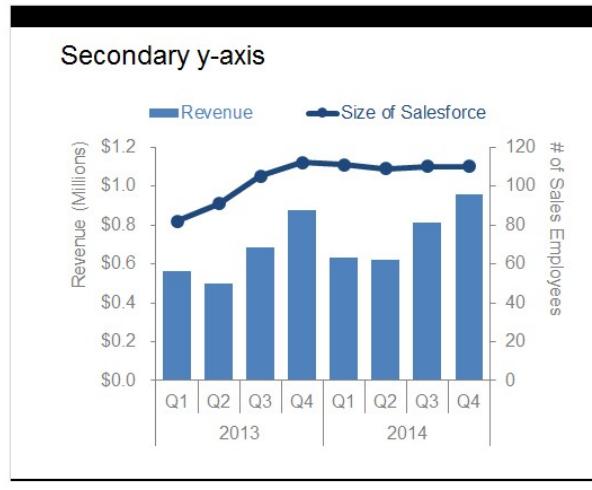
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Graphs to be avoided

Dual Axis chart Example



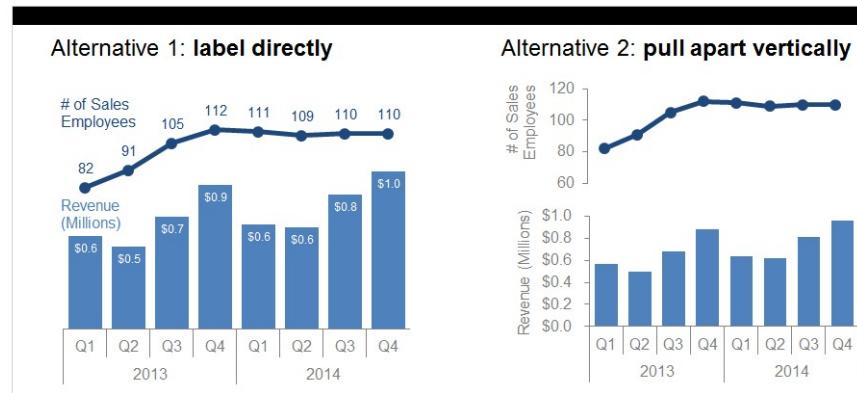
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Graphs to be avoided

Dual Axis chart Alternative



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Recap



❑ Visualization Types

❑ Text Based

- Simple text
- Table
- Heatmap

❑ Graphs

- Points
- Lines
- Bars
- Areas

❑ To be avoided

- Pie and Donut
- 3D
- Dual Axis

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Cases

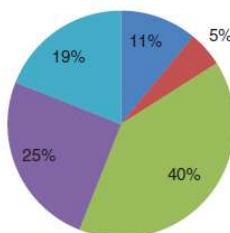


Case 1: Alternative to Pie Charts

Survey results: summer learning program on science

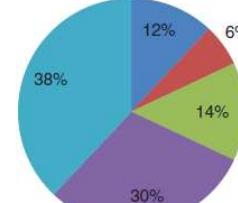
PRE: How do you feel about doing science?

■ Bored ■ Not great ■ OK ■ Kind of interested ■ Excited



POST: How do you feel about doing science?

■ Bored ■ Not great ■ OK ■ Kind of interested ■ Excited



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Case 1



Alternative 1: Use Texts to show the numbers

Pilot program was a success

After the pilot program,

68%

of kids expressed interest towards science,
compared to 44% going into the program.

Based on survey of 100 students conducted before and after pilot program (100% response rate on both surveys).

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Case 1

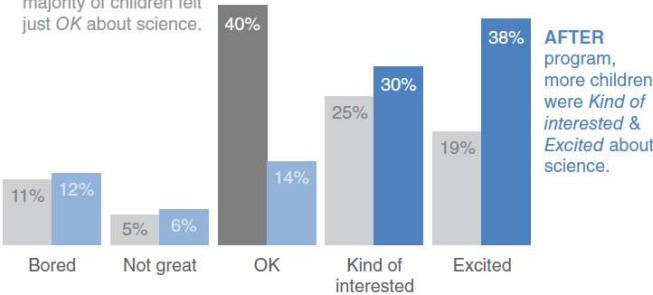


Alternative 2: Simple bar graph

Pilot program was a success

How do you feel about science?

BEFORE program, the majority of children felt just *OK* about science.



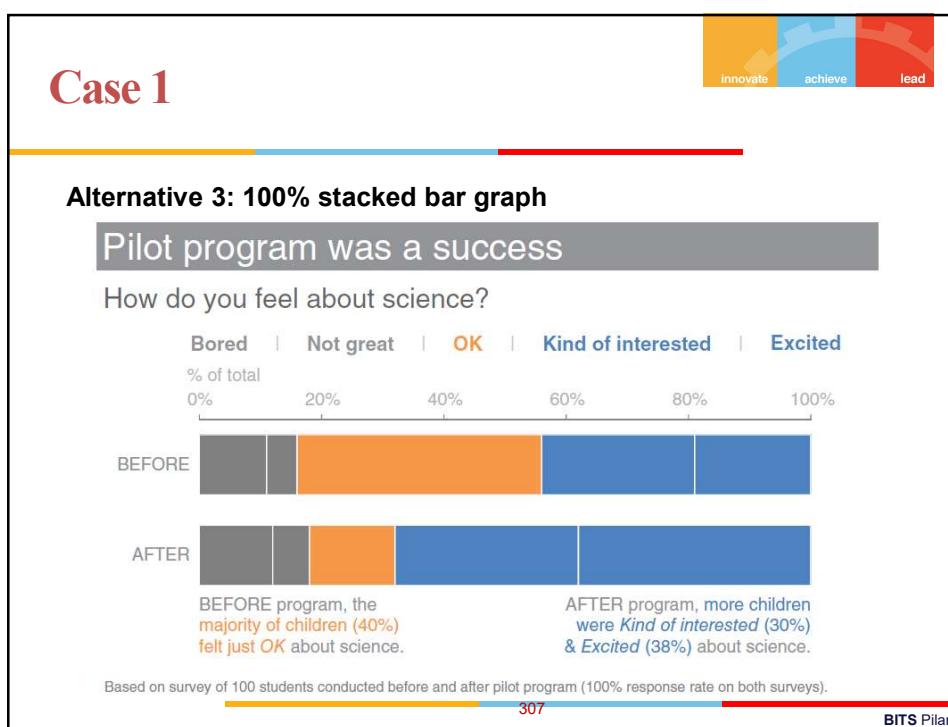
Feeling	Percentage (Before)	Percentage (After)
Bored	11%	12%
Not great	5%	6%
OK	40%	14%
Kind of interested	25%	30%
Excited	19%	38%

AFTER program, more children were *Kind of interested* & *Excited* about science.

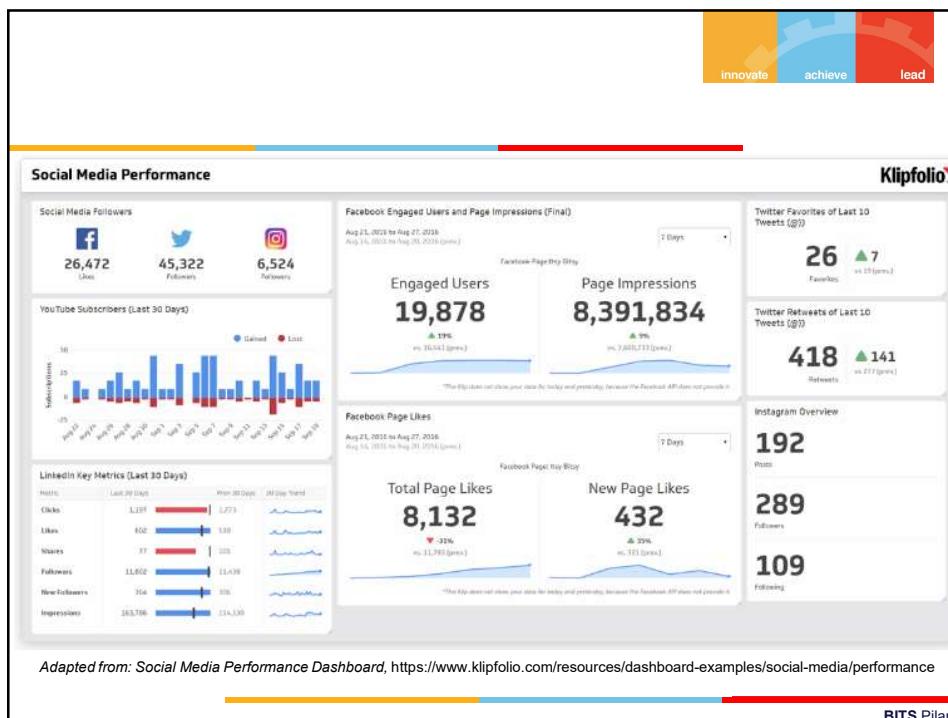
Based on survey of 100 students conducted before and after pilot program (100% response rate on both surveys).

