

Dr. Deming's System of Profound Knowledge

Appreciation for a System, Statistical Thinking,
Scientific Thinking, Knowledge of Psychology

13 September 2005

Systems Thinking

Or why cutting a cow in half doesn't produce two little cows

13 September 2005



Dr. Deming's System of Profound Knowledge

SYSTEMS THINKING

“Elements united by a common aim”

Contribution: each part of a system contributes something to performance

Interdependence: the performance of one part of a system is always dependent upon another

Expansionism: systems are nested subsystems ad infinitum

STATISTICAL THINKING

There must be a reason to group data in a set

Variation is ubiquitous and inevitable

Customers don't feel the “average;” they feel the “standard deviation”

Separating signals from noise will help us minimize economic loss

Signals must be detected before their effects can be assessed

Evaluating homogeneity is the first step in analysis

SCIENTIFIC THINKING

Meaningful language is operationally definite

Knowledge is prediction

The purpose of knowledge is to be true to something beyond it

There is nothing more practical than good theory

Some important things to manage are unknown and unknowable

The successive application of random forces produces instability and loss

PDSA cycle is theory that builds knowledge

APPLICATIONS OF PSYCHOLOGY

People are diverse

We are born with intrinsic motivation: the three “Cs”

The capacity to learn is our most defining characteristic

We must balance the benefits of individualism and the benefits of affiliation

Systems Thinking

A way of thinking and talking about the world
that reveals interrelationship
and illuminates causal reasoning

What is a System?

Any group of interrelated, interacting, or interdependent parts that form a complex and unified whole that has a specific purpose

Test: Which are Systems?

- Bowl of fruit
- Football team
- Toaster
- Kitchen
- Database of customer names
- Tools in a toolbox
- Marriage

Collections of Parts

- Bowl of fruit
- Football team
- Toaster
- **Kitchen**
- **Database of customer names**
- **Tools in a toolbox**
- Marriage

Systems

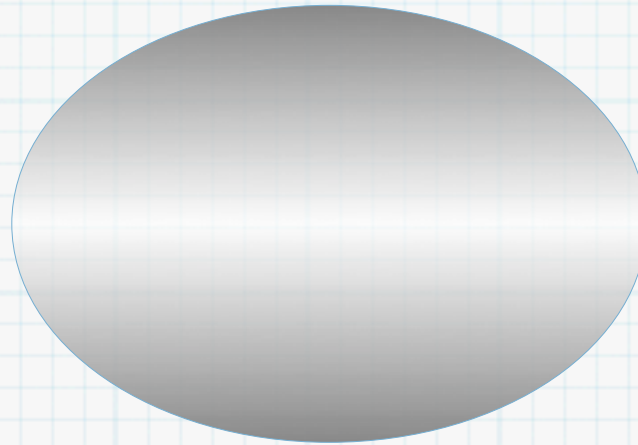
- **Bowl of fruit**
- **Football team**
- **Toaster**
- Kitchen
- Database of customer names
- Tools in a toolbox
- **Marriage**

Defining Characteristics of Systems

- Systems have purpose
- All parts must be present for a system to operate optimally
- The order in which the parts are arranged affects the performance of the system
- Systems maintain stability through feedback

Purpose

- A primary function of leadership is to ensure the purpose is defined
- Goals must be separated from necessary conditions
- The ideal state of a system is to be optimized
- If the components of a system are all optimized, the system will not be
- If the system is optimized, the components will not be
- Knowledge of optimization always comes from outside the system.



The Importance of Aim

If my aim is to create a birthday cake, I acquire my egg from the grocery store, keep it cold until I'm ready to use it, break it, combine it with other ingredients, and cook it at 350 degrees for 30 minutes.

If my aim is create a rooster, everything changes.



Analysis and Synthesis

- A system cannot understand itself
- You cannot explain a system by analysis -- consider left-hand drive in US cars and right-hand drive in UK
- Analysis tells you how something works -- Synthesis tells you why it works.

