

# **SURFACING & SOLVING PROBLEMS**

## **TOOLS FOR CONTINUOUS IMPROVEMENT**

***Presented By: Maria Friedman  
Chicago, IL  
July 15, 2015***

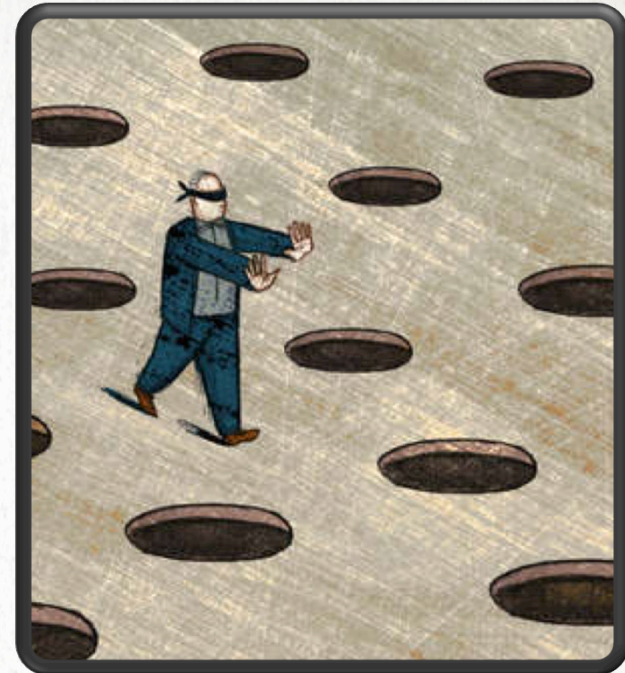
# AGENDA

- Introduction to Continuous Improvement
  - The 7 Basic Quality Tools
  - Scenarios
-



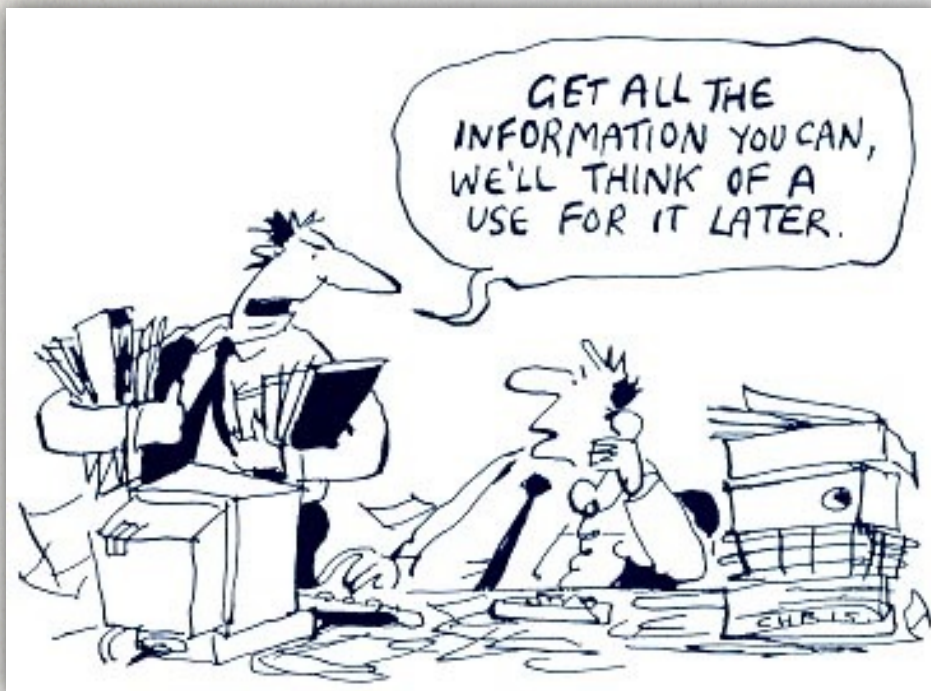
# INTRODUCTION

**Data are critical  
for any  
continuous  
improvement  
initiative**





# INTRODUCTION



**Measurements are the primary driver of improvement, and measurements mean generating data**



# INTRODUCTION



**Top management decisions are typically based on data**



# INTRODUCTION

**It is easier to gain  
their buy-in for a  
continuous  
improvement  
initiative when  
plans and  
projected outputs  
are backed by  
data**





# 7 BASIC QUALITY TOOLS

- Cause-and-effect diagrams
- Check sheets
- Flow charts
- Run charts
- Histograms
- Pareto charts
- Scatter diagrams





# 7 BASIC QUALITY TOOLS

- Cause-and-effect diagrams
- Check sheets
- Flow charts
- **Run charts**
- **Histograms**
- **Pareto charts**
- **Scatter diagrams**





**WHY?**

---

1	Jan-10	165	95%	4.2%	7	85%	3072	82	2.7%	100%	175	88%	11%
1	Jan-11	164	95%	4.3%	7	84%	3015	46	1.5%	100%	177	87%	12%
1	Jan-12	184	86%	12.0%	22	12%	3067	81	0.0%	0%	176	85%	14%
1	Jan-13	174	89%	10.9%	19	34%	2983	180	6.0%	0%	177	84%	15%
2	Feb-10	177	89%	9.6%	17	31%	3117	71	2.3%	100%	180	87%	12%
2	Feb-11	164	96%	3.0%	5	95%	2908	44	1.5%	100%	180	89%	10%
2	Feb-12	184	81%	17.9%	33	0%	2239	139	6.2%	0%	180	92%	7%
2	Feb-13	174	88%	12.1%	21	24%	3244	89	2.7%	50%	177	95%	5.1%
3	Mar-10	176	90%	8.5%	15	40%	3688	95	2.6%	100%	182	75%	24.7%
3	Mar-11	174	96%	3.4%	6	91%	3627	56	1.5%	100%	179	93%	5.0%
3	Mar-12	184	77%	22.3%	41	0%	3535	234	6.6%	0%	177	96%	4.0%
3	Mar-13	174	86%	14.4%	25	5%	3311	100	3.0%	32%	184	78%	20.7%
4	Apr-10	173	90%	9.2%	16	38%	3105	58	1.9%	100%	178	90%	8.4%
4	Apr-11	174	96%	4.0%	7	91%	3042	52	1.7%	100%	182	95%	5.5%
4	Apr-12	184	74%	25.0%	46	0%	3247	412	12.7%	0%	180	91%	7.8%
4	Apr-13	173	81%	19.1%	33	0%	2959	77	2.6%	60%	180	94%	4.4%
5	May-10	180	94%	4.4%	8	74%	3028	71	2.3%	100%	177	96%	4.0%
5	May-11	177	96%	4.0%	7	92%	3203	34	1.1%	100%	180	68%	30.0%
5	May-12	180	68%	30.0%	54	0%	3242	98	3.0%	0%	169	77%	23.1%
5	May-13	169	77%	23.1%	39	0%	2718	120	4.4%	0%	181	93%	5.0%
6	Jun-10	181	93%	5.0%	9	65%	3156	77	2.4%	100%	177	95%	5.1%
6	Jun-11	177	95%	5.1%	9	83%	3105	61	2.0%	100%	182	75%	24.7%
6	Jun-12	182	75%	24.7%	45	0%	3320	390	11.7%	0%	179	93%	5.0%
7	Jul-10	179	93%	5.0%	9	64%	2908	82	2.8%	100%	170	88%	10.0%
7	Jul-11	177	96%	4.0%	7	92%	3132	47	1.5%	100%	188	87%	12.8%
7	Jul-12	184	78%	20.7%	38	0%	3030	265	8.7%	0%	179	95%	5.0%
8	Aug-10	178	90%	8.4%	15	41%	3016	75	2.5%	100%	169	92%	7.1%
8	Aug-11	182	95%	5.5%	10	79%	3436	53	1.5%	100%	185	89%	10.3%
8	Aug-12	180	91%	7.8%	14	51%	3212	116	3.6%	0%	174	89%	9.6%
9	Sep-10	181	87%	11.0%	20	19%	2715	65	2.4%	100%	180	96%	3.0%
9	Sep-11	184	93%	6.0%	11	66%	2865	33	1.2%	100%	177	81%	17.9%
9	Sep-12	180	93%	6.1%	11	69%	2987	97	3.2%	0%	180	88%	12.1%
10	Oct-10	179	91%	7.8%	14	46%	2908	65	2.2%	100%	169	90%	8.5%
10	Oct-11	188	91%	7.4%	14	54%	3353	46	1.4%	100%	181	96%	3.4%
10	Oct-12	179	93%	6.7%	12	69%	3406	76	2.2%	51%	177	77%	22.3%
11	Nov-10	170	88%	10.0%	17	27%	3361	67	2.0%	100%	182	86%	14.4%
11	Nov-11	188	87%	12.8%	24	14%	3483	64	1.8%	100%	179	90%	9.2%
11	Nov-12	179	95%	5.0%	9	83%	3299	106	3.2%	0%	177	96%	4.0%
12	Dec-10	169	92%	7.1%	12	61%	2957	64	2.2%	100%	184	74%	25.0%



# WHY?

The 7 Basic Quality Tools are graphical problem-solving methods

Puts the brain's innate ability to recognize patterns to work; enables users to make decisions using visual cues

"I don't know what I'm looking for, but I'll know it when I see it!"

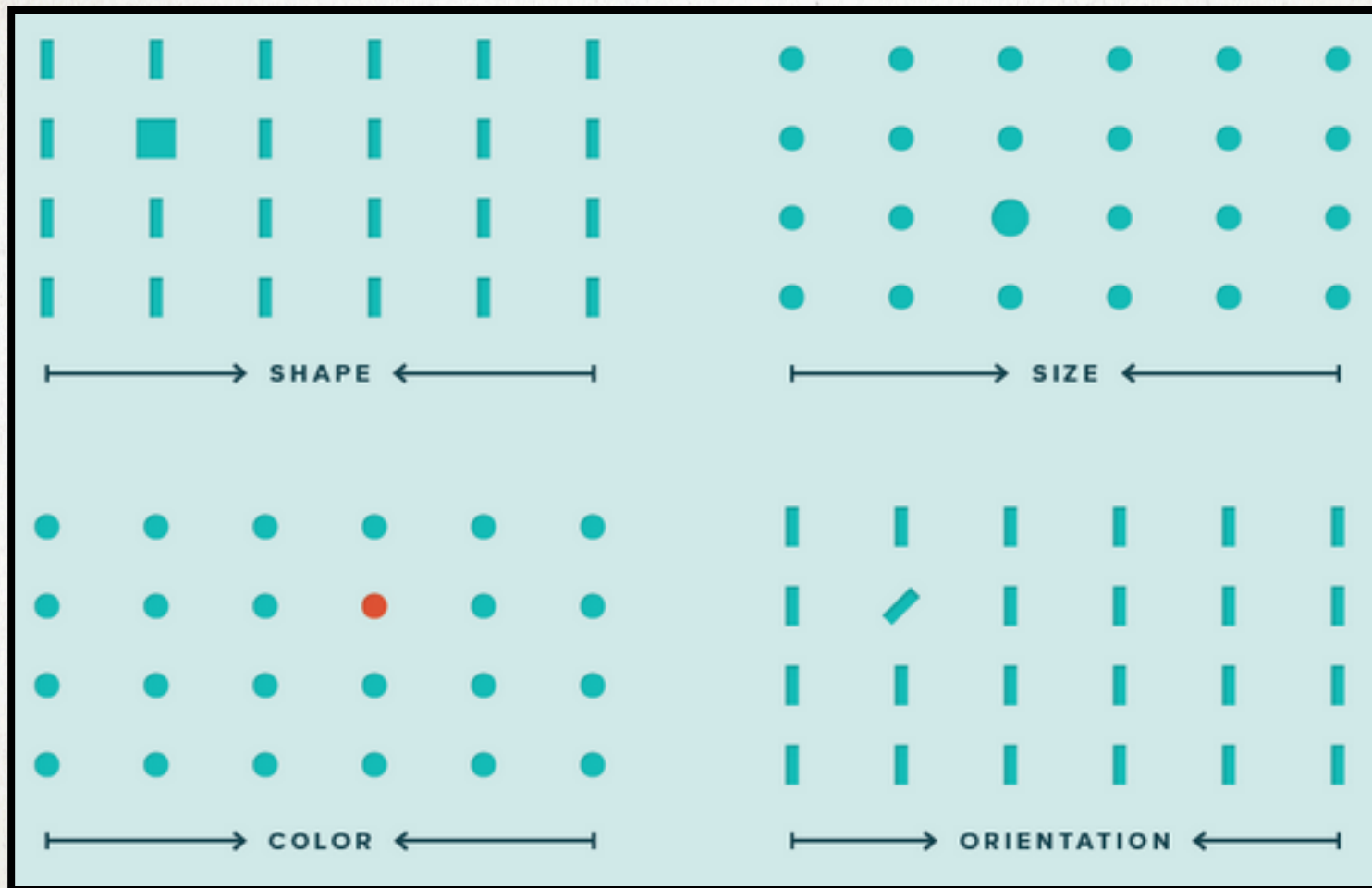


# GRAPHICS VS TABLES

Tabular data is processed in our brain sequentially into our short term memory; visual data is processed in its entirety almost immediately into our long term memory

Our brains automatically interpret relationships between objects, allowing for almost instant comprehension with minimal effort