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Agenda

- ❑ Information Dashboard
 - ✓ Definition
 - ✓ Three 3's
 - ✓ Characteristics
- ❑ Common Dashboard Design Mistakes
 - ✓ Design issues
 - ✓ Display issues
 - ✓ Data issues

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Information Dashboard

Definition

A performance dashboard is a layered information delivery system that parcels out information, insights and alerts to users on demand so they can measure, monitor and manage business performance more effectively.

-- Wayne Eckerson



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Information Dashboard

Definition

A dashboard is a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance.¹

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Information Dashboard

Dashboard

- Organization's magnifying glass
- Translates organization's strategy into objectives, measures, metrics
- Provides timely information and insights to enable business users to improve decisions, optimize processes, plans

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Information Dashboard

Lets business people

- Monitor
 - ✓ Critical business processes and activities
- Analyze
 - ✓ The root cause of problems
- Manage
 - ✓ People and processes to improve decisions, optimize processes

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Information Dashboard

Benefits

- Communicate strategy
- Refine strategy
- Increase visibility
- Increase coordination
- Consistent view of business
- Reduce costs and redundancy
- Deliver actionable information

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Three 3's




Three 3's

- Three Applications
- Three Layers
- Three Types

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Three 3's



Three Applications

- Monitoring
 - ✓ Monitor performance against metrics defined
 - ✓ Usually used at operational levels
- Analysis
 - ✓ Allows exploration of data across many dimensions
 - ✓ Helps to identify the root cause of exceptional conditions
- Management
 - ✓ Foster collaboration and decision making
 - ✓ Support executive meetings

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Three 3's



Three Applications

	Monitoring	Analysis	Management
Purpose	Provide information at one sight	Observe exceptions and drill to detail	Decide and refine business strategy
Consists of	Dashboard Scorecard BI Portals Alerts	OLAP Reporting Ad hoc queries	KPIs

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Three 3's

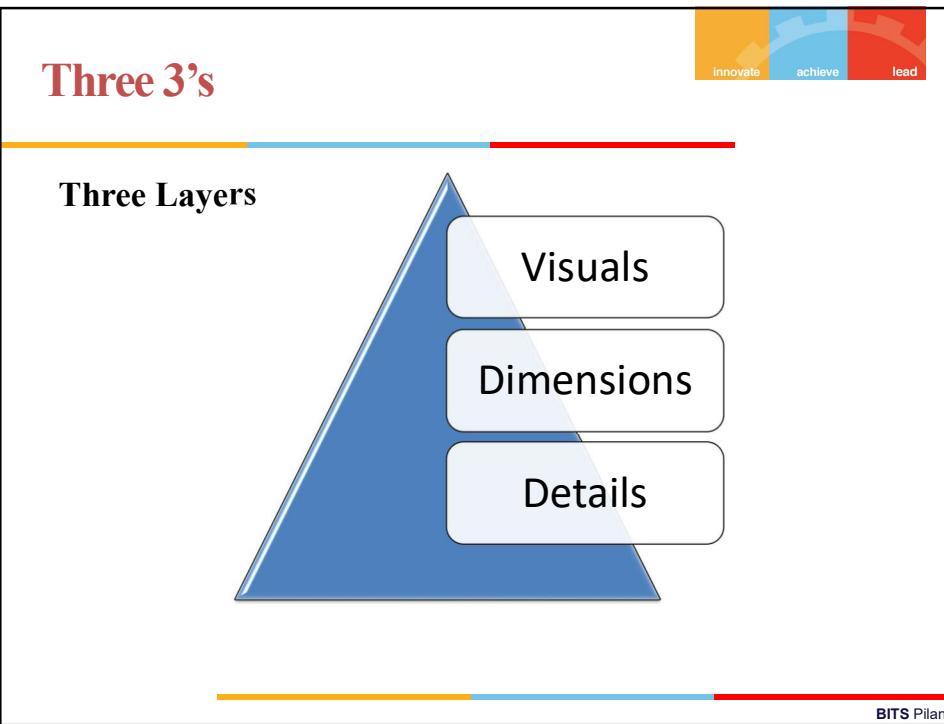


Three Layers

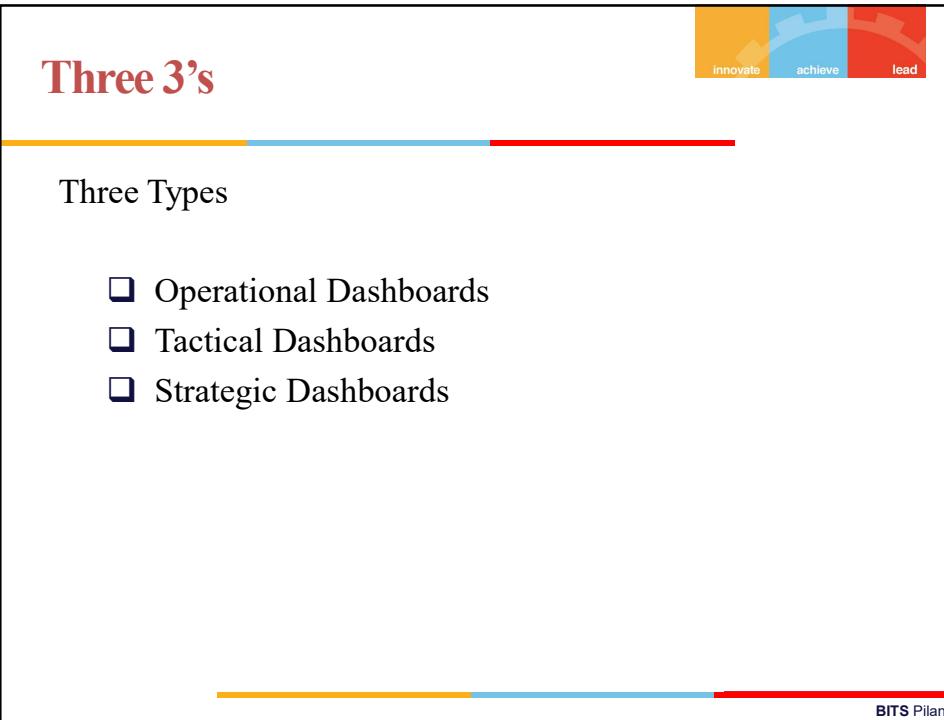
- Summarised / KPI data
- Dimensional data
- Detailed data

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320



Three 3's

Operational Dashboard

- Used by front line managers to manage processes
- Uses detailed data which is refreshed continuously
- Monitoring application

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Three 3's

Tactical Dashboard

- More emphasis on analysis
- Uses multidimensional view of data
- Monitor and manage departmental processes and projects

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Three 3's



Strategic Dashboard

- Implemented as scorecards
- Monitors execution of strategic objectives
- Used for review performance by high level executives

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Three 3's



Types comparison

	Operational	Tactical	Strategic
Objective	Processes Monitoring	Process Improvement	Strategy refinement
Level	Process	Department	Organization
Users	Front line / LOB managers	Analyst / Managers	Executives
Focus area	Act immediately	Root cause analysis	Future Perspective
Data refresh	Daily	Week or higher	Month or higher
Data	Detailed	Dimensional	Summarized

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Dashboard Characteristics

Visual Displays

- Displays information needed to achieve objective
- Fits on single computer screen
- Displays information in web browser
- Monitors information at a glance
- Small, clear, intuitive display mechanisms
- Customized

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Dashboard Design

Challenge

How to fit great amount of information into small amount of space?