Analysis and Synthesis

1

Take the thing you want to understand apart

Take the thing you want to understand as part of a larger whole

2

Explain the behavior of each part taken separately

Explain the behavior of the containing whole

3

Aggregate your explanation of the parts into an understanding of the whole

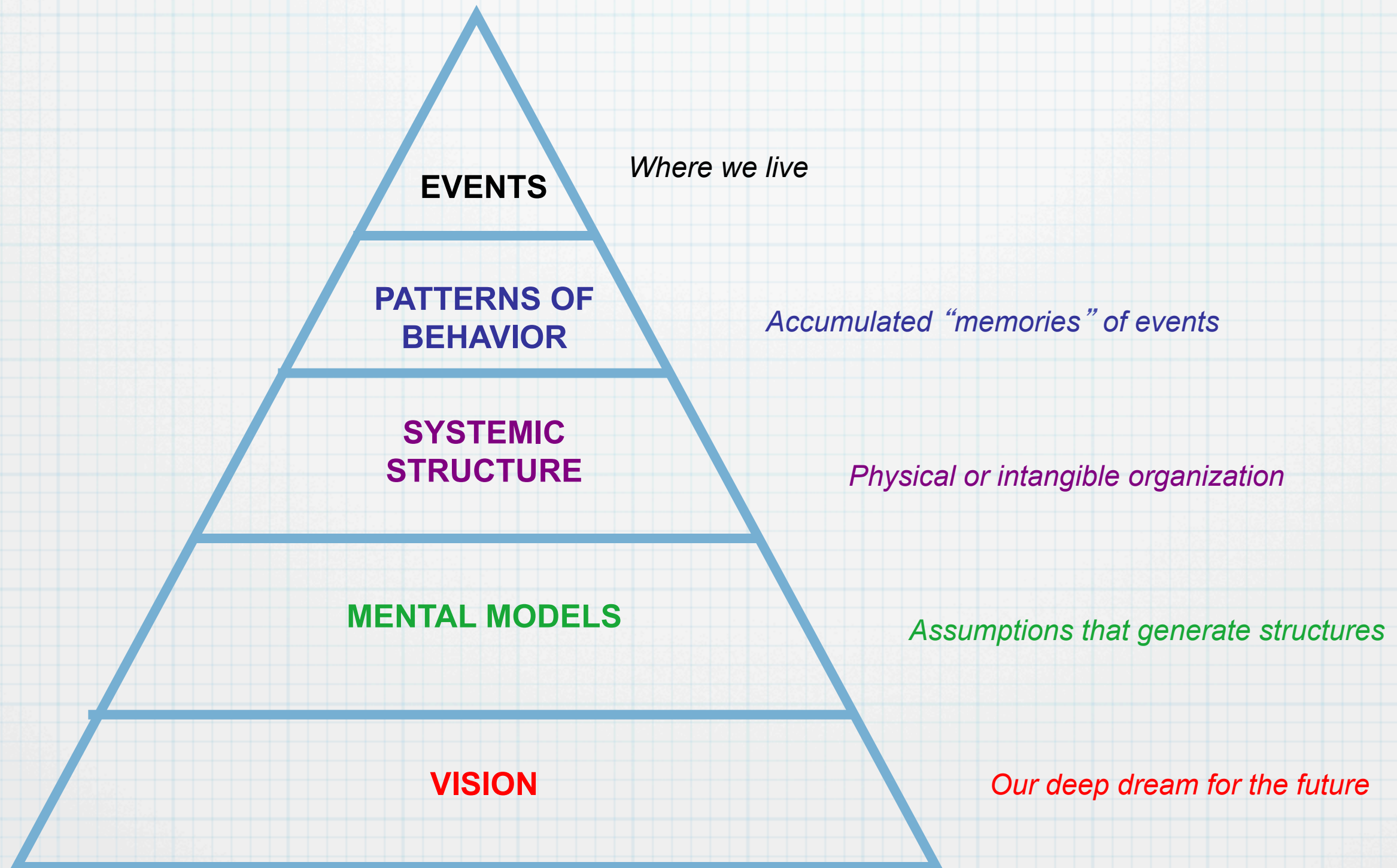
Deconstruct the understanding of the containing whole into the roles or functions of the parts