Notice how quickly your eye finds variations  
in these attributes.,,

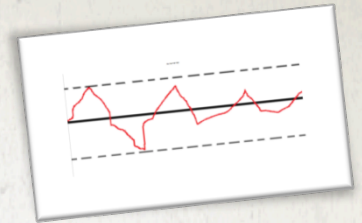




# QUALITY TOOLS

---

# RUN CHARTS



Used to see trends in data

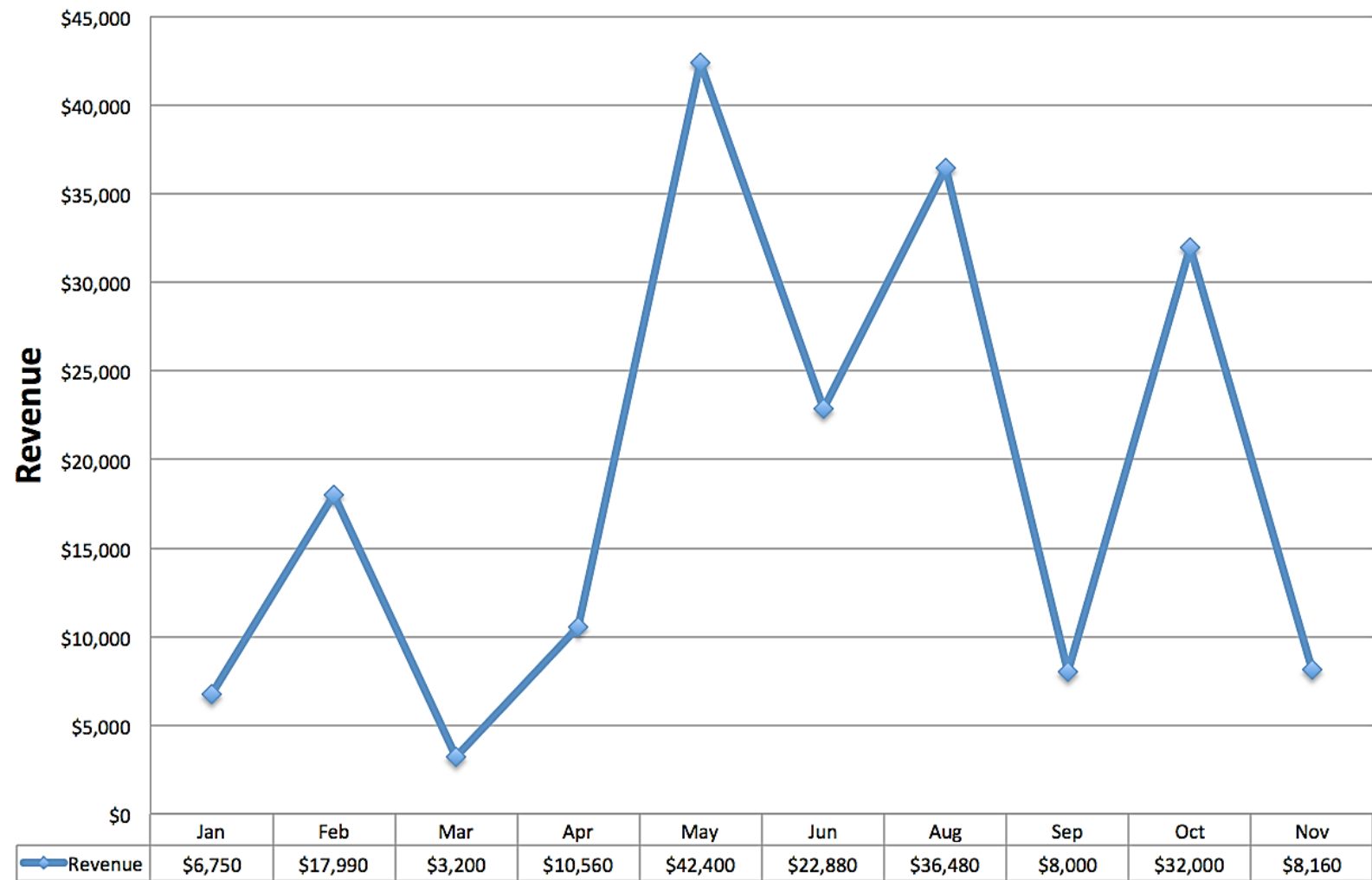
Help to visualize a process over time

Typically used to measure against a goal or specification

When control limits (e.g., LCS, MS/MSD) are calculated and plotted on a run chart, that chart is commonly referred to as a control chart



# RUN CHART - EXAMPLE



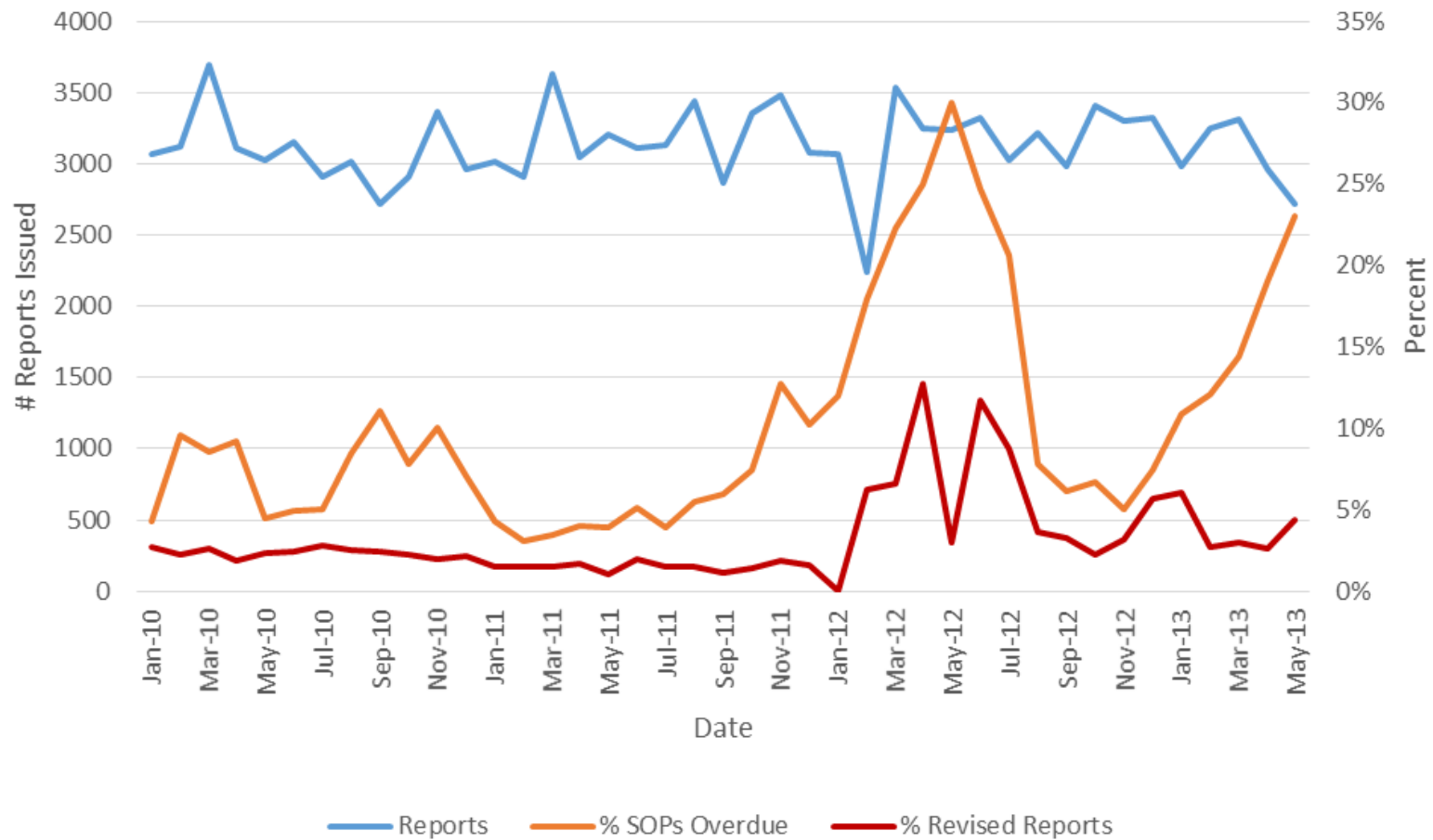
# CORRELATION VIA RUN CHARTS

Multi-axis run charts often used to find correlation between related data sets



# RUN CHART – EXAMPLE

REVISED REPORTS AND OVERDUE SOPS VS REPORTS ISSUED



# RUN CHART: LIMITATIONS

Beware of spurious correlations

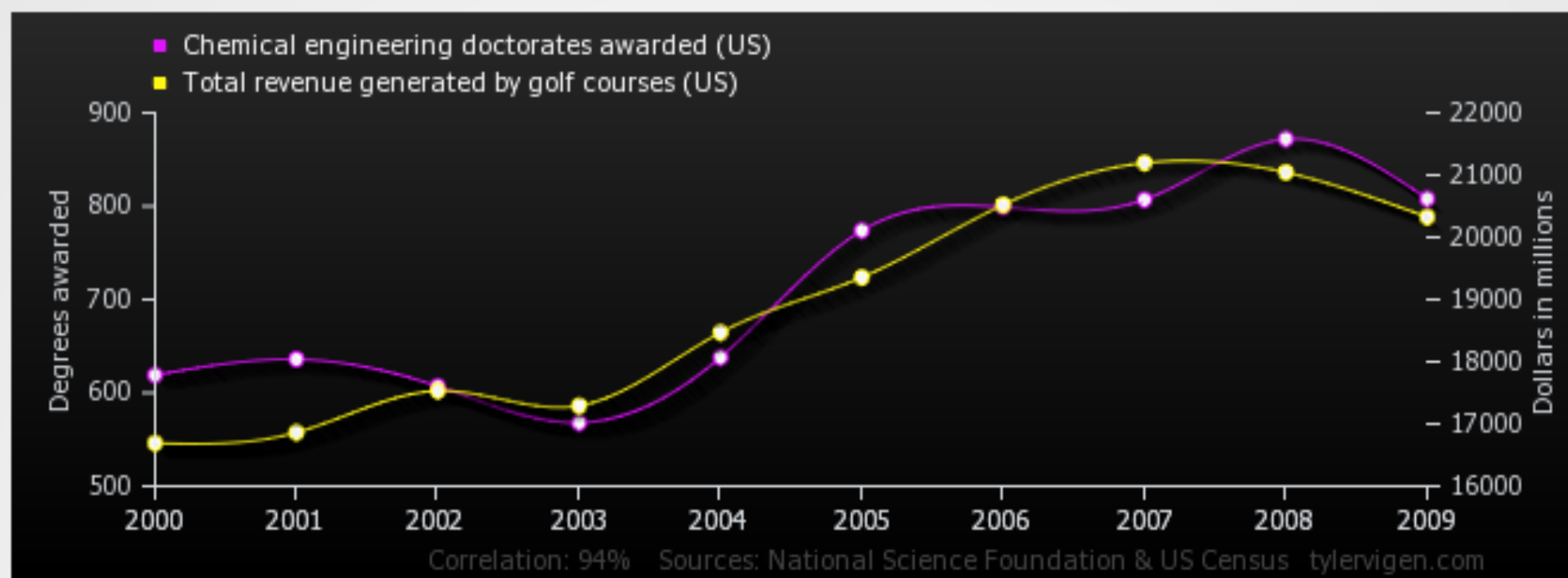
“Correlation does not imply causation”



# Chemical engineering doctorates awarded (US)

correlates with

## Total revenue generated by golf courses (US)



[Upload this image to imgur](#)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Chemical engineering doctorates awarded (US) Degrees awarded (National Science Foundation)	619	636	607	568	638	774	799	807	872	808
Total revenue generated by golf courses (US) Dollars in millions (US Census)	16,692	16,862	17,533	17,291	18,469	19,356	20,523	21,195	21,044	20,326