--- still keeping the easily usable and understandable display

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Dashboard Design Mistakes

Design issues

1. Exceeding the boundaries of single screen
2. Meaningless Variety
3. Cluttering the display with useless decoration
4. Unattractive visual display

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Design issues

Exceeding the boundaries of single screen - segments

Executive Dashboard

Past Due Loans as a % of Total Loans
June 30, 2003

Channel	Loan Type	Balance
ALL	ALL	ALL
Less than 30 days		1.26%
30-60 Days		1.47%
More than 60 Days		1.26%
		3.98%

Figure 3-1. This dashboard fragments the data in a way that undermines the viewer's ability to see meaningful relationships.

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The dashboard features a top navigation bar with links to Product Headlines, Product Ladders, Product Insight, Promotion, Pricing, and Basket. Below the navigation is a main content area divided into several sections:

- Promoted Products - Profit:** A donut chart comparing profit for January 1, 2000, and January 10, 2000.
- Top 10 Products - Profit:** A donut chart comparing profit for January 1, 2000, and January 10, 2000.
- PC Sales:** A donut chart showing sales for January 1, 2000, and January 10, 2000.
- Product Tracker:** A section with three cards:
 - 1 QUESTION MARK:** products exhibit greater growth but lower than average volume share within the Laptops range.
 - 1 STAR product(s):** exhibit greater average growth and greater than average volume share within the Laptops range.
 - 3 DOG product(s):** exhibit lower than average growth and lower than average volume share within the Laptops range.
 - 4 CASH COW:** product(s) exhibit lower than average growth but greater than average volume share within the Laptops range.
- Top 10 Products by Units Sold - Current Full Year:** A table listing the top 10 products with columns for Rank, Product Name, Units Shipped, % Change, Contribution, and Remainder.

A large orange double-headed arrow labeled "High Growth" spans vertically between the Promoted Products and Top 10 Products sections. Another orange double-headed arrow labeled "High Volume" spans horizontally between the Product Tracker and the Top 10 Products section.

Figure 3-3. This dashboard demonstrates the effectiveness that is sacrificed when scrolling is required to see all the information.

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The dashboard has a top navigation bar with links to Sheet - Sales - Revenue, View, Index, Data, Help, and various icons. Below the navigation is a main content area with the following components:

- Revenue by Region:** A title with a small image of a globe.
- Revenue over Margin:** Three circular icons representing Barbados (red), Canada (green), and USA (yellow).
- Revenue vs Average Margin:** A line chart comparing revenue against average margin for Barbados, Canada, and USA.
- Revenue by Country:** A pie chart showing the distribution of revenue among Barbados, USA, and Canada.
- Order Method:** A bar chart comparing sales volume across different order methods: TeleSales, e-Commerce, Mail Order, and Direct Sales.
- Table:** A summary table with columns for Total Sales Net Amount, Total Sales Profit Margin, Total Number of Sales, and Average Sales Net Amount, showing data for Canada, USA, and Barbados.

Figure 3-18. This dashboard exhibits an unnecessary variety of display media.

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Design issues



Cluttering the display with useless decoration

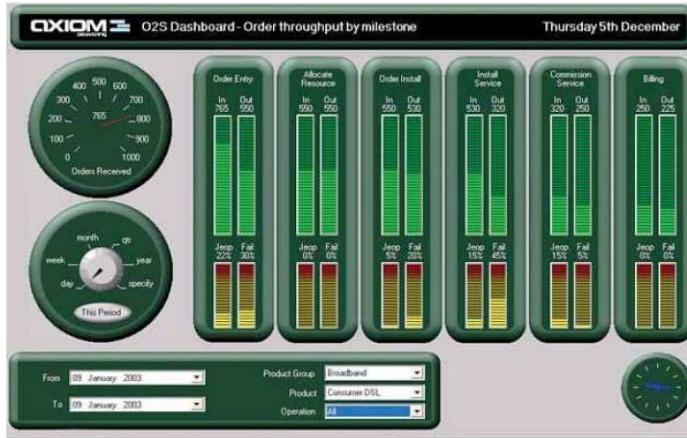


Figure 3-28. This dashboard is trying to look like something that it is not, resulting in useless and distracting decoration.

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Design issues



Cluttering the display with useless decoration

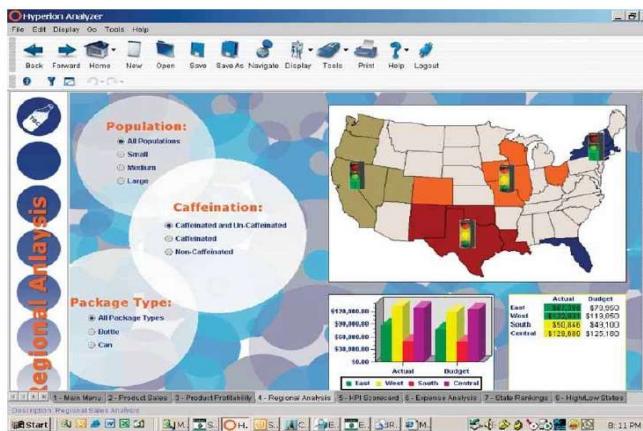


Figure 3-30. This dashboard is a vivid example of distracting ornamentation.

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Design issues

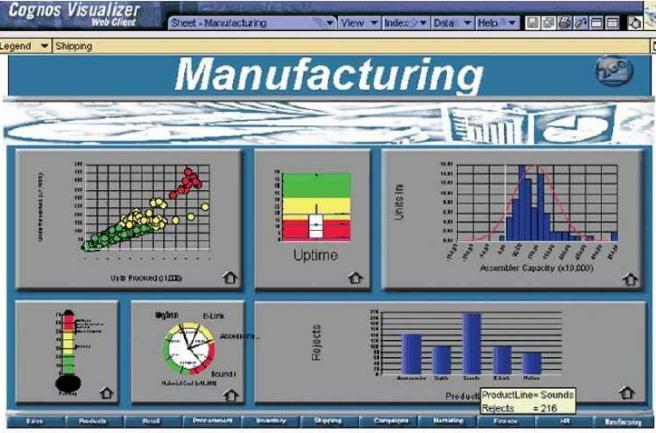


Figure 3-32. This is an example of a rather unattractive dashboard.

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Dashboard Design Mistakes

Display issues

- 5. Inappropriate display media
- 6. Poorly designed display media
- 7. Misusing or overusing colors

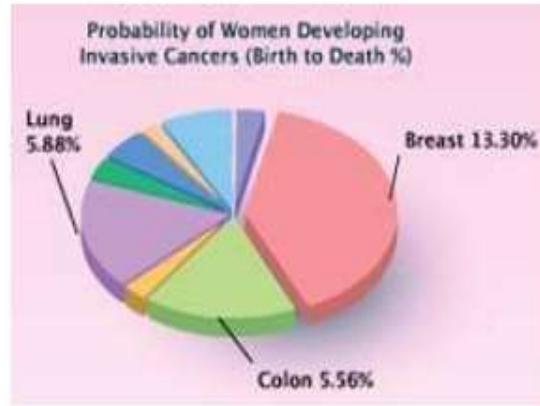
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Display issues

Inappropriate display media – Problems with Pie chart



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Display issues

Inappropriate display media

- Uses the 2D area of circles to encode their values, which needlessly obscures the data



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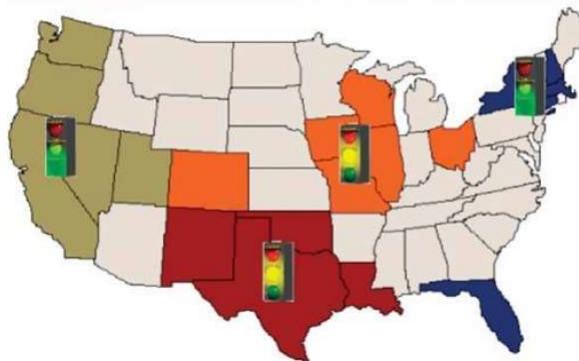
336