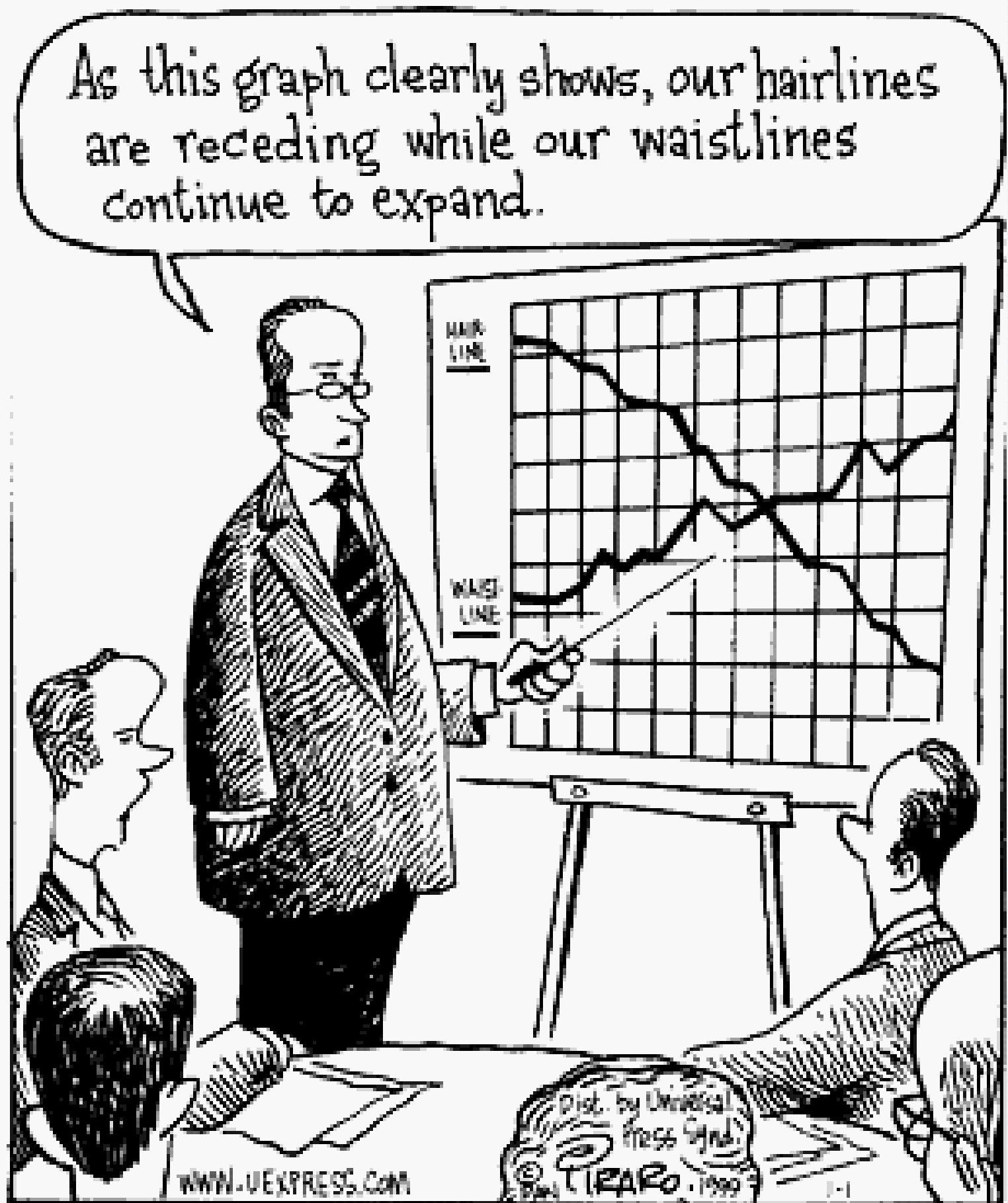
Orchestral Efficiency

- "For considerable periods of time the four oboe players had nothing to do. The number should be reduced and the work spread more evenly over the whole of the concert, thus eliminating peaks of activity.
- All 12 violins were playing identical notes; this seems unnecessary duplication. The staff of this section should be drastically cut. If a larger volume of sound is required, it would be obtained by means of electronic apparatus.
- Much effort was absorbed in the playing of sixteenth, eighth, and quarter notes; this seems to be an unnecessary refinement. It is recommended that all notes be rounded up to the nearest quarter. If this were done, it would be possible to use trainees and lower grade operatives more extensively.
- Obsolescence of equipment is another matter into which further investigation should be made, as it was reputed in the program that the leading violinist's instrument was already several hundred years old. If normal depreciation schedules had been applied, the value of this instrument should have been reduced to zero.
- There seems to be too much repetition of some musical passages. Scores should be drastically pruned. No useful purpose is served by repeating on the horns a passage which has already been handled by the strings. It is estimated that if all the redundant passages were eliminated, the whole concert time of two hours could be reduced to twenty minutes and there would be no need for an intermission."

Systems in Context



The Level of Events



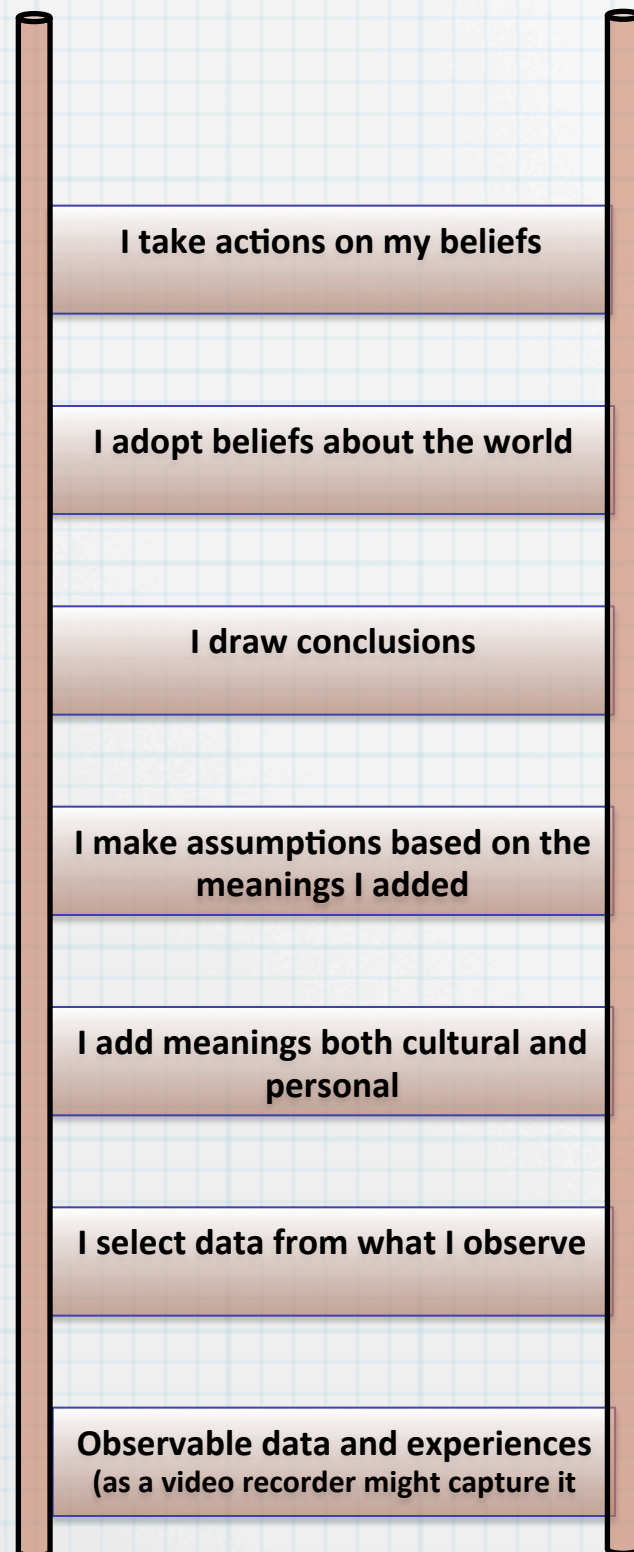
The Level of Patterns of Behavior



The Level of Systemic Structure



The Ladder of Abstraction: Mental Models



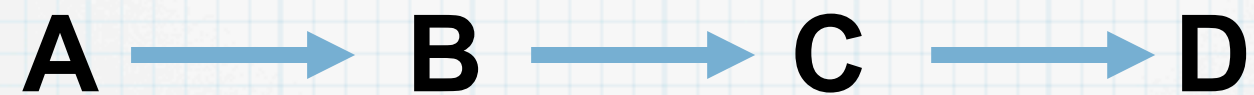
We live in a world of self-generating beliefs which remain largely untested.

We adopt those beliefs because they are based on conclusions, which are inferred from what we observe, plus our past experience.