**Correlation: 0.938017**

## Per capita consumption of margarine

Upload this image to imgur

**Correlation: 0.992558**



# HISTOGRAM



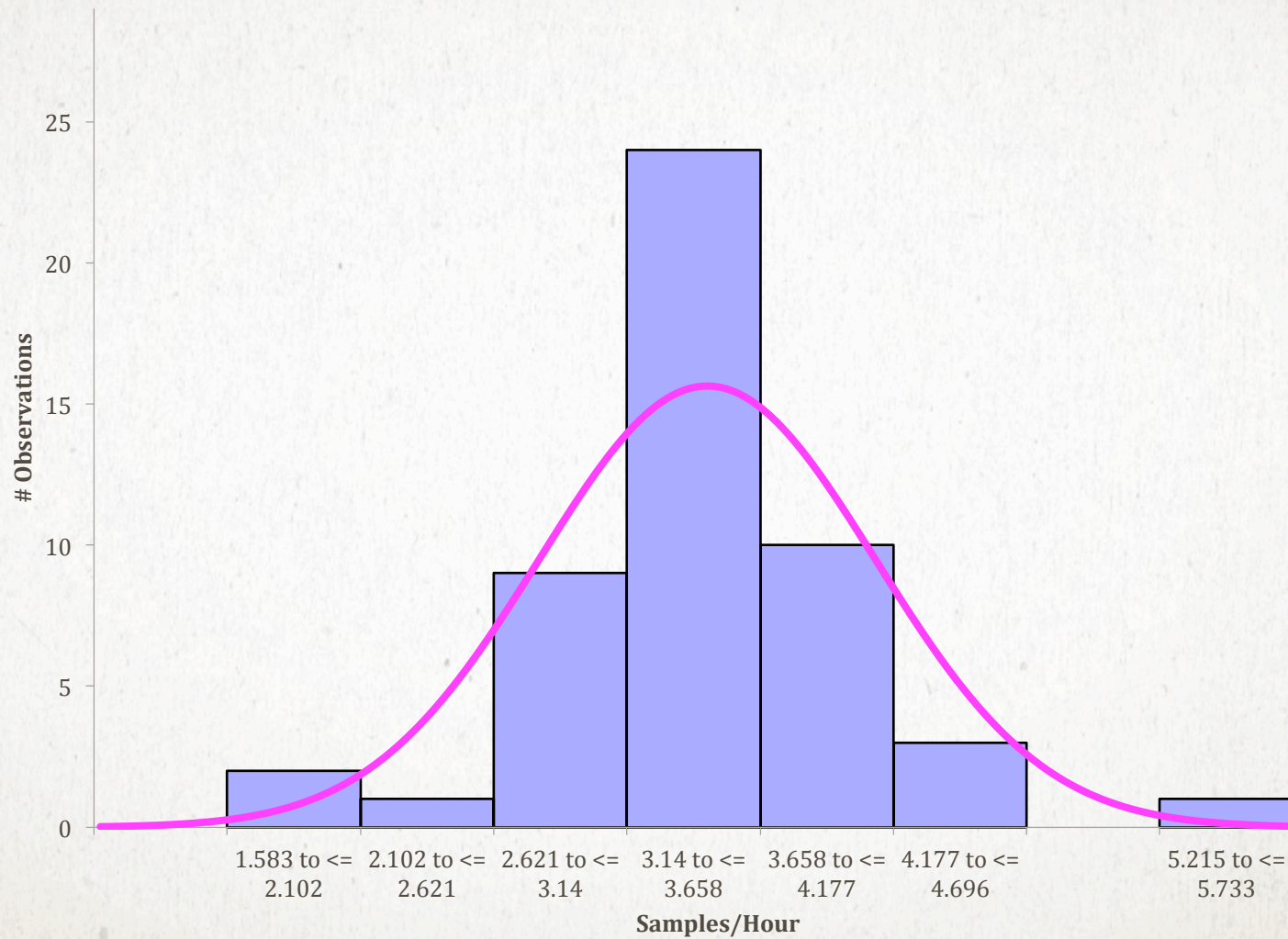
Plots frequency of data

Used to determine shape of distribution

Can be used to determine “spread” of data

Prerequisite for additional statistical analysis

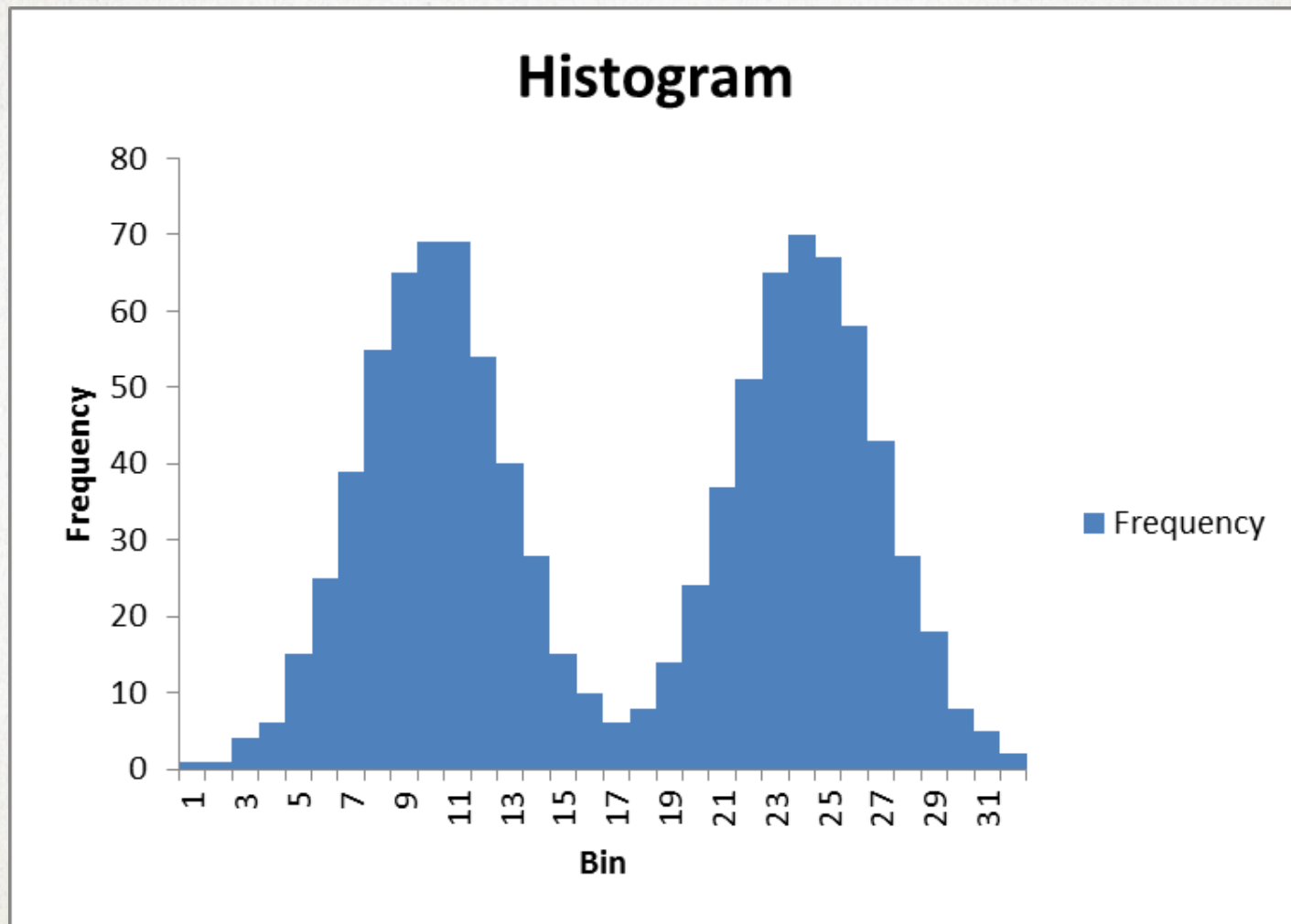
# HISTOGRAM – EXAMPLE



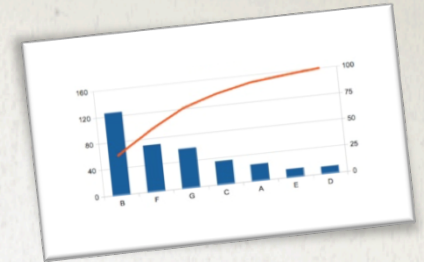


# HISTOGRAM – EXAMPLE

## BIMODAL DISTRIBUTION



# PARETO CHART



Based on 80-20 rule

- 80% of effect comes from 20% of causes

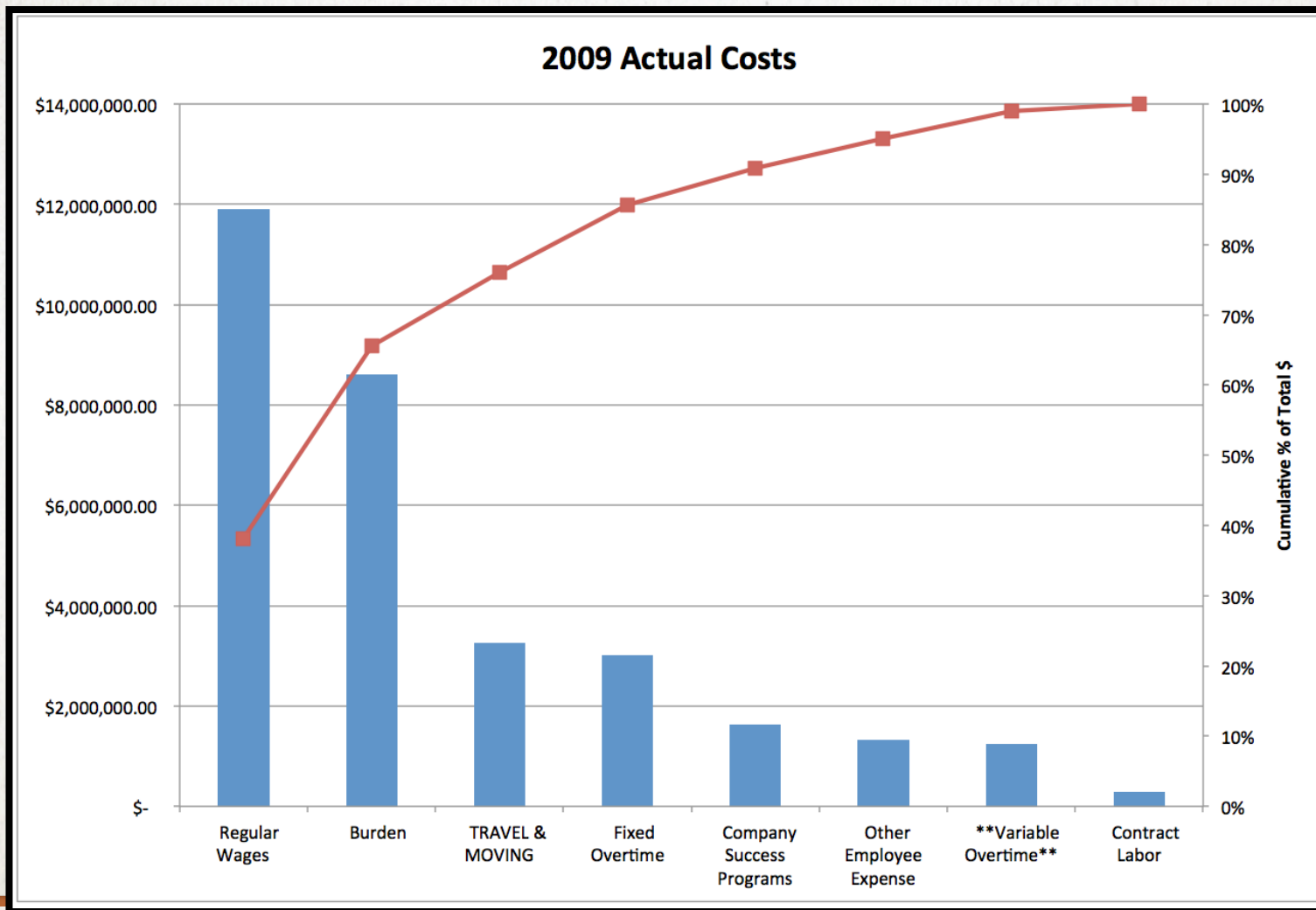
Identify projects with greatest potential return or benefits

Categorizes data from high to low

Helps separate the “vital few” problems from the “trivial many”



# PARETO CHART – EXAMPLE



# PARETO CHART LIMITATIONS

Data from short time period may be misleading!

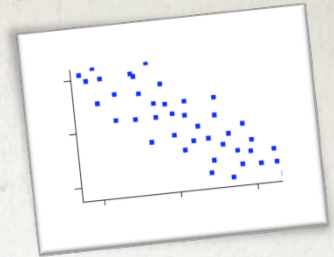
- Unstable processes magnify this

Data from long time period may be misleading!

- The longer the time period, the more likely that changes were made to the process at some point along the way. A histogram can be used to check for a bimodal distribution.