Display issues



Inappropriate display media

- Uselessly encodes quantitative values on a map of the US



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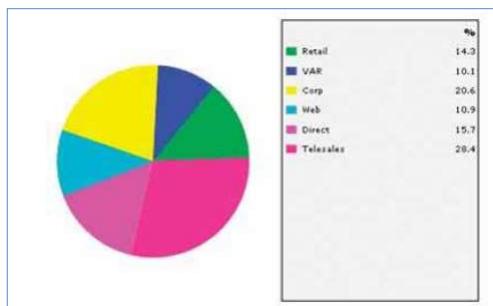
337

Display issues



Poorly designed display media

- This pie chart illustrates several design problems



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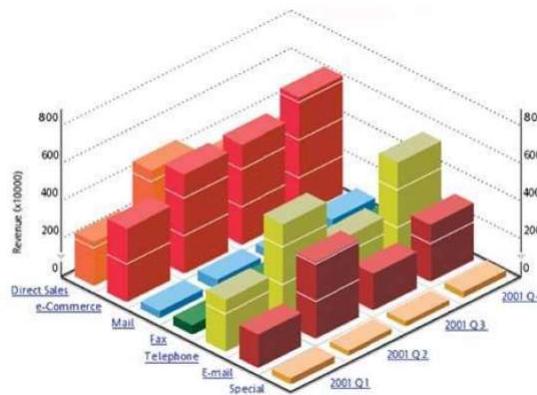
338

Display issues



Poorly designed display media

- Difficult to read for the 3D design



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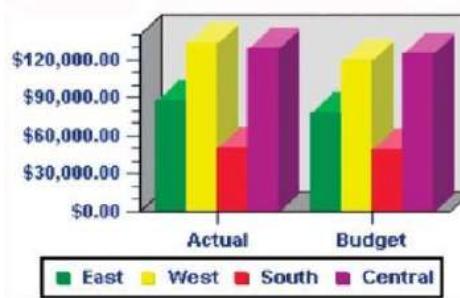
339

Display issues



Poorly designed display media

- Many examples of poor design features



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Dashboard Design Mistakes



Data issues

8. Inadequate context for the data
9. Using excessive detail or precision
10. Using deficient measure
11. Incorrect data encoding
12. Poor data arrangement
13. Ineffective data highlighting

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Data issues



Inadequate context for the data

- These dashboard gauges fail to provide adequate context to make the measures meaningful



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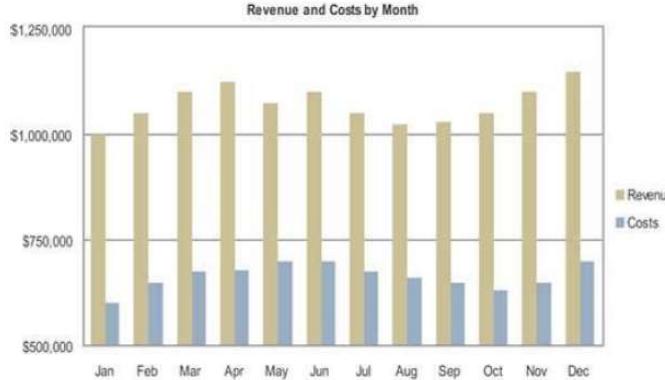
The screenshot shows the CELEQUEST Quality Yield Analysis dashboard. At the top, there's a navigation tree with 'Dashboards' selected, and under it, 'All Dashboards' and 'Bookmarked Dashboards'. Below this is a section titled 'Active Alert Messages' with a table showing several alerts, each with a subject, importance level (e.g., Normal, High), and activation date. Below the alert table are three charts: 'Board Yield Barchart', 'Board Yield Change Barchart', and 'Tests Breakdown Pie'. The 'Board Yield Barchart' shows yield percentages for different categories. The 'Board Yield Change Barchart' shows yield change percentages. The 'Tests Breakdown Pie' chart shows the distribution of test types. At the bottom, there's a 'Board Yield Table Summary' table with columns like PRODUCT_DESC, YIELD_2004, YIELD_2005, etc. The dashboard has a header with 'innovate', 'achieve', and 'lead' colored boxes.

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The screenshot shows a line graph titled 'Revenue Actual to Budget Variance'. The y-axis represents revenue in dollars from \$0 to \$120,000. The x-axis represents weeks from 1 to 20. Two lines are plotted: 'Budget' (blue line) and 'Actual' (orange line). The actual revenue generally follows the budget line but shows significant fluctuations, particularly a peak around week 15 and a dip around week 17. The graph has a header with 'innovate', 'achieve', and 'lead' colored boxes.

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Data issues



The chart displays monthly revenue and costs. Revenue is represented by brown bars and costs by blue bars. The y-axis ranges from \$500,000 to \$1,250,000. The x-axis shows months from January to December. Revenue values are consistently higher than cost values, with both showing a general upward trend over the year.

Incorrect data encoding

Revenue and Costs by Month

Month	Revenue (\$)	Costs (\$)
Jan	1,050,000	600,000
Feb	1,100,000	650,000
Mar	1,150,000	700,000
Apr	1,200,000	750,000
May	1,150,000	800,000
Jun	1,200,000	850,000
Jul	1,150,000	800,000
Aug	1,100,000	800,000
Sep	1,050,000	800,000
Oct	1,100,000	750,000
Nov	1,150,000	700,000
Dec	1,200,000	800,000

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Data issues



The dashboard is cluttered with various charts and alerts. It includes a 'My Analytics' header with tabs for My Business and My XPls. Below are several charts: 'Order Sizes' (donut chart), 'Sales' (donut chart), 'Order Size Trends' (line chart), 'Count' (donut chart), 'Profit Trends' (line chart), and 'Pareto of computer returns' (bar chart). A large alert panel on the left lists numerous notifications with checkboxes, such as 'Alerts have exceeded 40s', 'Leavers have exceeded 10m', and 'Revenue pipe for quarter 25 before target'. At the bottom right is a chart titled 'COMPUTERS RETURNS ACROSS MODELS' showing returns across three desktop models (Desktop Model 1, Desktop Model 2, Desktop Model 3) for various reasons (A through J).

Poor data arrangement

- This dashboard exemplifies poorly managed data

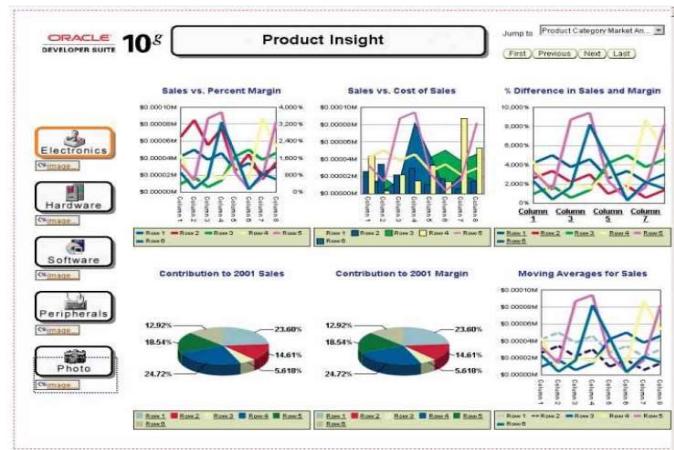
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Data issues

Ineffective data highlighting



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Recap

Information Dashboard

- ✓ Definition
- ✓ Three 3's
 - ❖ Three Applications
 - ❖ Three Layers
 - ❖ Three types
- ✓ Characteristics

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Recap

Common Dashboard Design Mistakes

- ✓ Design issues
 - ❖ Exceeding the boundaries of single screen
 - ❖ Meaningless Variety
 - ❖ Cluttering the display with useless decoration
 - ❖ Unattractive visual display
- ✓ Display issues
 - ❖ Inappropriate display media
 - ❖ Poorly designed display media
 - ❖ Misuse or overuse of colors
- ✓ Data issues
 - ❖ Inadequate context for the data
 - ❖ Using excessive detail or precision
 - ❖ Using deficient measure
 - ❖ Incorrect data encoding
 - ❖ Poor data arrangement
 - ❖ Ineffective data highlighting