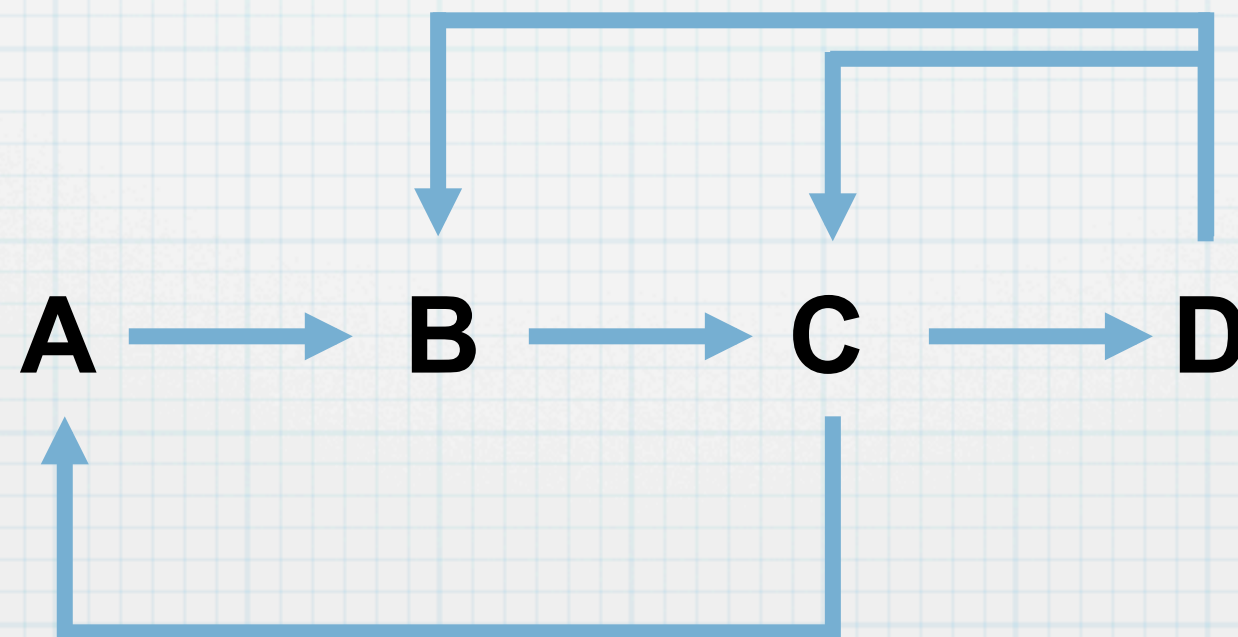
Our ability to achieve the results we truly desire is eroded by our feelings that:

- Our beliefs are the truth
- The truth is obvious
- Our beliefs are based on real data
- The data we select are the real data

Fun with Feedback



Linear thinking might assume that A causes B which causes C and in turn causes D. The world rarely works so neatly, however. Much more likely is a complex set of relationships in which A might cause B but both B and C are influenced by D and C is actually the main driver for A. The real world is almost always nonlinear.