# SCATTER DIAGRAM

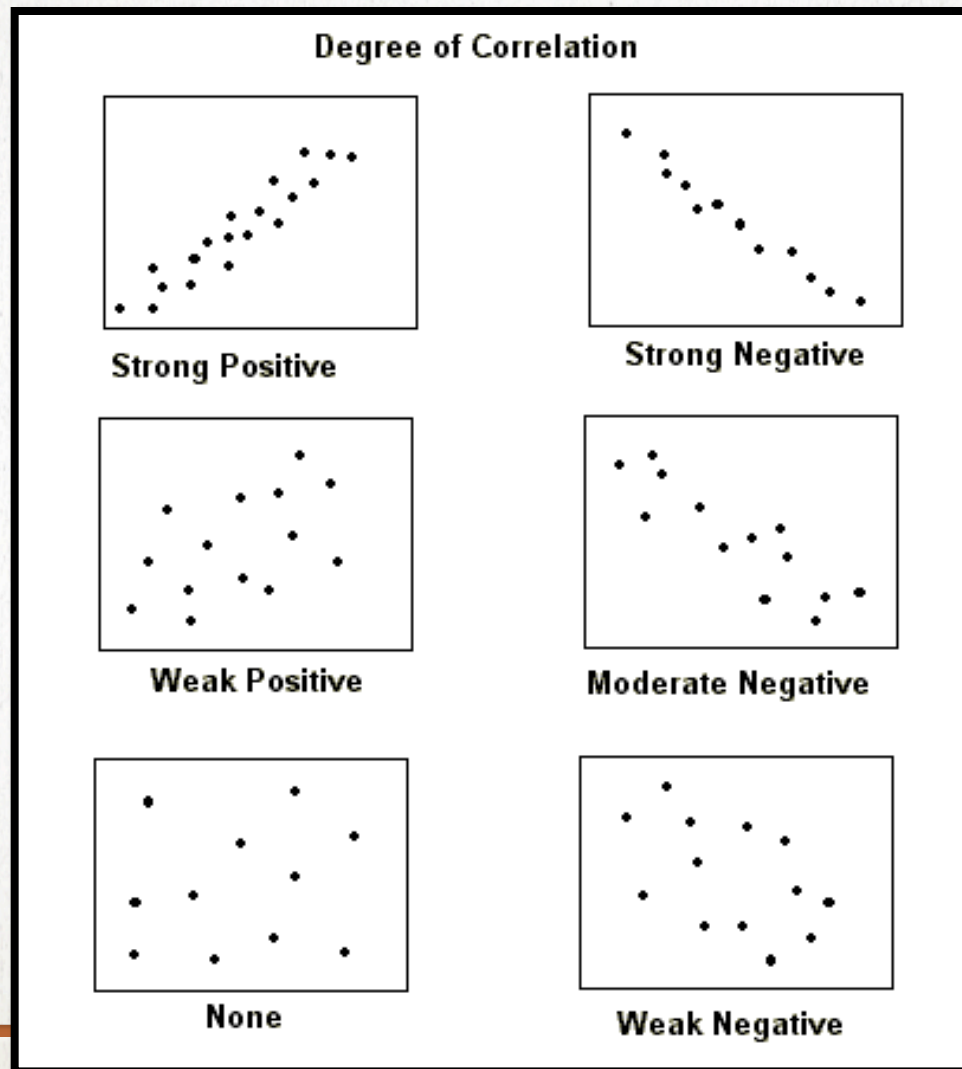


Illustrate relationships between variables

Commonly referred to as correlation analysis

Used to determine strength of relationship

# SCATTER DIAGRAM EVALUATION

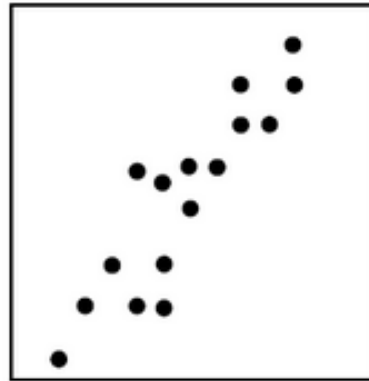




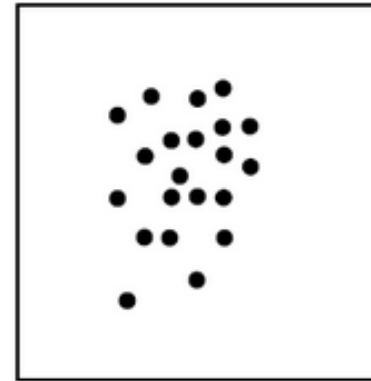
# SCATTER DIAGRAM EVALUATION



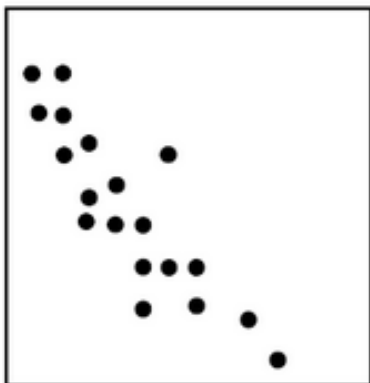
Strong positive correlation



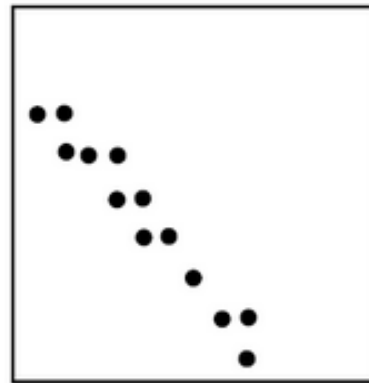
Moderate positive correlation



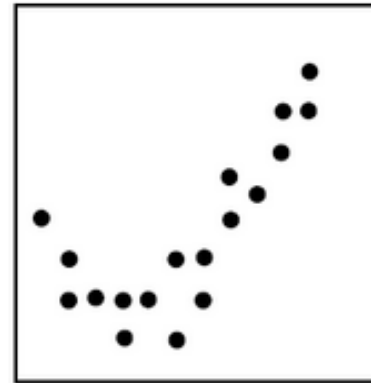
No correlation



Moderate negative correlation

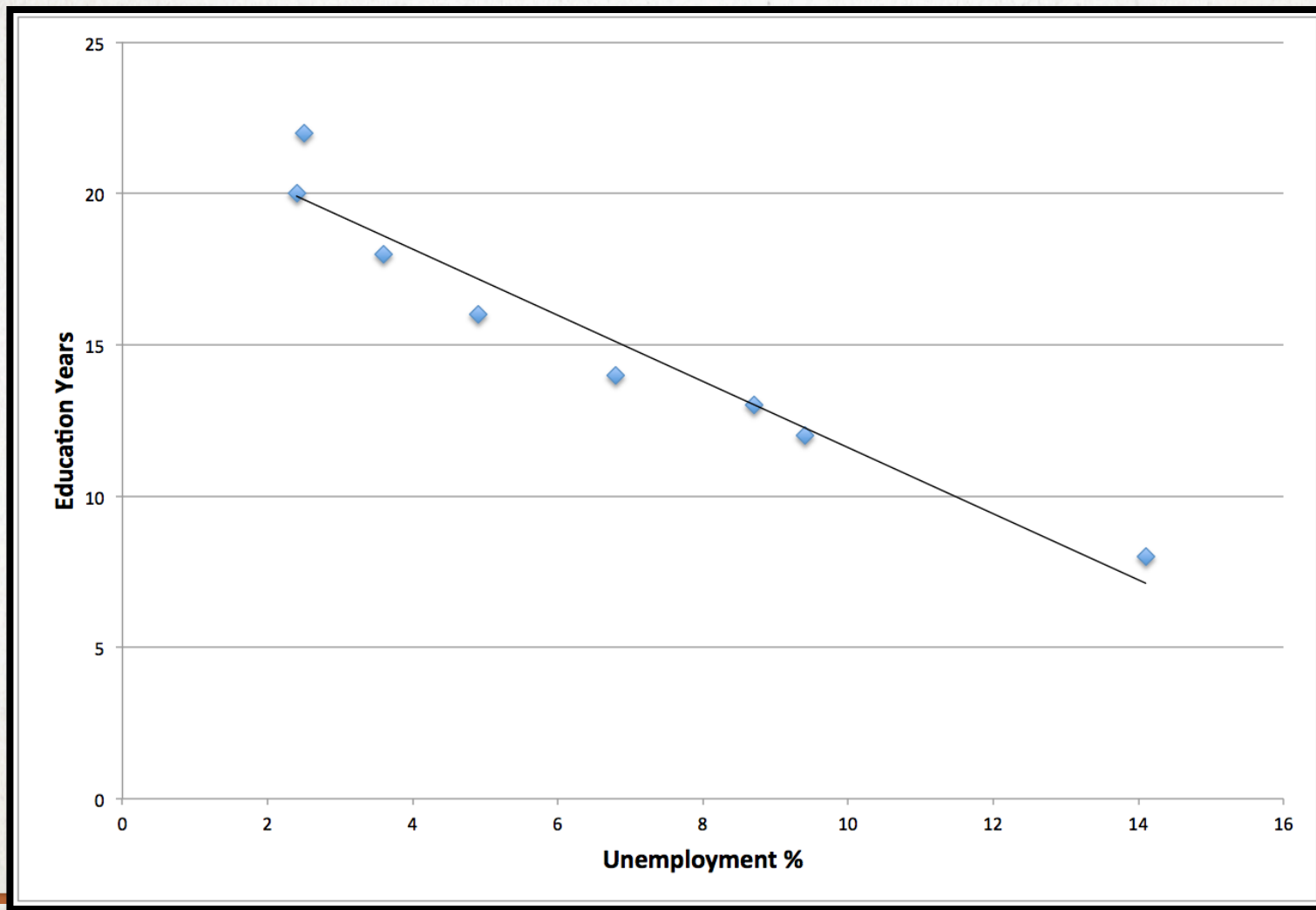


Strong negative correlation



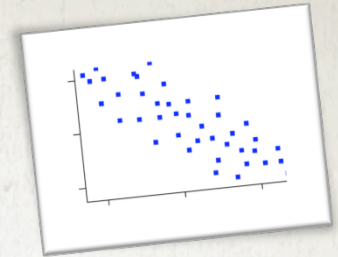
Curvilinear relationship

# SCATTER DIAGRAM - EXAMPLE





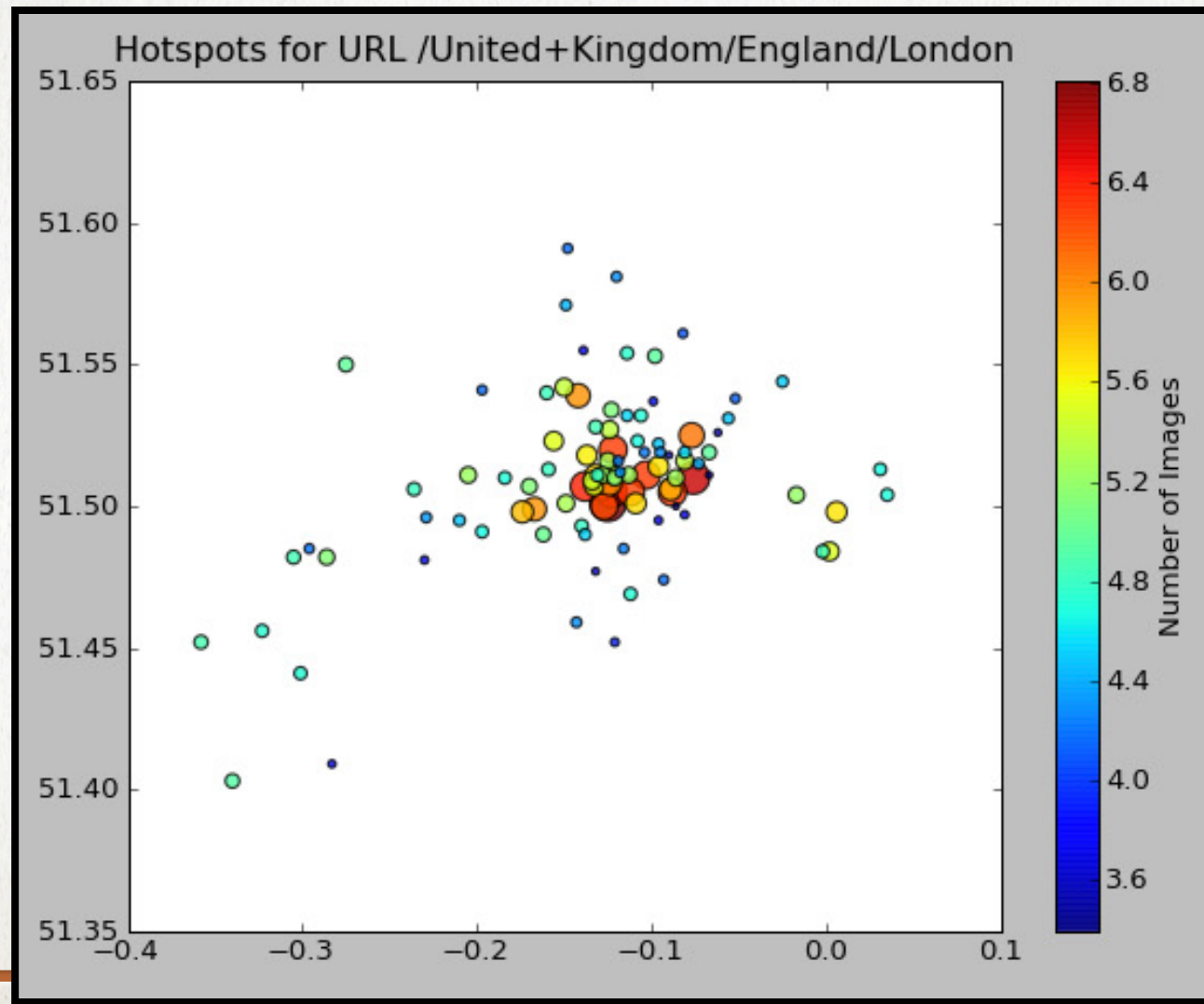
# SCATTER DIAGRAM



Large data sets representing few categories results in “stacking” points on top of each other, making the scatter diagram misleading

Consider using alternative charts such as “heat maps” that can visually differentiate overlapping data points