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References

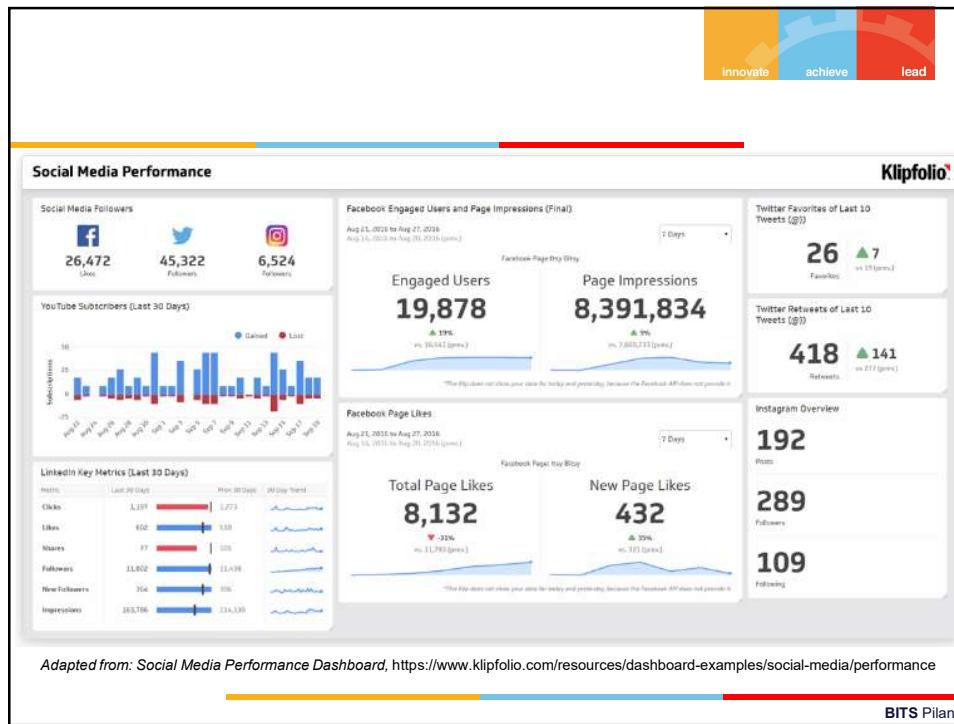
Information Dashboard Design - Stephen Few

- Chapter 1 : Clarifying the vision
- Chapter 2: Variations in Dashboard Uses and Data
- Chapter 3 : Thirteen Common Mistakes in Dashboard Design



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Contact Session 7-Agenda

inovate achieve lead

- ❑ Information Dashboard
 - ✓ Definition
 - ✓ Three 3's
 - ✓ Characteristics
- ❑ Common Dashboard Design Mistakes
 - ✓ Design issues
 - ✓ Display issues
 - ✓ Data issues

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Information Dashboard

Definition

A performance dashboard is a layered information delivery system that parcels out information, insights and alerts to users on demand so they can measure, monitor and manage business performance more effectively.

-- Wayne Eckerson

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Information Dashboard

Definition

A dashboard is a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance.¹

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Dashboard Characteristics



Visual Displays

- Displays information needed to achieve objective
- Fits on single computer screen
- Displays information in web browser
- Monitors information at a glance
- Small, clear, intuitive display mechanisms
- Customized

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Information Dashboard



Dashboard

- Organization's magnifying glass
- Translates organization's strategy into objectives, measures, metrics
- Provides timely information and insights to enable business users to improve decisions, optimize processes, plans

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Information Dashboard

Lets business people

- Monitor
 - ✓ Critical business processes and activities
- Analyze
 - ✓ The root cause of problems
- Manage
 - ✓ People and processes to improve decisions, optimize processes

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Information Dashboard

Benefits

- Communicate strategy
- Refine strategy
- Increase visibility
- Increase coordination
- Consistent view of business
- Reduce costs and redundancy
- Deliver actionable information

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Three 3's




Three 3's

- Three Applications
- Three Layers
- Three Types

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Three 3's



Three Applications

- Monitoring
 - ✓ Monitor performance against metrics defined
 - ✓ Usually used at operational levels
- Analysis
 - ✓ Allows exploration of data across many dimensions
 - ✓ Helps to identify the root cause of exceptional conditions
- Management
 - ✓ Foster collaboration and decision making
 - ✓ Support executive meetings

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Three 3's



Three Applications

	Monitoring	Analysis	Management
Purpose	Provide information at one sight	Observe exceptions and drill to detail	Decide and refine business strategy
Consists of	Dashboard Scorecard BI Portals Alerts	OLAP Reporting Ad hoc queries	KPIs

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Three 3's

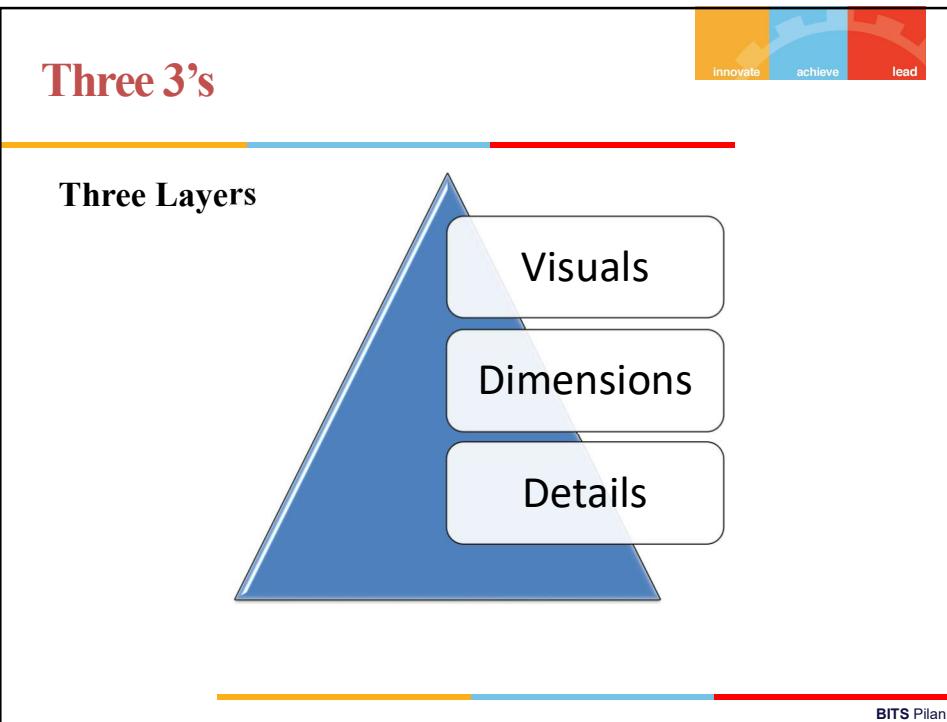


Three informational Layers

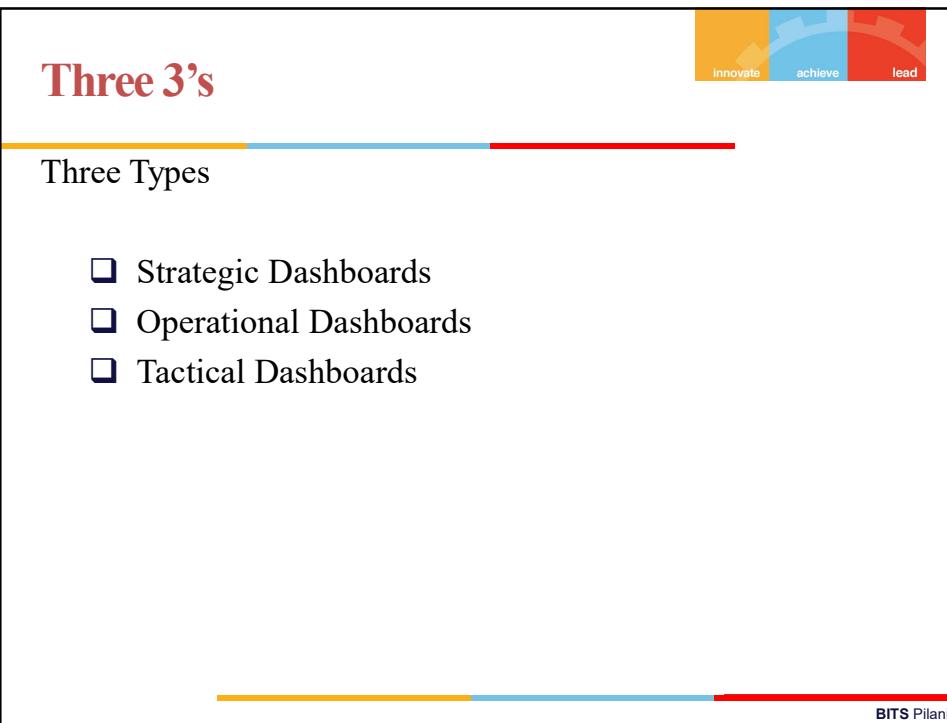
- Summarised / KPI data
- Dimensional data
- Detailed data