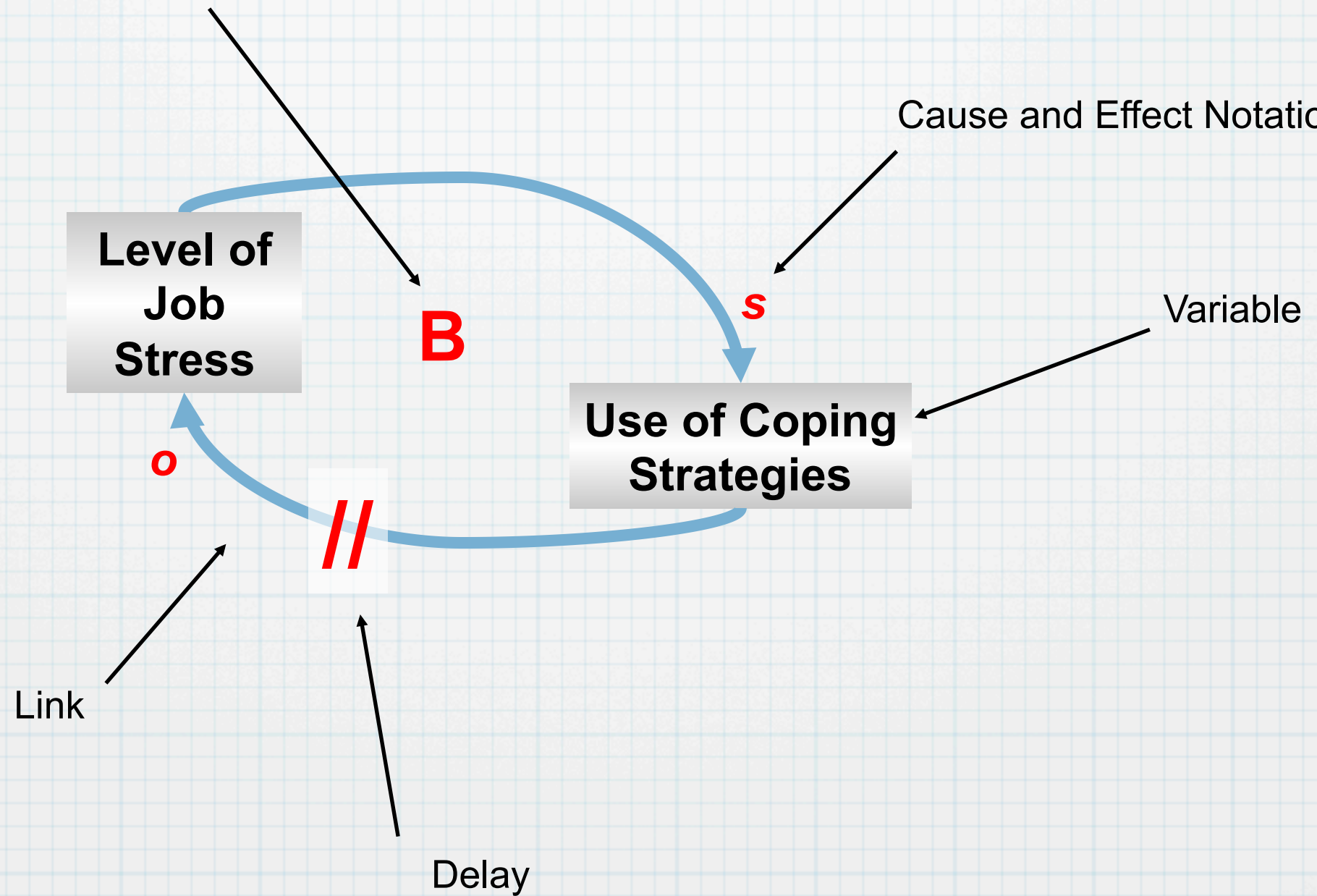


Anatomy of a Causal Loop

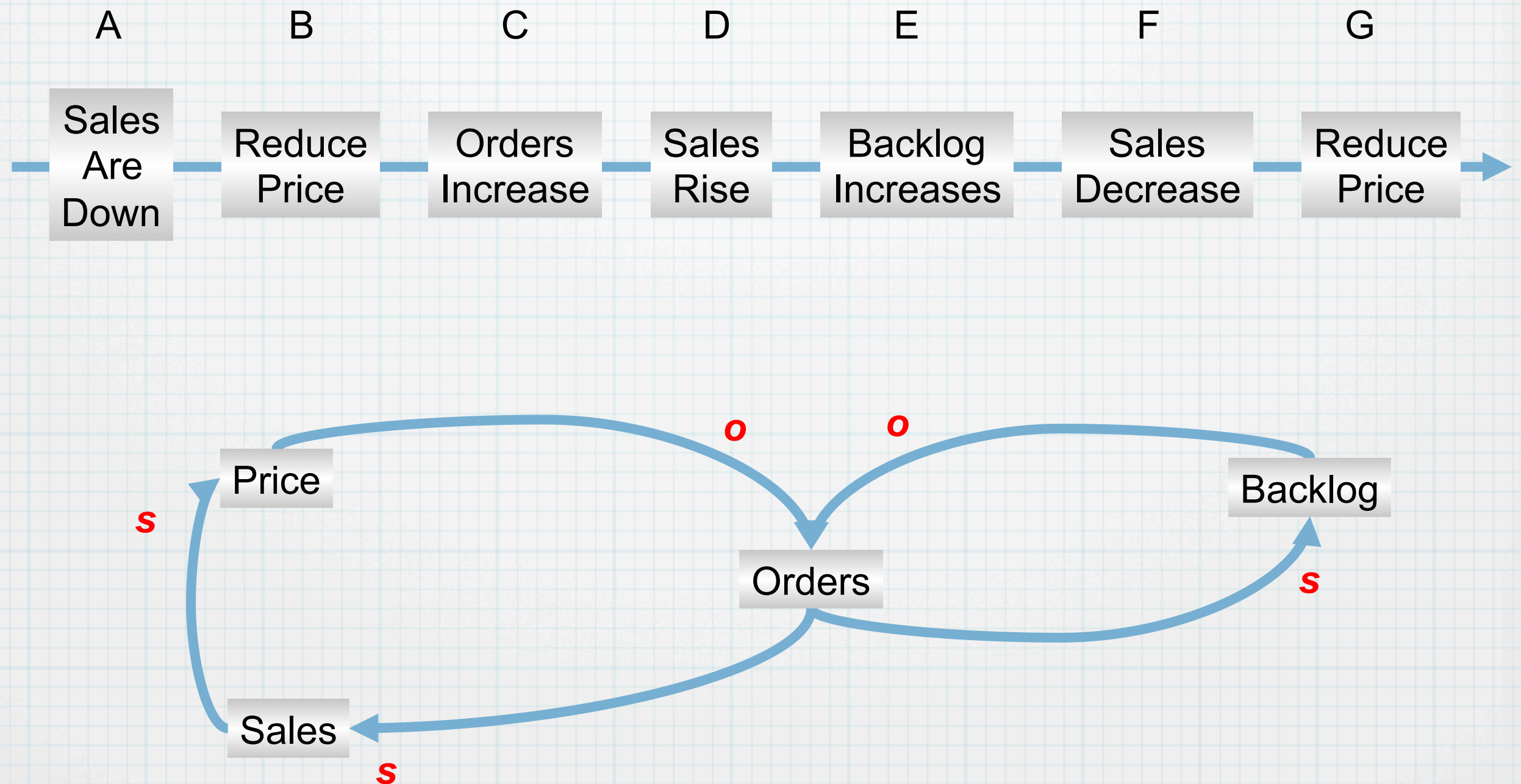
Balancing Process Notation

Cause and Effect Notation

Variable



Thinking in Loops

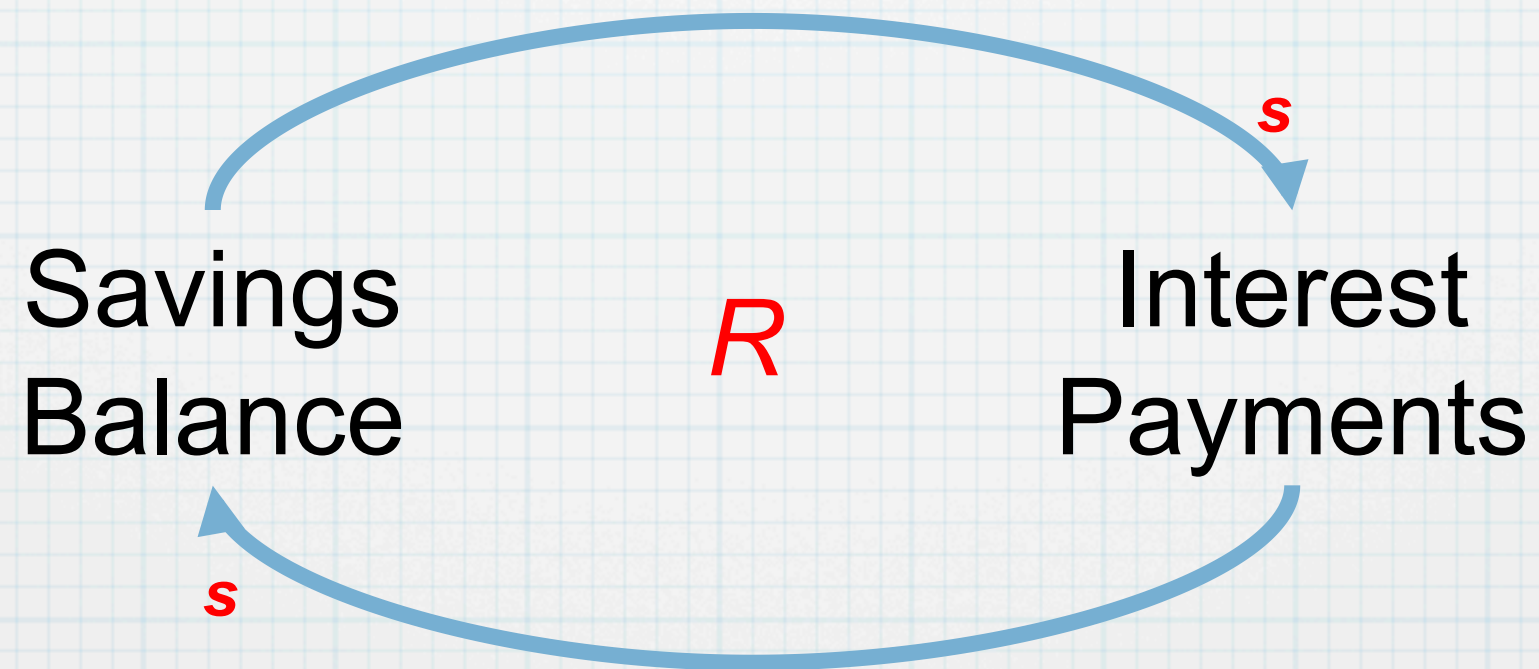


Using Causal Loops

- Description drives action
- The feedback view illuminates the interrelationships among all the events instead of event pairs