# SCATTER DIAGRAM HEAT MAP





**BONUS TOOL!**

---

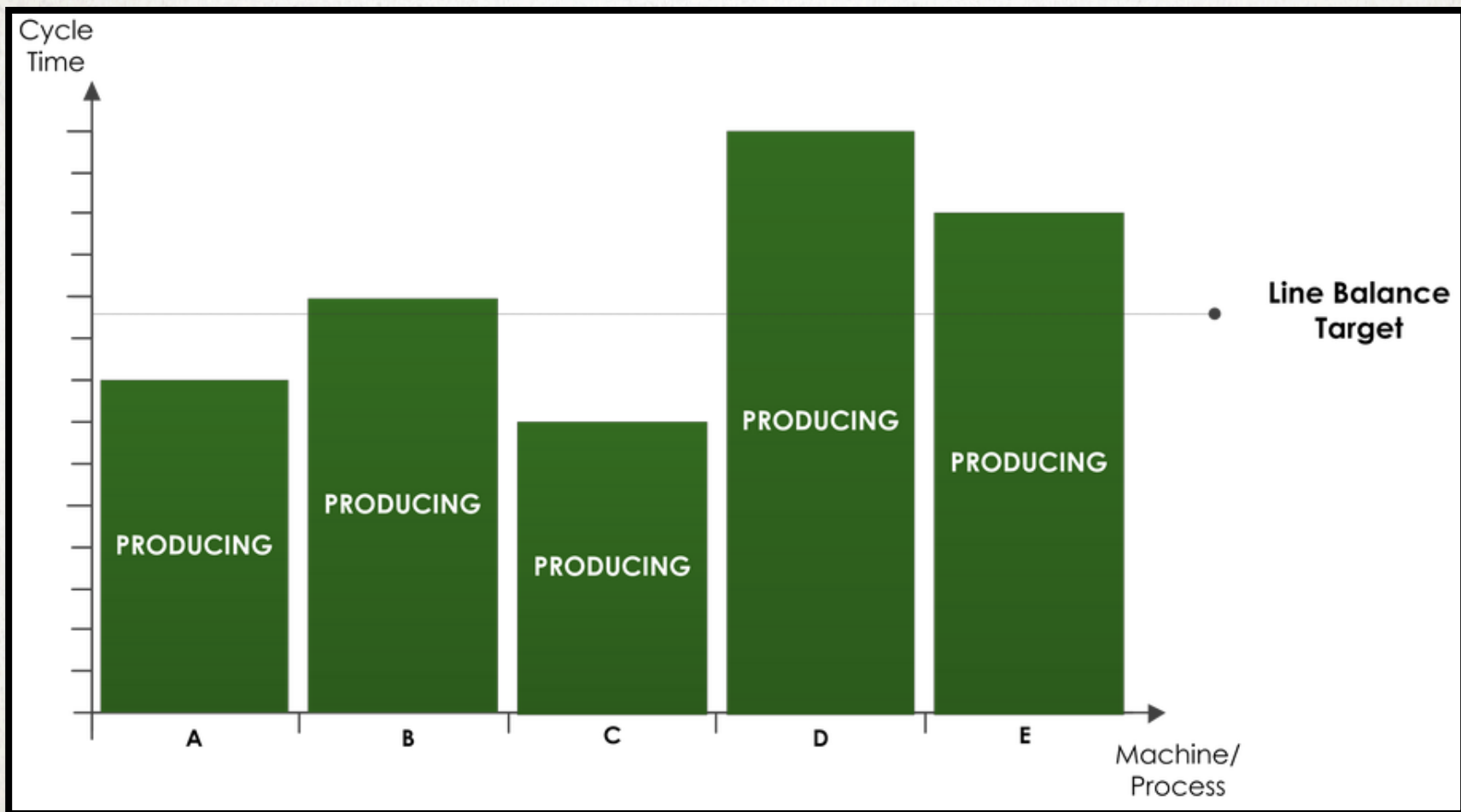
# LINE BALANCING

Line Balancing is typically used in Lean Six Sigma projects to improve workflow by eliminating the backlogs between steps

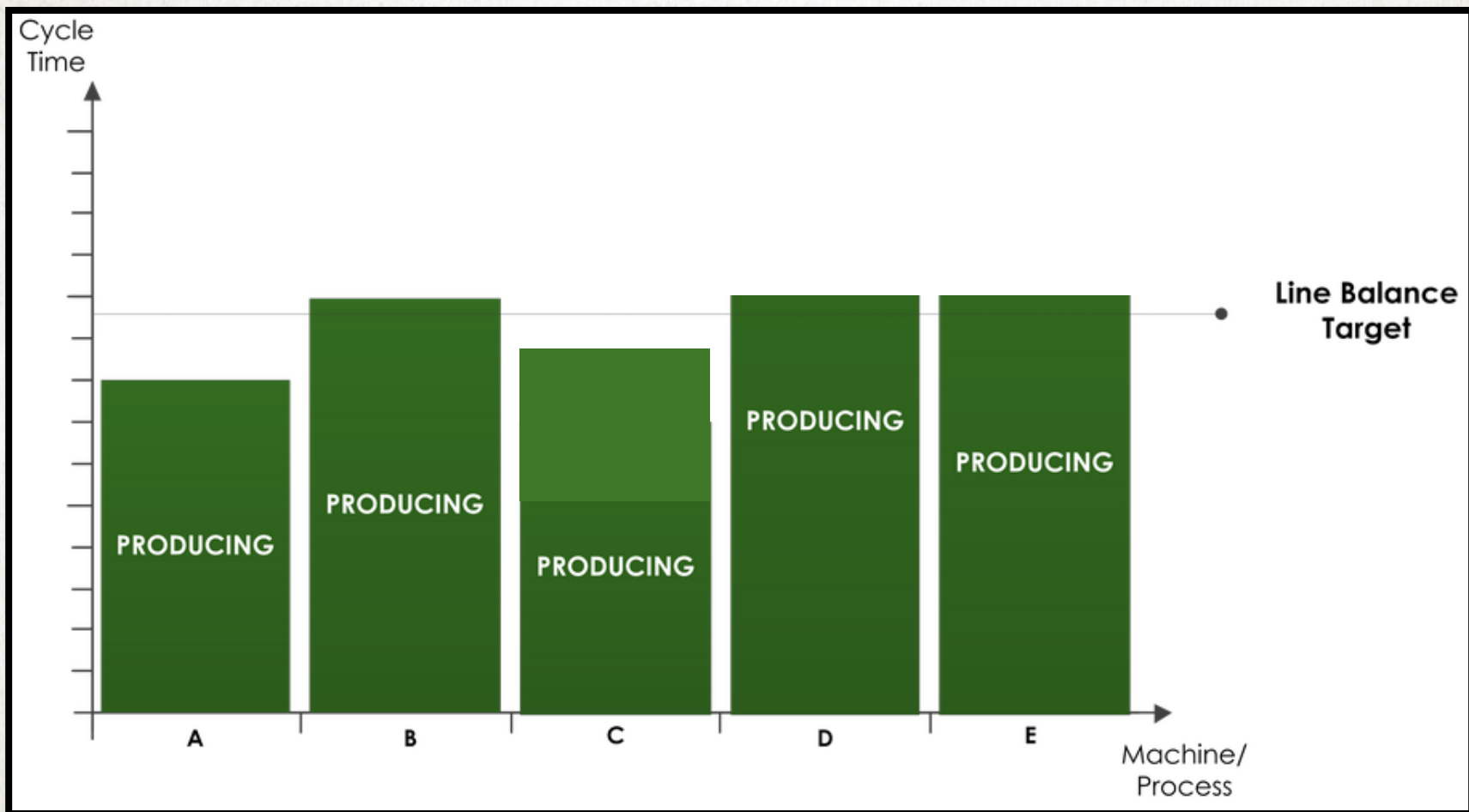
In its simplest form, Line Balancing is simply evening out workflow by eliminating extremes (too little work vs too much work)



# LINE BALANCING - EXAMPLE



# LINE BALANCING - EXAMPLE





# CHARTING IN EXCEL

## Run Charts and Scatter Plots

- Use built-in chart types

## Histograms

- Create using “Data Analysis” tools
- Activate the “Analysis Toolpak” add-in

# CHARTING IN EXCEL

## Pareto Charts

- Not a built-in chart type
- Can be created using dual-axis chart with source data properly set up in advance
- Google!

## Alternatives

- Free Excel templates from ASQ  
(<http://asq.org/learn-about-quality/tools-templates.html>)
- Activate the “Analysis Toolpak” add-in



## **SCENARIO #1:**

**Lean Six Sigma Project to Reduce  
Holding Time Violations (HTVs)**

---

## **SCENARIO #1:**

**Problem:** A facility (an environmental laboratory) is undertaking a process improvement project to identify the root causes of holding time violations, and to thereafter develop means to reduce and, ultimately, eliminate them.

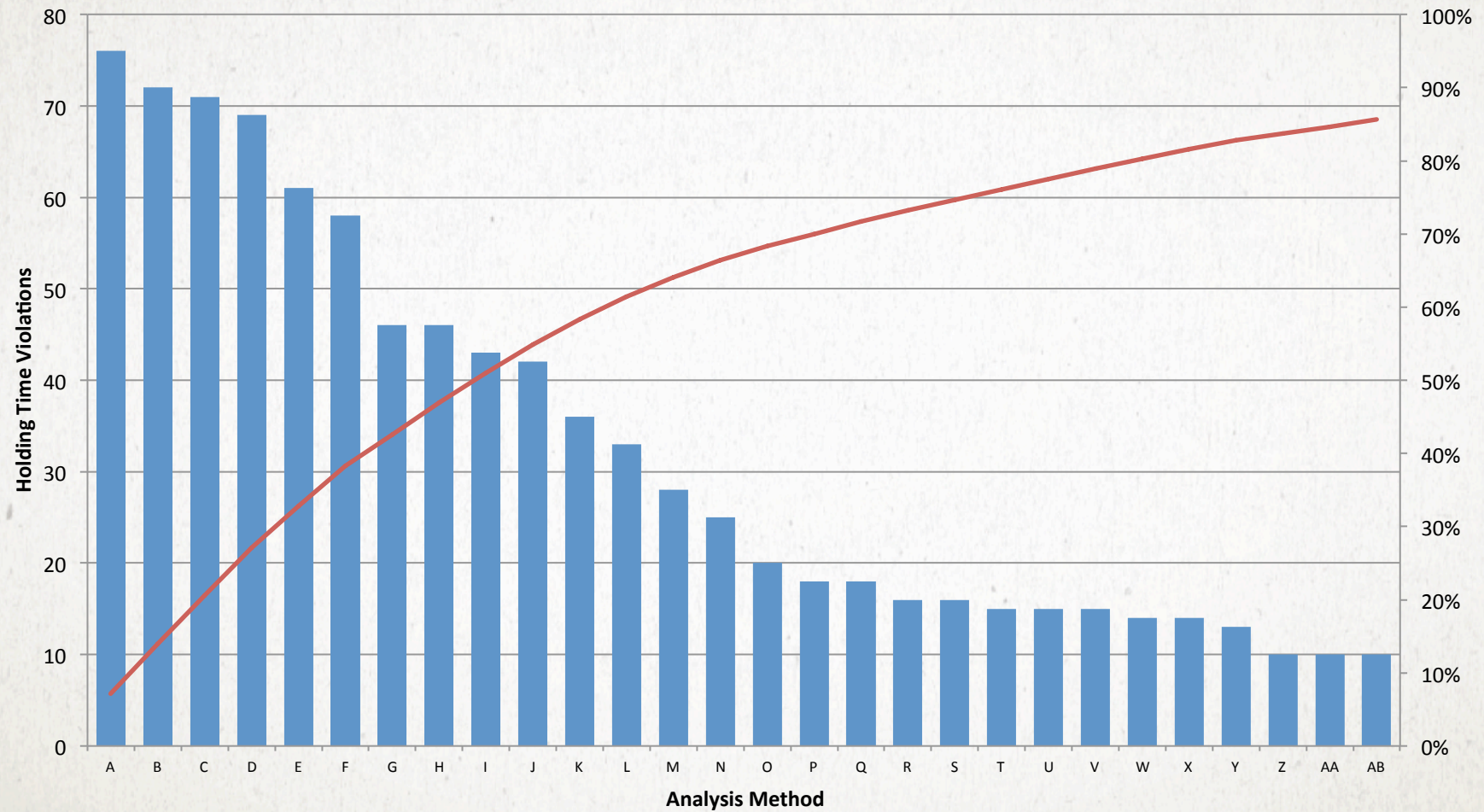
---



## INITIAL QUESTIONS

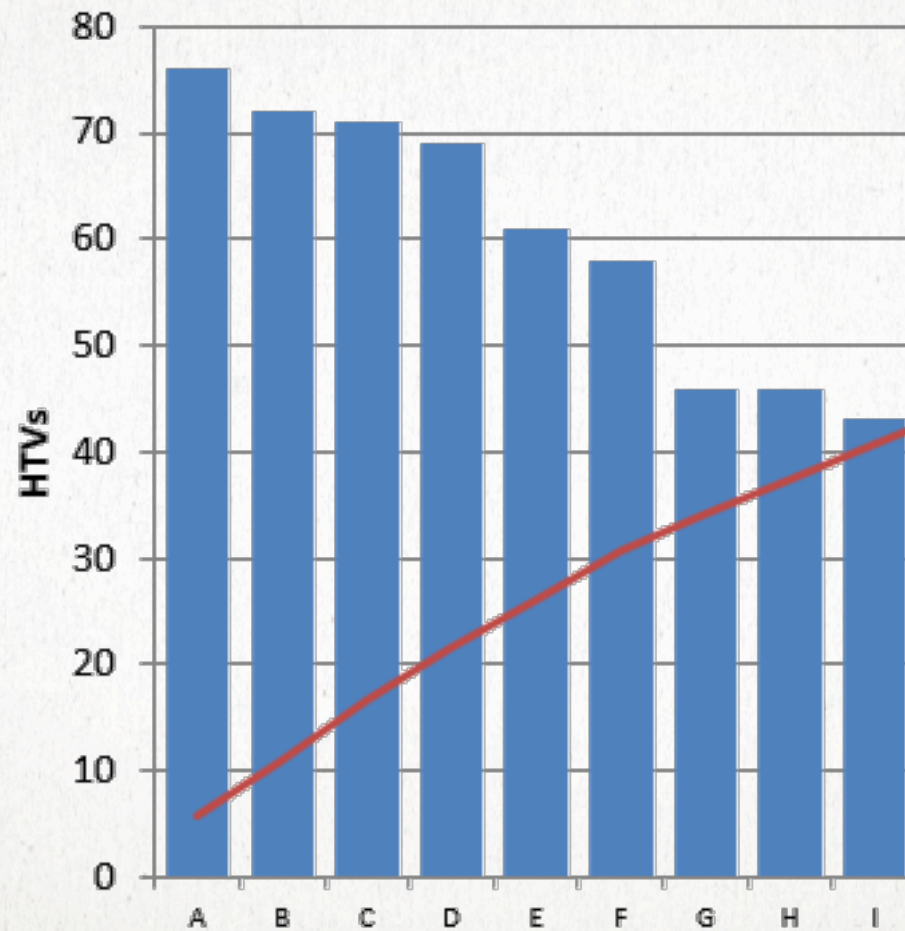
- What is the frequency of HTVs?
  - Is there a correlation between the number of HTVs and the number of samples received (workload)?
  - Do HTVs occur for certain methods more often than for others?
  - What is the revenue impact of HTVs per method?
  - Where should we focus our efforts to reduce HTVs?
-