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Three 3's



Strategic Dashboard

- Implemented as scorecards
- Monitors execution of strategic objectives
- Used for review performance by high level executives

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Three 3's



Tactical Dashboard

- More emphasis on analysis
- Uses multidimensional view of data
- Monitor and manage departmental processes and projects

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Three 3's

Operational Dashboard

- Used by front line managers to manage processes
- Uses detailed data which is refreshed continuously
- Monitoring application

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Three 3's

Types comparison

	Operational	Tactical	Strategic
Objective	Processes Monitoring	Process Improvement	Strategy refinement
Level	Process	Department	Organization
Users	Front line / LOB managers	Analyst / Managers	Executives
Focus area	Act immediately	Root cause analysis	Future Perspective
Data refresh	Daily	Week or higher	Month or higher
Data	Detailed	Dimensional	Summarized

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Dashboard Design



Challenge

How to fit great amount of information into small amount of space?

--- still keeping the easily usable and understandable display

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Dashboard Design Mistakes



Design issues

1. Exceeding the boundaries of single screen
2. Meaningless Variety
3. Cluttering the display with useless decoration
4. Unattractive visual display

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Dashboard Design Mistakes



Display issues

5. Inappropriate display media
6. Poorly designed display media
7. Misusing or overusing colors

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Dashboard Design Mistakes



Data issues

8. Inadequate context for the data
9. Using excessive detail or precision
10. Using deficient measure
11. Incorrect data encoding
12. Poor data arrangement
13. Ineffective data highlighting

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Design issues

innovate achieve lead

Exceeding the boundaries of single screen - segments

Figure 3-1. This dashboard fragments the data in a way that undermines the viewer's ability to see meaningful relationships.

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Design issues

innovate achieve lead

Exceeding the boundaries of single screen - scrolling

Figure 3-3. This dashboard demonstrates the effectiveness that is sacrificed when scrolling is required to see all the information.

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Data issues

Inadequate context for the data

- These dashboard gauges fail to provide adequate context to make the measures meaningful

October Units YTD Units Returns Rate

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Data issues

Using excessive detail or precision

The screenshot shows the CELEQUEST software interface with several data visualizations and tables related to board yield analysis. At the top, there's a navigation tree for dashboards and a message center showing 'Active Alert Messages' for various yield drop incidents. Below this are three charts: 'Board Yield Barchart', 'Board Yield Change Barchart', and 'Tests Breakdown Pie'. The bottom section contains a 'Board Yield Table Summary' with detailed data for specific board components like ASY1_16PORT_Card, ASY1_16PORT_Card_01_SW2000, and ASY1_2PULL_LENGTH. The table includes columns for Product_ID, Model_ID, Yield, Yield_Change, and Yield_Change_Percentage.

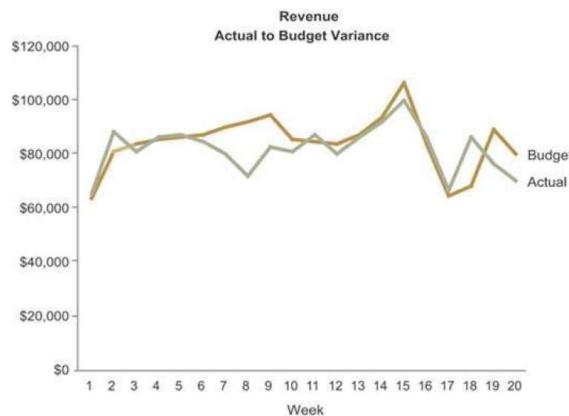
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Data issues



Using deficient measure



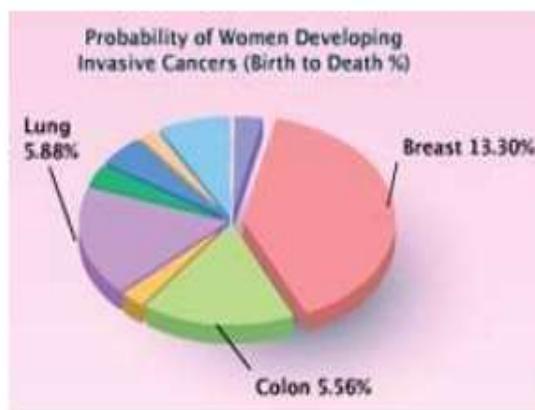
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Display issues



Inappropriate display media – Problems with Pie chart



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Display issues

Inappropriate display media
- Uselessly encodes quantitative values on a map of the US

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Design issues

Meaningless Variety

	Total Sales Net Amount	Total Sales Profit Margin	Total Number of Sales	Average Sales Net Amount
1 Canada	\$340,924,098	\$18,480,765	10,760	\$31,400
2 USA	\$413,95K	\$195,27K	206	\$1,400K
3 Barbados	\$113,27K	\$11,48K	31	\$4,99K

Figure 3-18. This dashboard exhibits an unnecessary variety of display media.

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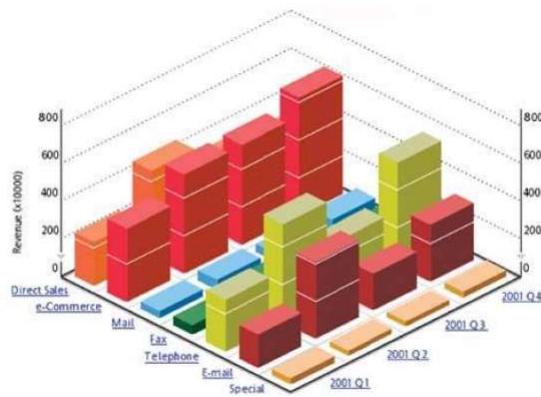
380



Display issues

Poorly designed display media

- Difficult to read for the 3D design



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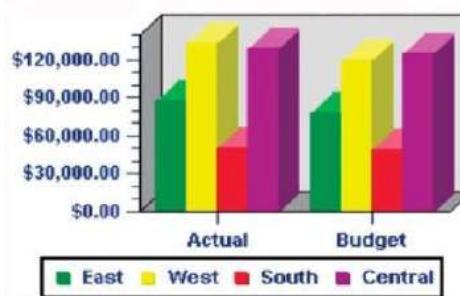
381



Display issues

Poorly designed display media

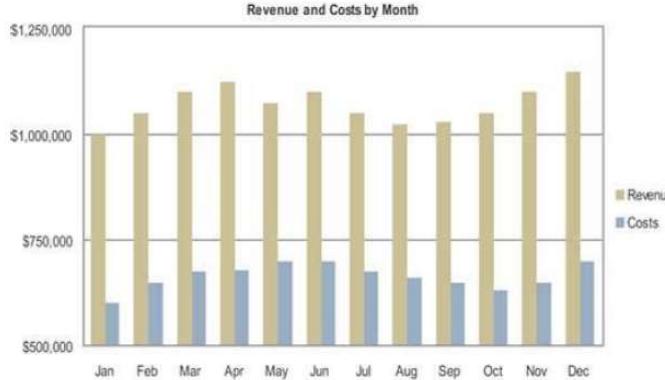
- Many examples of poor design features



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Data issues



The chart displays monthly revenue and costs. Revenue is represented by brown bars and costs by blue bars. The y-axis ranges from \$500,000 to \$1,250,000. The x-axis shows months from January to December. Revenue values are approximately: Jan (\$1,050,000), Feb (\$1,100,000), Mar (\$1,150,000), Apr (\$1,200,000), May (\$1,100,000), Jun (\$1,150,000), Jul (\$1,050,000), Aug (\$1,000,000), Sep (\$1,050,000), Oct (\$1,100,000), Nov (\$1,150,000), Dec (\$1,200,000). Cost values are approximately: Jan (\$600,000), Feb (\$650,000), Mar (\$680,000), Apr (\$680,000), May (\$700,000), Jun (\$720,000), Jul (\$680,000), Aug (\$680,000), Sep (\$680,000), Oct (\$650,000), Nov (\$680,000), Dec (\$700,000).