- The linear view may be technically accurate about what happened when, but it provides very little insight into how things happened and why
- Linear thinking gets stuck in chicken - egg priority questions.

Reinforcing Processes

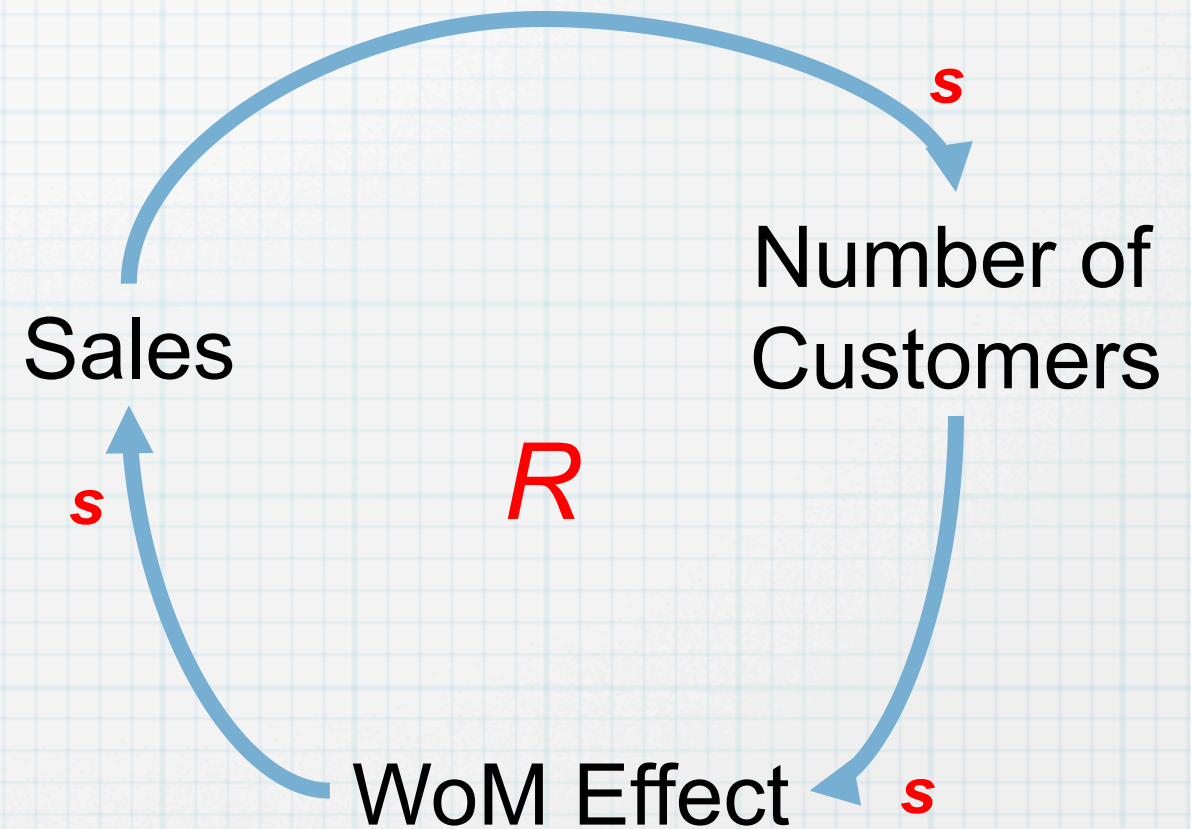
Reinforcing processes are the engines of growth and collapse
(Positive Feedback)



Reinforcing Processes (OK, you try it)

What's the WoM
Effect on Sales?