# PARETO CHART – HTV COUNT

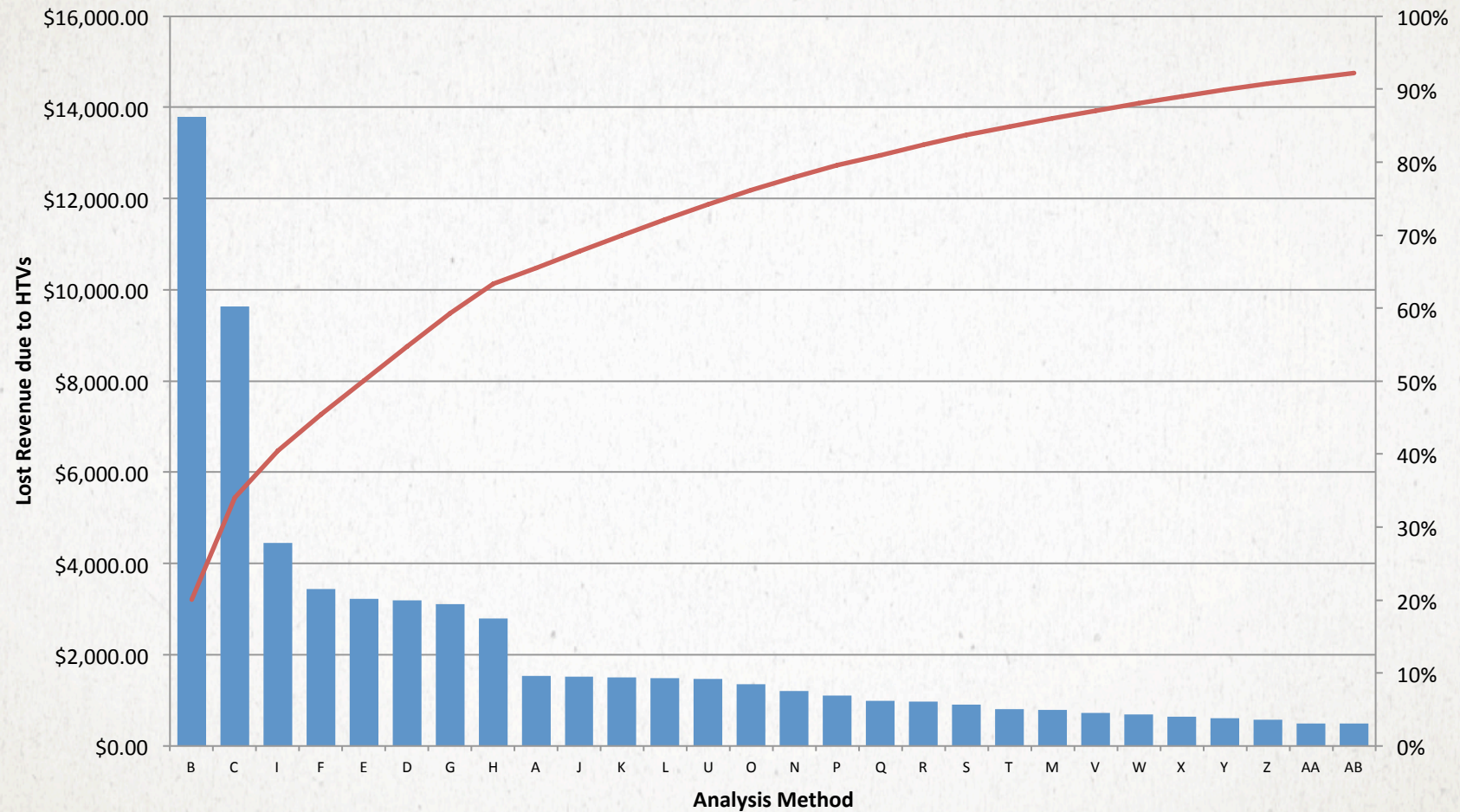




# PARETO CHART – HTV COUNT DETAIL

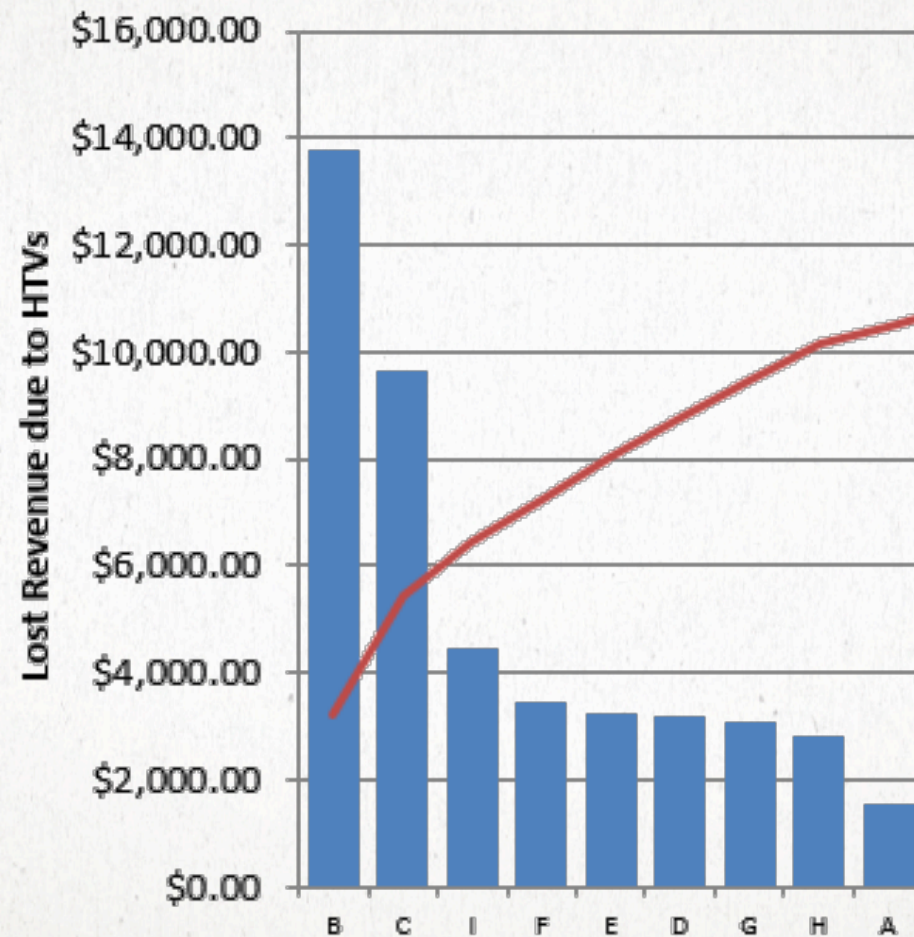


# PARETO CHART – HTV COST

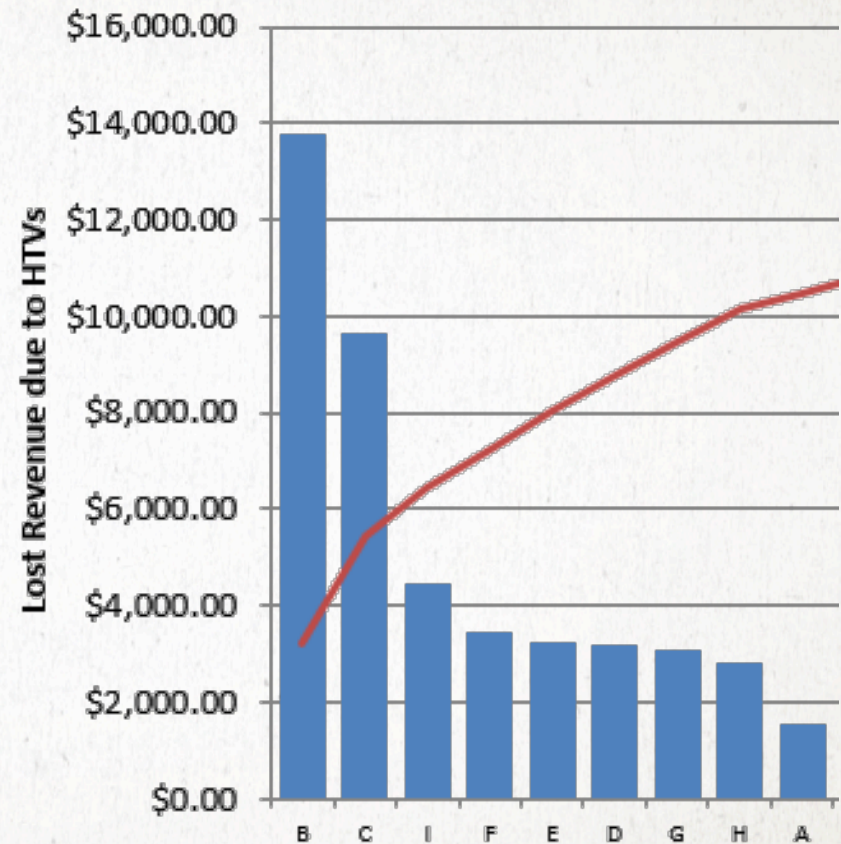
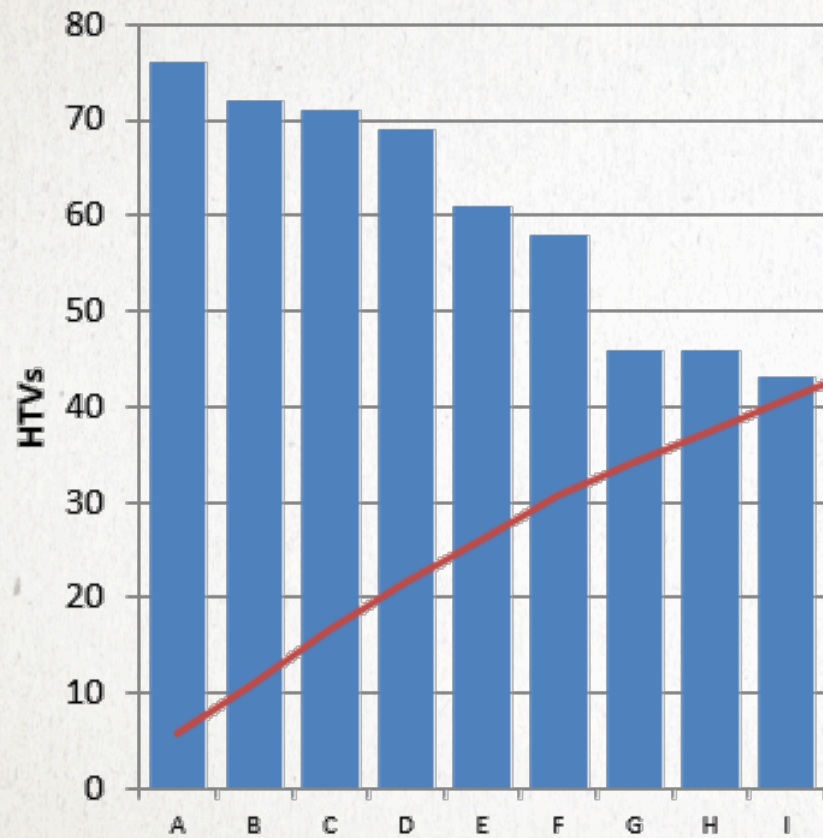