Incorrect data encoding

Revenue and Costs by Month

Revenue Costs

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

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Data issues



The dashboard features several data visualizations and an alert panel. The alert panel lists various notifications such as 'Alerts have exceeded 40s', 'Levers have exceeded 100s', and 'Revenue pipe for quarter 25 before target'. The main area includes a 'Order Sizes' donut chart, a 'Sales' donut chart, a 'Order Size Trends' line graph, a 'Count' pie chart, a 'Profit Trends' line graph, and a 'Pareto of computer returns' chart. Below these is a section titled 'COMPUTERS RETURNS ACROSS MODELS' showing three bar charts for Desktop Model 1, Desktop Model 2, and Desktop Model 3 across categories A through J.

My Analytics My Business My XPls

Order Sizes Sales Order Size Trends Count Profit Trends

Alerts

Pareto of computer returns

Do Action Subject Date

- Alerts have exceeded 40s Jun 6, 2001
- Levers have exceeded 100s Jun 6, 2001
- Revenue pipe for quarter 25 before target Jun 6, 2001
- Larar orders below all Jun 6, 2001
- Stocks at 5% of re-order level Jun 6, 2001
- Profit trend information updated Nov 21, 2001
- Levers Trend increasing Nov 21, 2001

Computers Returns Across Models

Desktop Model 1 Desktop Model 2 Desktop Model 3

A: Setup Difficulty - B: Not Easy to Use - C: Won't Print - D: Not Fast Enough - E: Wrong Manual
F: Worst Staff - G: Internet Inoperative - H: Missing Card - I: Screen Smell - J: Too Heavy
K: Incompatible - L: Other

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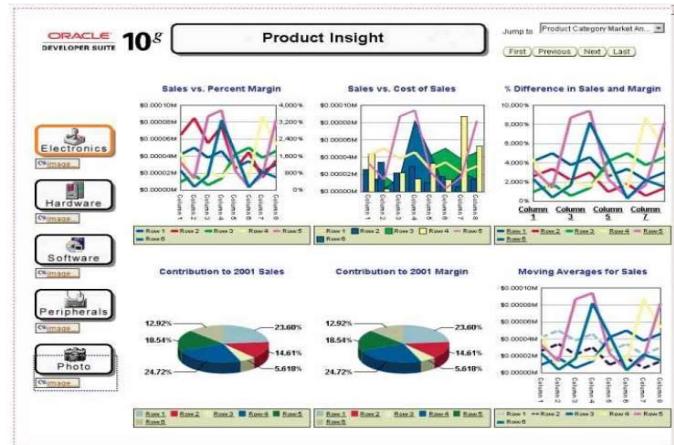
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Data issues

Ineffective data highlighting



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Design issues

Cluttering the display with useless decoration

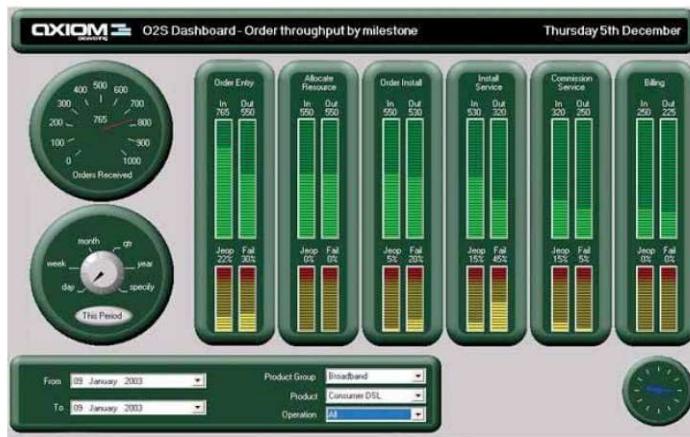


Figure 3-28. This dashboard is trying to look like something that it is not, resulting in useless and distracting decoration.

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Design issues

Cluttering the display with useless decoration

The dashboard is titled 'Hyperion Analyzer' and contains several charts and maps. On the left, there are three circular icons labeled 'Regional Analysis'. In the center, there are three main sections: 'Population' (with categories All Populations, Small, Medium, Large), 'Caffeination' (with categories Caffeinated and Un Caffeinated, Caffeinated, Non-Caffeinated), and 'Package Type' (with categories All Package Types, Bottle, Can). To the right, there is a map of the United States where states are colored according to their population size. Below the map is a bar chart comparing Actual vs. Budget for East, West, South, and Central regions. At the bottom, there is a table showing Actual and Budget values for these regions. The dashboard has a cluttered appearance with many overlapping elements and a busy color palette.

Figure 3-30. This dashboard is a vivid example of distracting ornamentation.

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Design issues

Unattractive visual display

The dashboard is titled 'Manufacturing' and features a blue header with the word 'Manufacturing' in large white letters. Below the header are six data visualization cards arranged in a grid. From top-left to bottom-right, the cards are: 1. A scatter plot titled 'Uptime' showing data points for 'Uptime' and 'Latency'. 2. A bar chart titled 'Uptime' showing 'Uptime' across different categories. 3. A histogram titled 'Uptime' showing 'Uptime' distribution. 4. A gauge titled 'Uptime' showing a value of 95%. 5. A donut chart titled 'Projects' showing project status. 6. A bar chart titled 'Products' showing 'ProductLine' and 'Rejects' with a total of 216 rejects. The overall design is dark and lacks visual appeal, with a focus on functional data representation over aesthetic presentation.

Figure 3-32. This is an example of a rather unattractive dashboard.

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Recap



Information Dashboard

- ✓ Definition
- ✓ Three 3's
 - ❖ Three Applications
 - ❖ Three Layers
 - ❖ Three types
- ✓ Characteristics

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Recap



Common Dashboard Design Mistakes

- ✓ Design issues
 - ❖ Exceeding the boundaries of single screen
 - ❖ Meaningless Variety
 - ❖ Cluttering the display with useless decoration
 - ❖ Unattractive visual display
- ✓ Display issues
 - ❖ Inappropriate display media
 - ❖ Poorly designed display media
 - ❖ Misuse or overuse of colors
- ✓ Data issues
 - ❖ Inadequate context for the data
 - ❖ Using excessive detail or precision
 - ❖ Using deficient measure
 - ❖ Incorrect data encoding
 - ❖ Poor data arrangement
 - ❖ Ineffective data highlighting

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References

Information Dashboard Design - Stephen Few

- Chapter 1 : Clarifying the vision
- Chapter 2: Variations in Dashboard Uses and Data
- Chapter 3 : Thirteen Common Mistakes in Dashboard Design

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Anscombe's Quartet

- Anscombe stated that you can't just use summary statistics to understand the data, you have to visualize it
- It's not to say that summary statistics aren't important. They are absolutely essential, but you must also visualize it

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Anscombe's Quartet



This is the data that Francis Anscombe used.

x1	y1	x2	y2	x3	y3	x4	y4
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.10	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.10	4	5.39	8	5.56
12	10.84	12	9.13	12	8.15	19	12.50
7	4.82	7	7.26	7	6.42	8	7.91
5	5.68	5	4.74	5	5.73	8	6.89
x1	y1	x2	y2	x3	y3	x4	y4

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Anscombe's Quartet



	x1	y1	x2	y2	x3	y3	x4	y4
10	8.04	10	9.14	10	7.46	8	6.58	
8	6.95	8	8.14	8	6.77	8	5.76	
13	7.58	13	8.74	13	12.74	8	7.71	
9	8.81	9	8.77	9	7.11	8	8.84	
11	8.33	11	9.26	11	7.81	8	8.47	
14	9.96	14	8.10	14	8.84	8	7.04	
6	7.24	6	6.13	6	6.08	8	5.25	
4	4.26	4	3.10	4	5.39	8	5.56	
12	10.84	12	9.13	12	8.15	19	12.50	
7	4.82	7	7.26	7	6.42	8	7.91	
5	5.68	5	4.74	5	5.73	8	6.89	
x1	y1	x2	y2	x3	y3	x4	y4	
Mean of x	9	9		9		9		
Variance of x	11		11		11		11	
Mean of y		7.5		7.5		7.5		
Variance of y		4.122		4.122		4.122		
Correlation between								
x & y	0.816	0.816		0.816		0.816		
	y1 = 3 + 0.5x1	y2 = 3 + 0.5x2		y3 = 3 + 0.5x3		y4 = 3 + 0.5x4		

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Anscombe's Quartet

- So one would naturally assume that the sets would look roughly the same when shown visually.
- However, once plotted, we realise this is far from the truth.