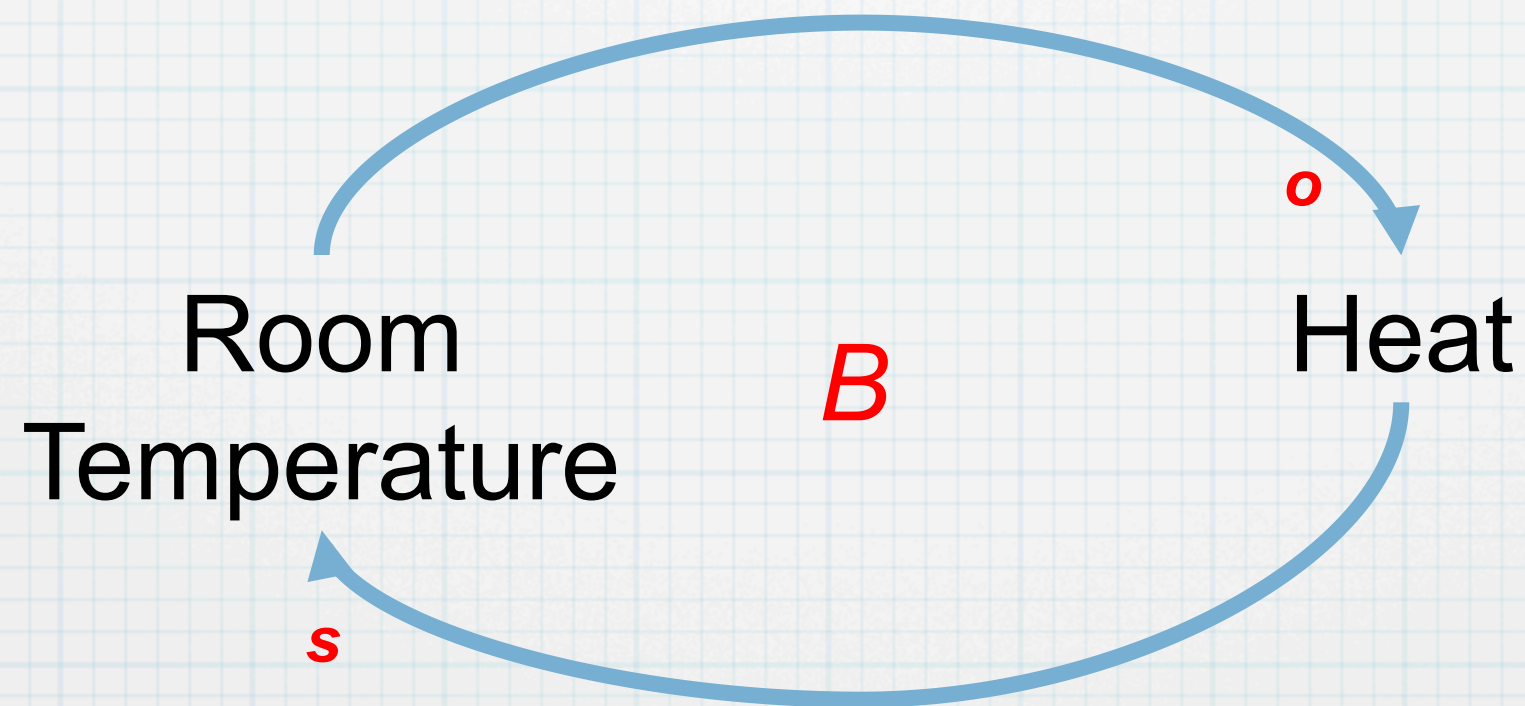
(Begin by listing the
key variables...)



Balancing Processes

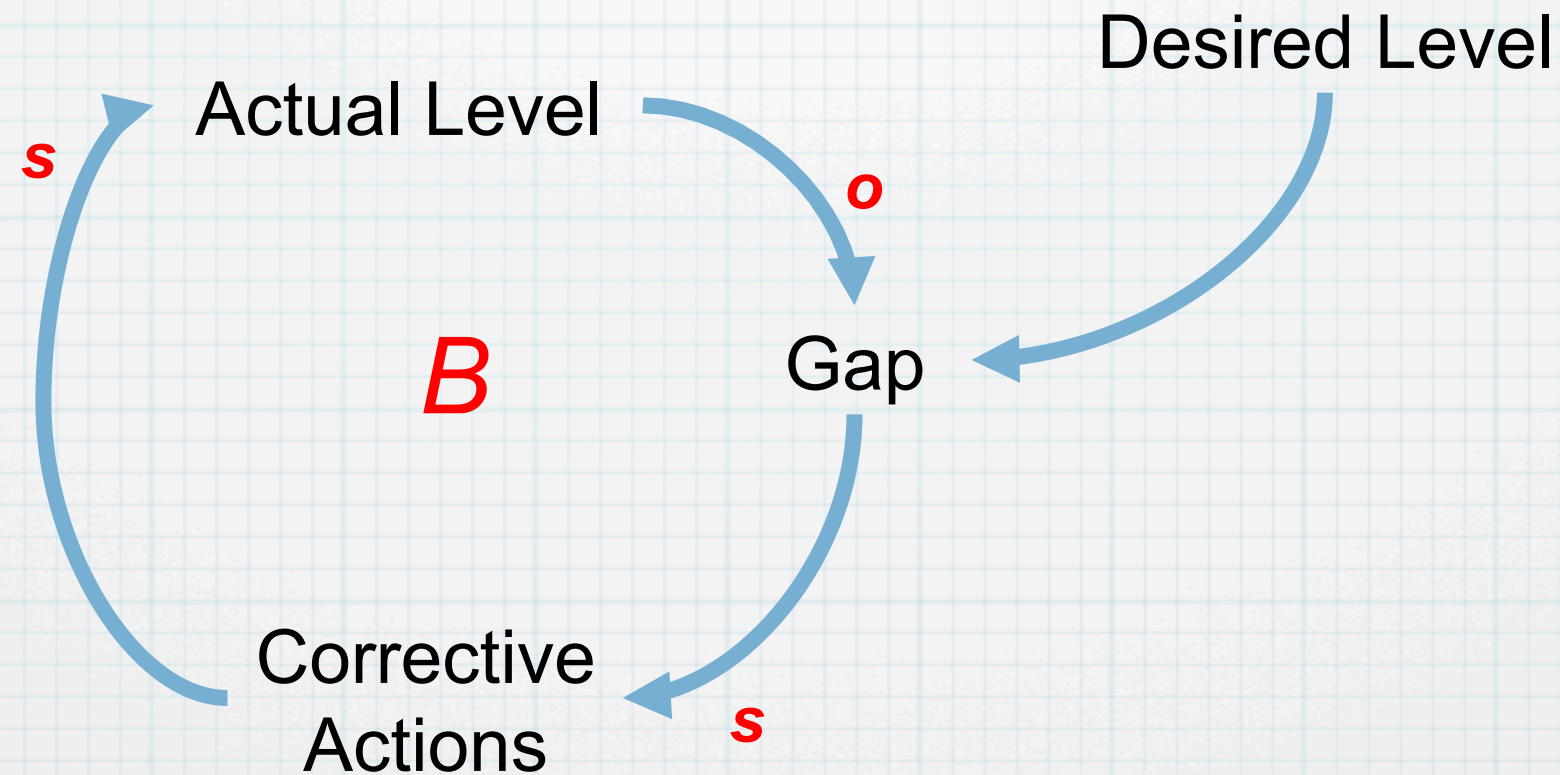
Balancing processes are the great stabilizers