# PARETO CHART – HTV COST DETAIL

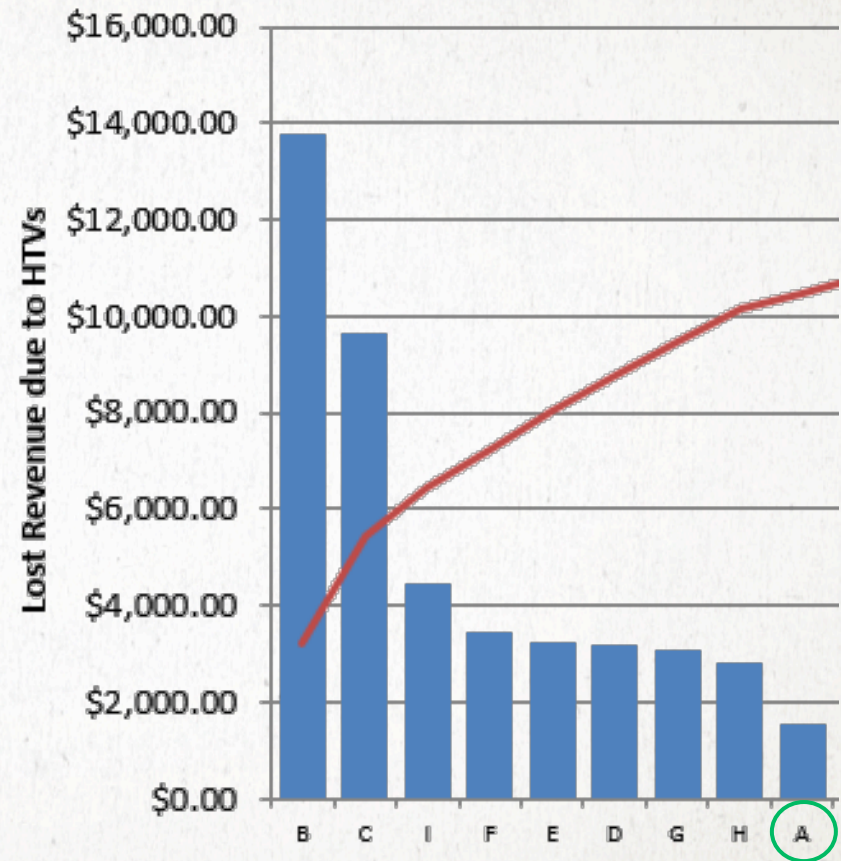
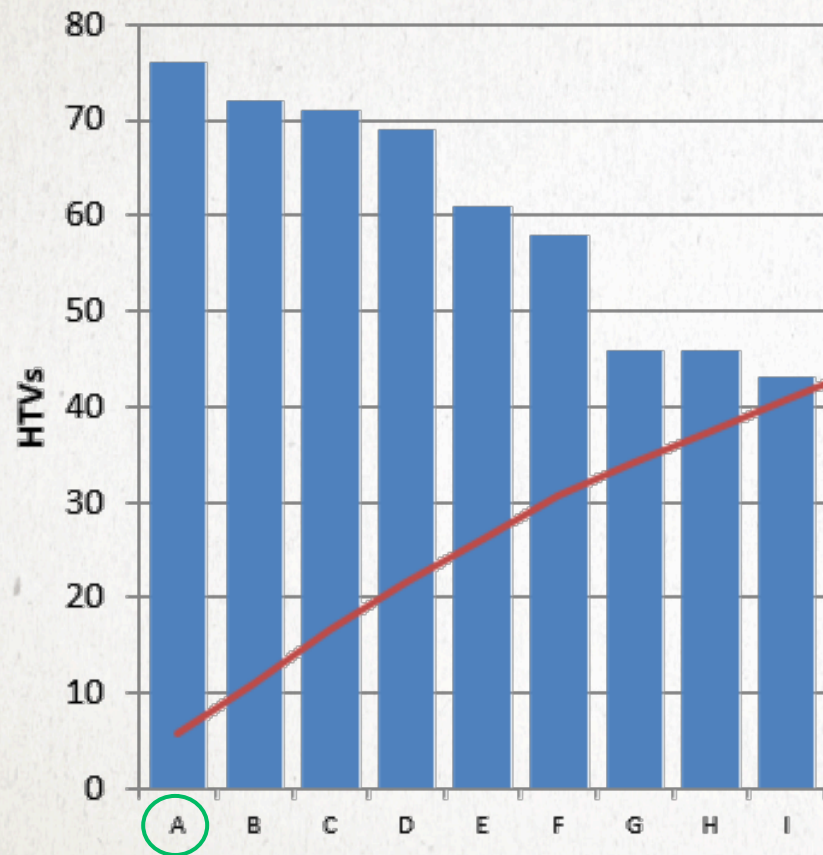


# EVALUATION

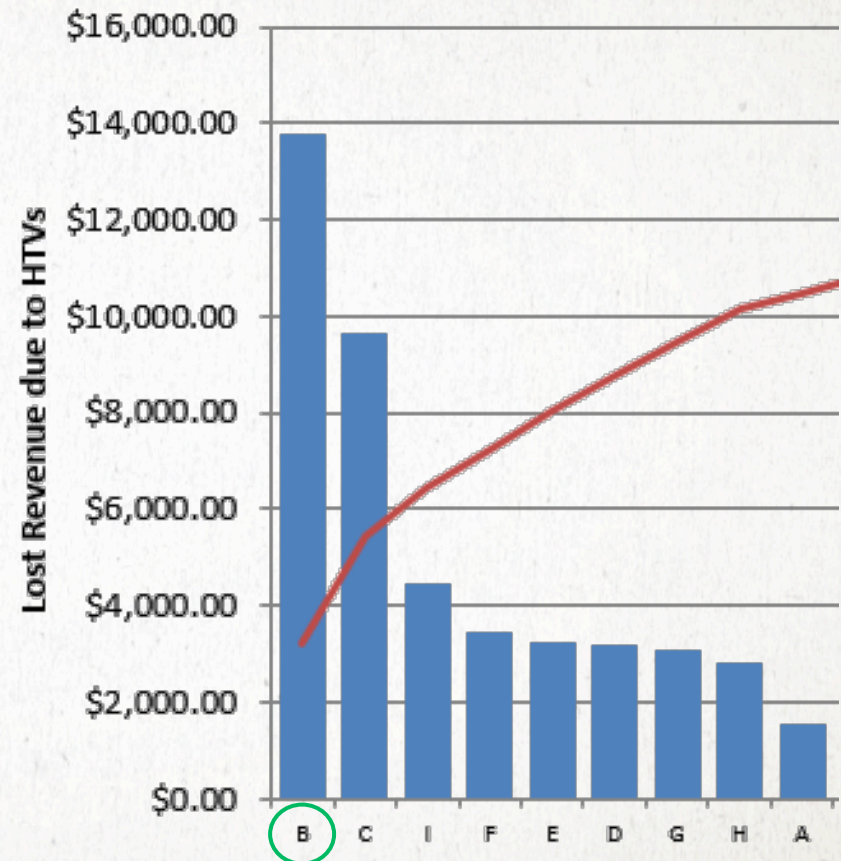
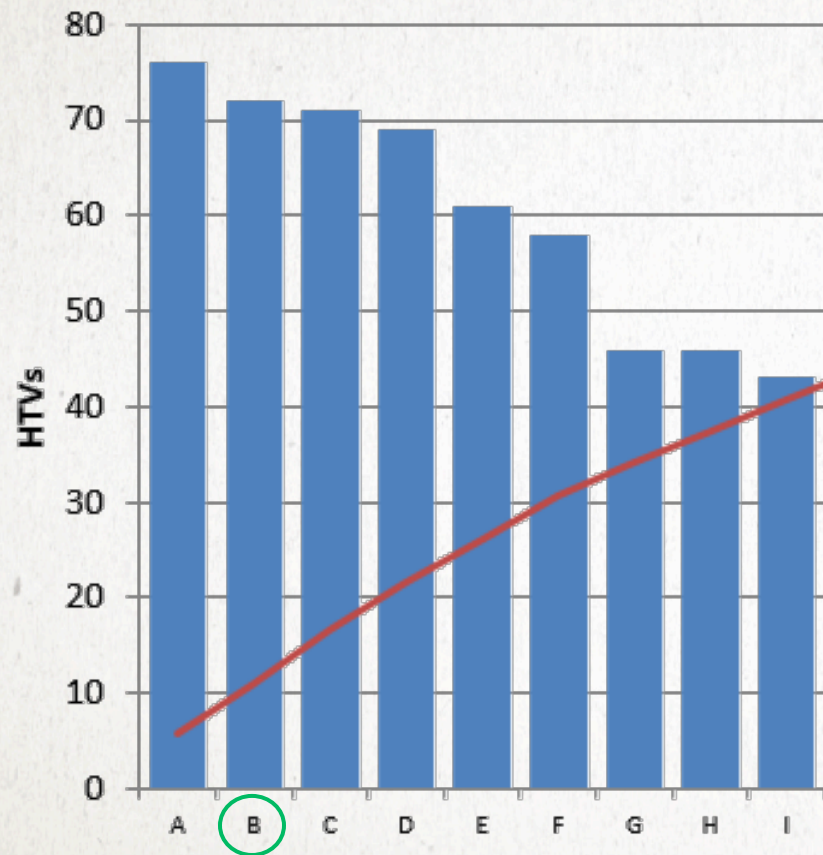




# EVALUATION



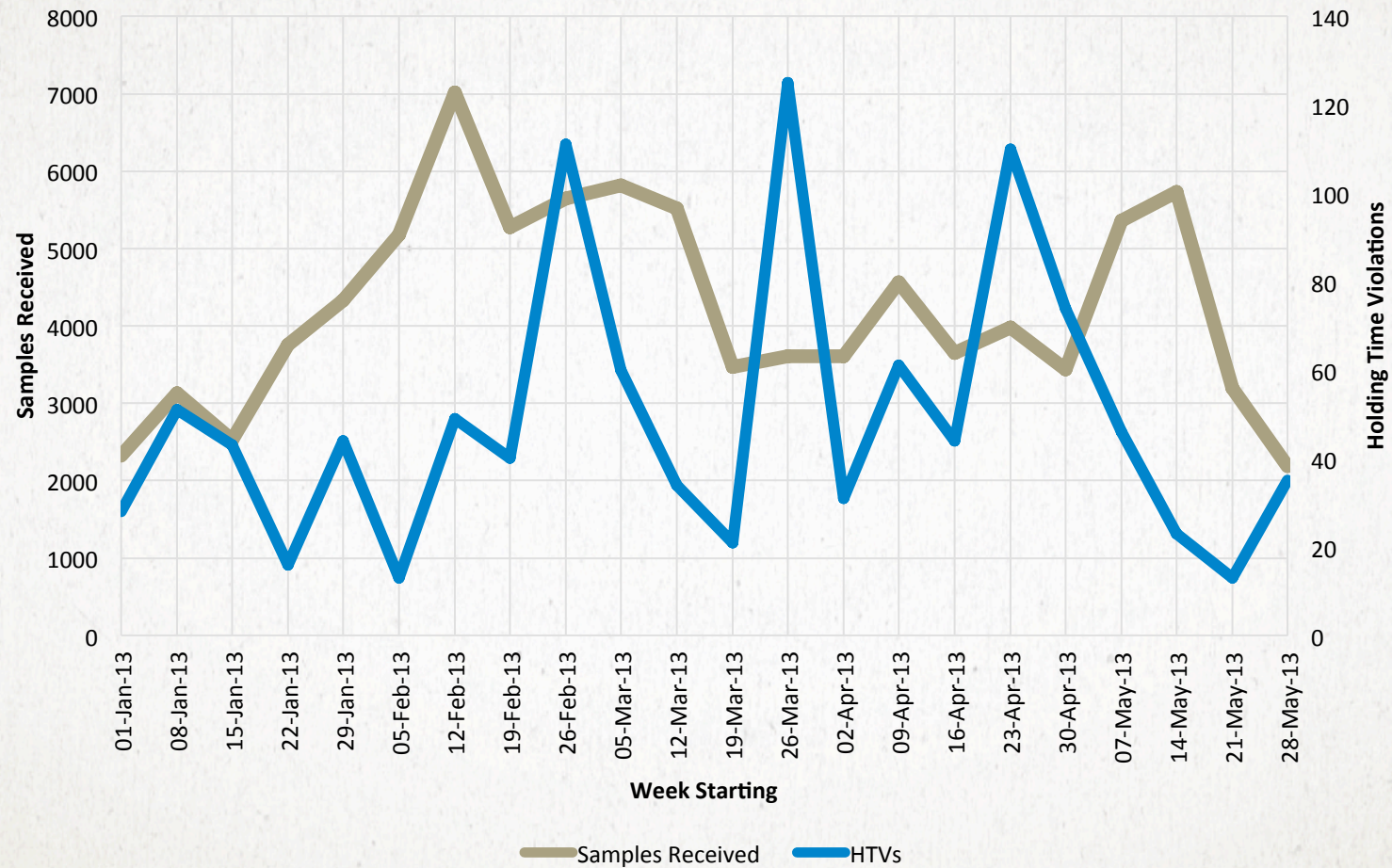
# EVALUATION





# RUN CHART

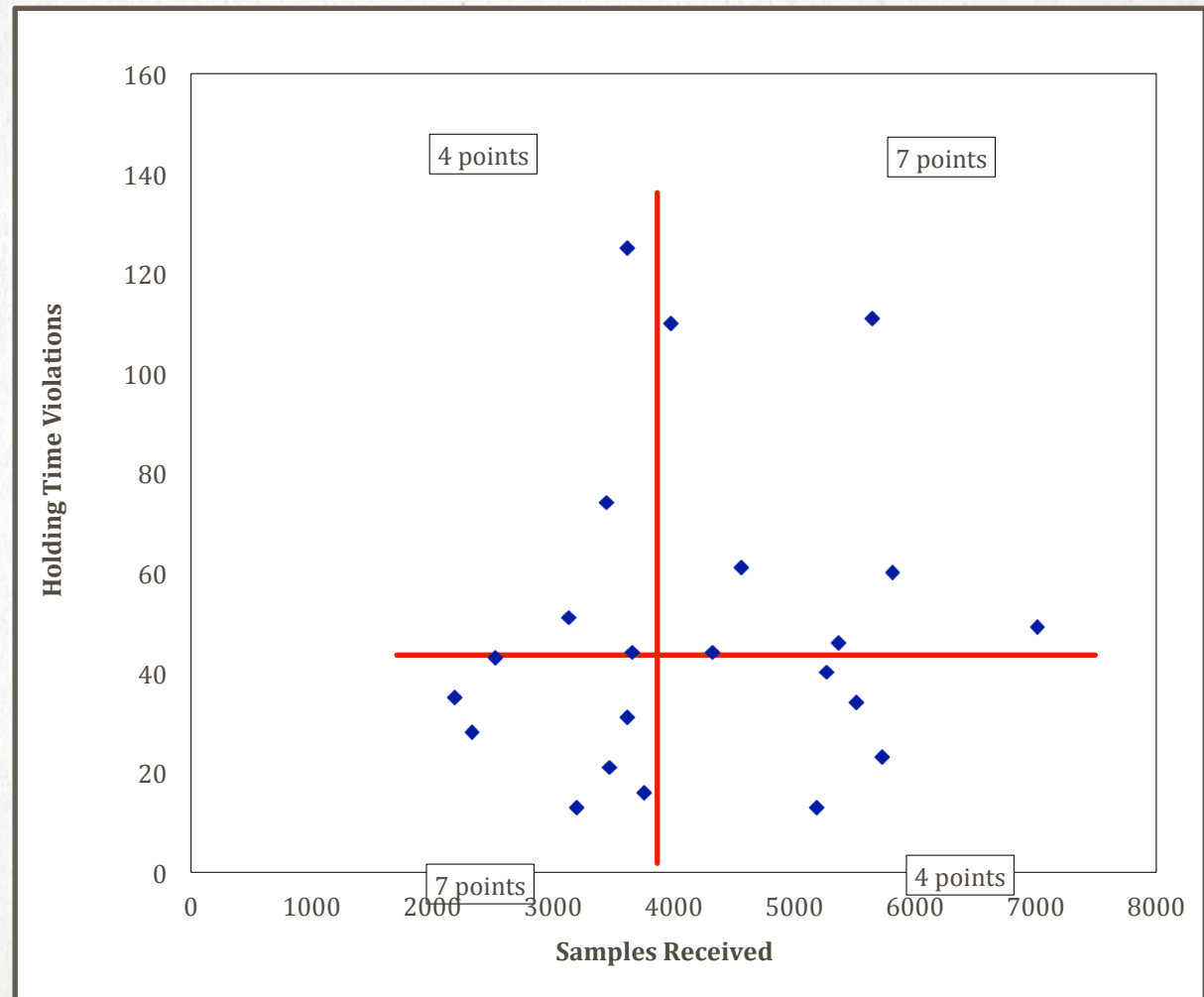
## SAMPLES RECEIVED VERSUS HTV



# SCATTER DIAGRAM

## SAMPLES RECEIVED VERSUS HTV

	Results
# in 1st Q	7
# in 2nd Q	4
# in 3rd Q	7
# in 4th Q	4
A = 4 + 4	8
B = 7 + 7	14
Q = min	8
N = # pts	22
Trend test limit	5
Q < Limit?	No
Correlated?	No