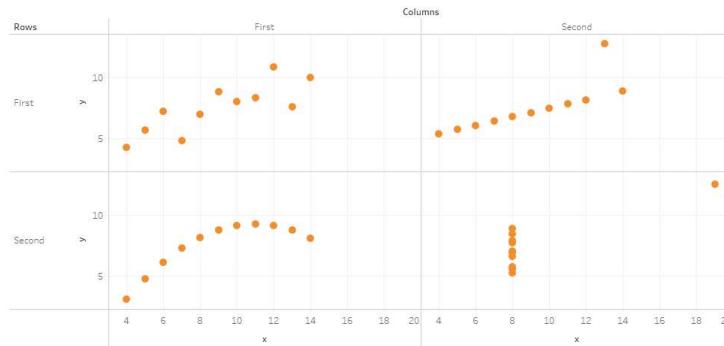
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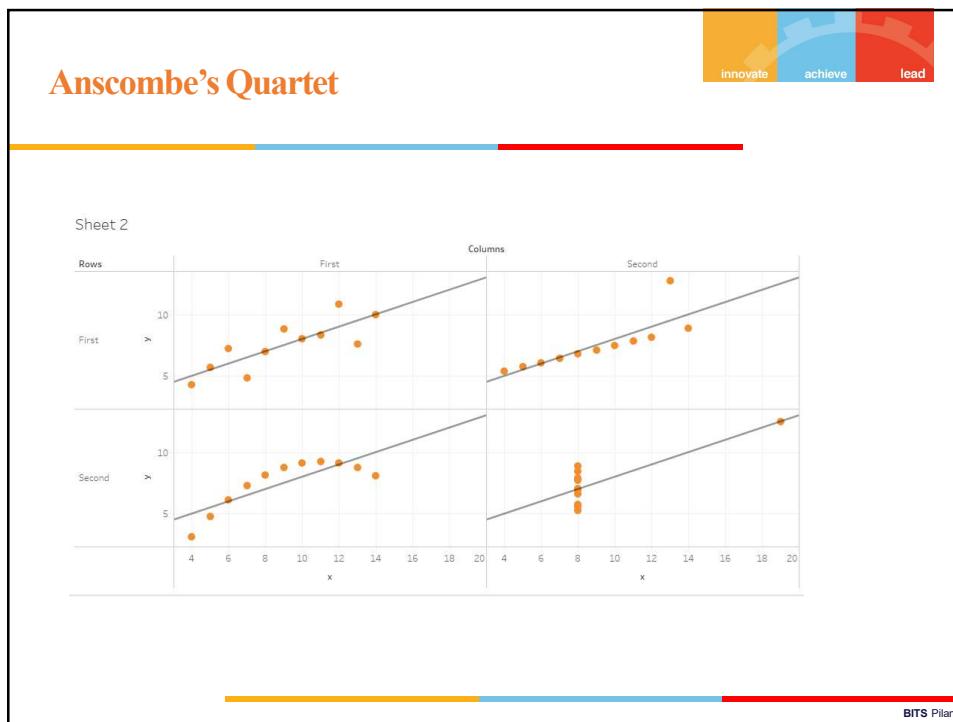
Anscombe's Quartet

Sheet 2

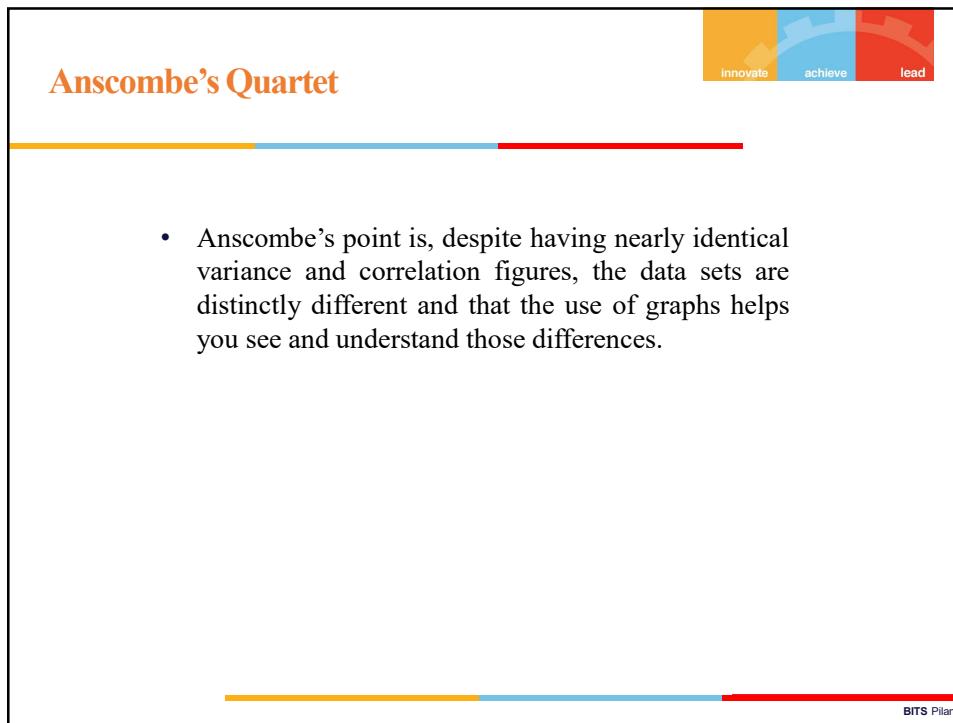


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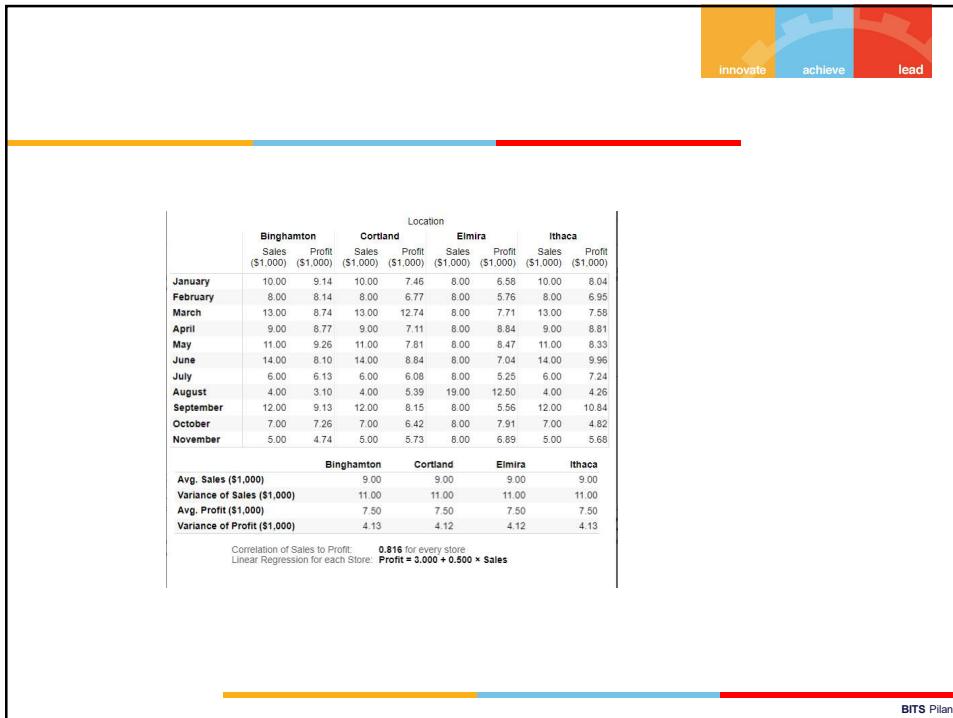
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