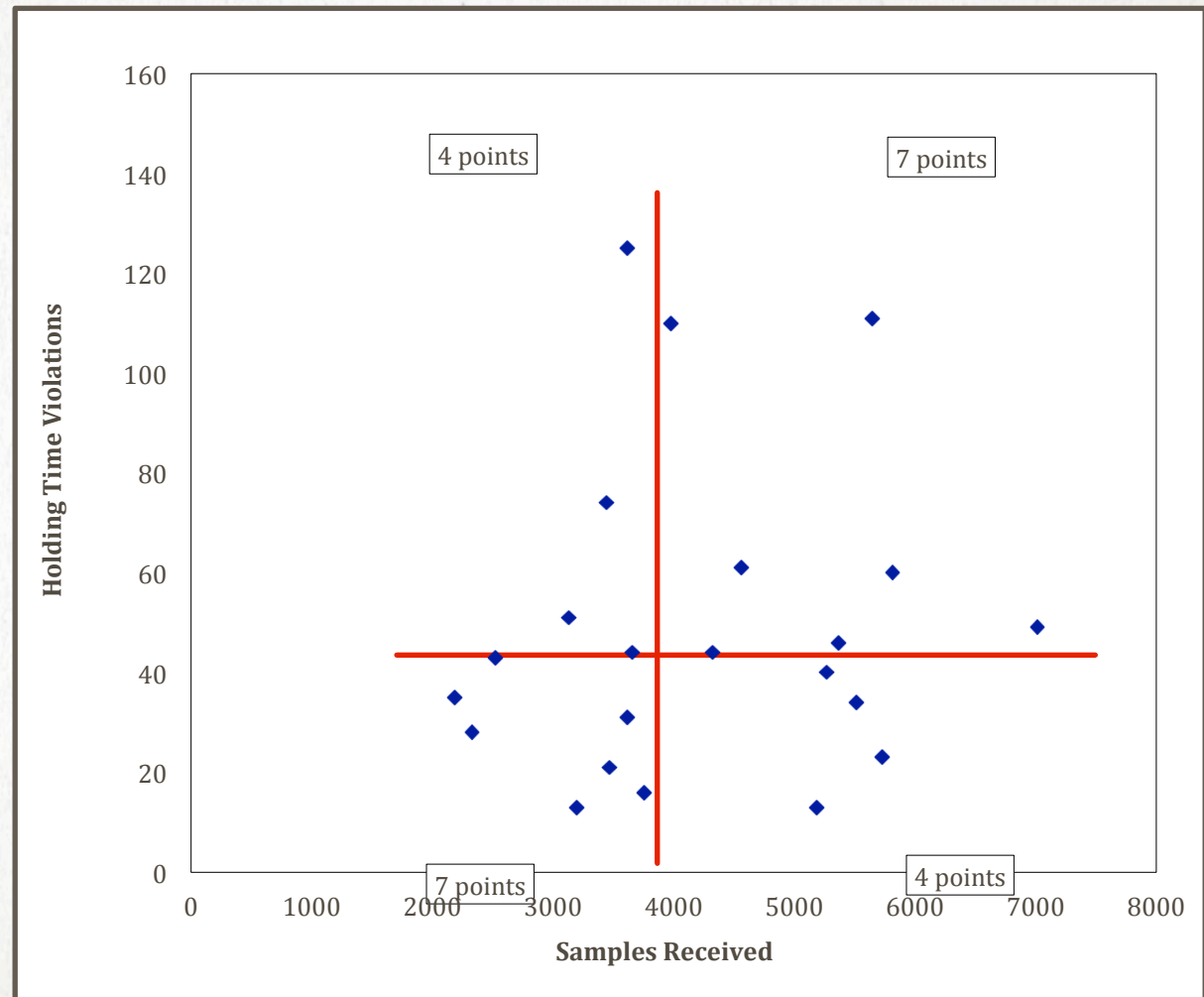




# SCATTER DIAGRAM

## SAMPLES RECEIVED VERSUS HTV

	Results
# in 1st Q	7
# in 2nd Q	4
# in 3rd Q	7
# in 4th Q	4
A = 4 + 4	8
B = 7 + 7	14
Q = min	8
N = # pts	22
Trend test limit	5
Q < Limit?	No
Correlated?	No



**Which tool is the best fit?**

---



## **SCENARIO #2:**

**Project to Improve Compliance with  
SOP Review Due Dates**

---

## **SCENARIO #2:**

**Problem:** A facility maintains over 100 SOPs, and is required to review and update those SOPs every 1-2 years (depending on subject matter). The facility has had problems historically meeting the deadlines to complete the necessary reviews and updates.

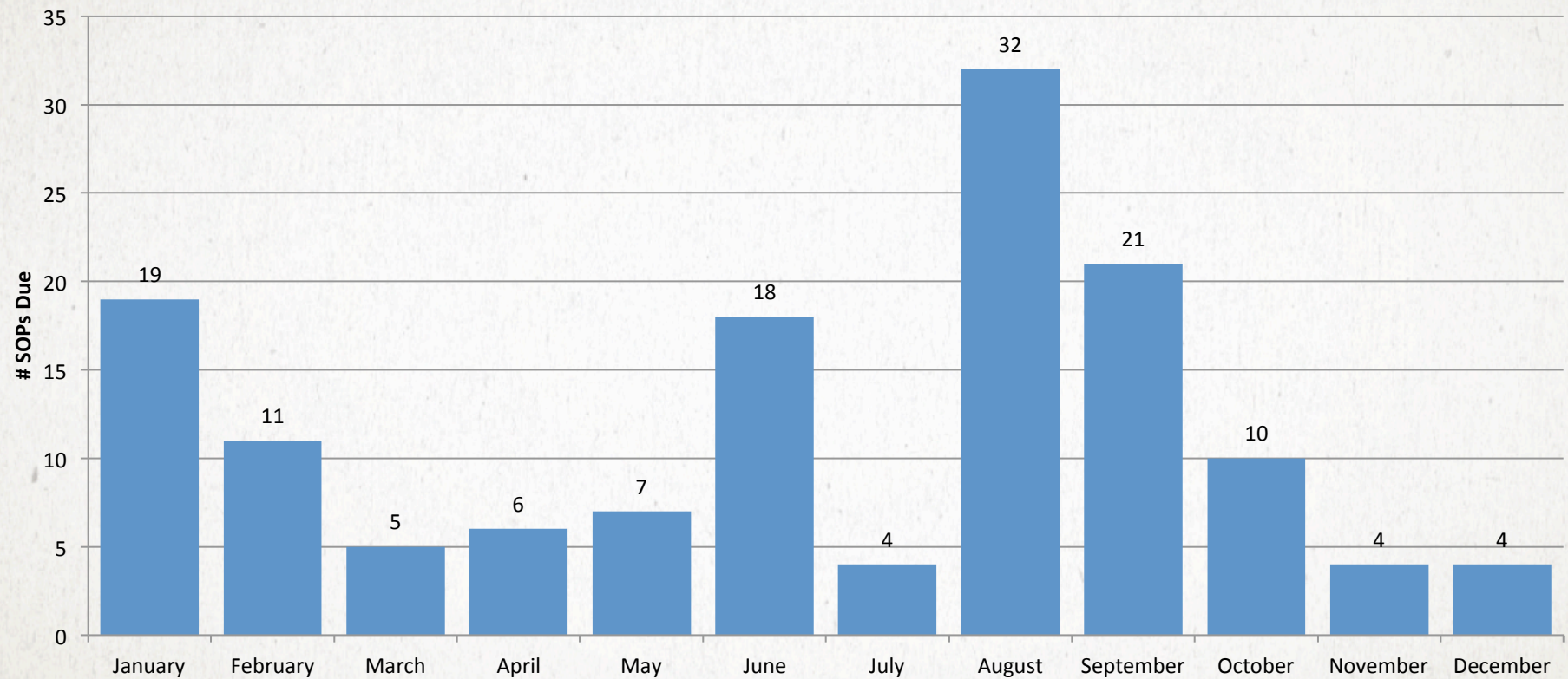
**Task:** Improve compliance with due dates.

---



# LINE BALANCING CHART

## SOPS WITH REVIEWS DUE PER MONTH - CURRENT



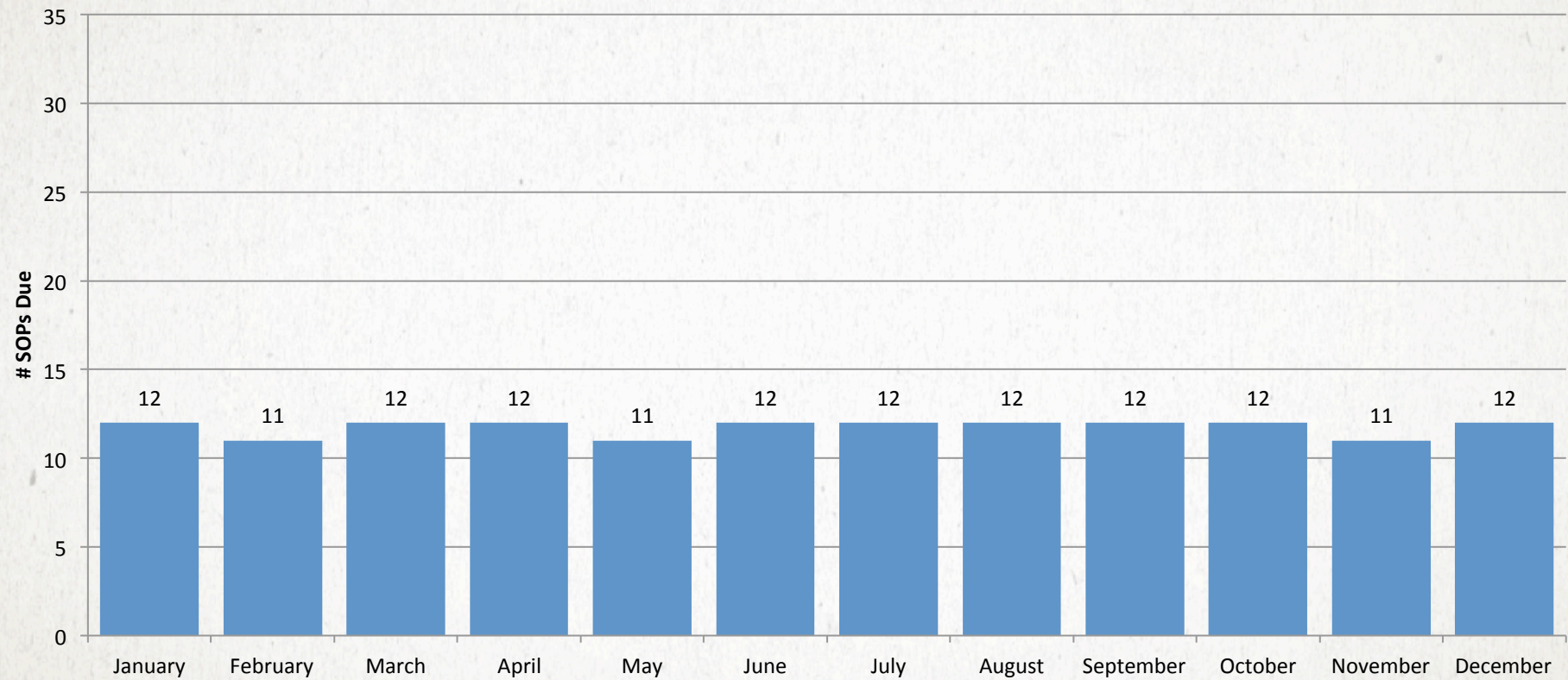
# ABOUT LINE BALANCING

Applying Line Balancing to this project involves adjusting due dates so that SOPs are due evenly throughout the year



# LINE BALANCING CHART

## SOPS WITH REVIEWS DUE PER MONTH - FUTURE



# IN CONCLUSION

Of course there are many tools available to help evaluate data and analyze problems

This has been just a glimpse of a few graphical tools and techniques – many more exist, and there is no single best tool for every problem



**Thank you**

---