They are driven by the gap between a desired level (goal) and an actual level



Balancing process are far more numerous but much more subtle than reinforcing processes

Structure of Balancing Processes

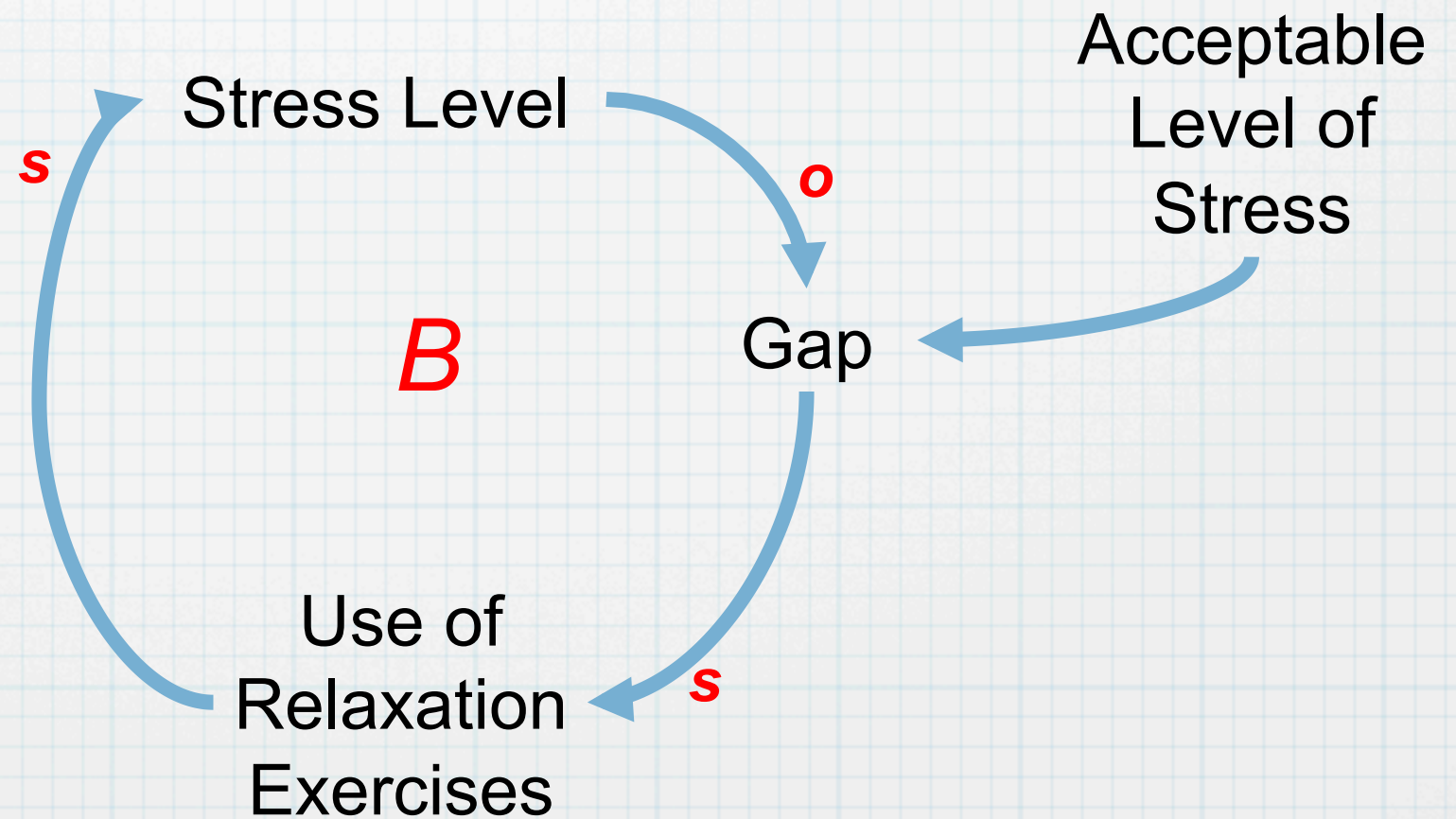


Structure of Balancing Processes (OK, you try it)

Stress Level

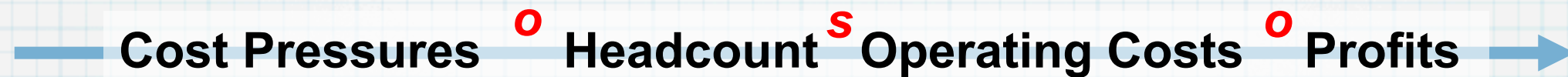
Acceptable
Level of
Stress

Use of
Relaxation
Exercises

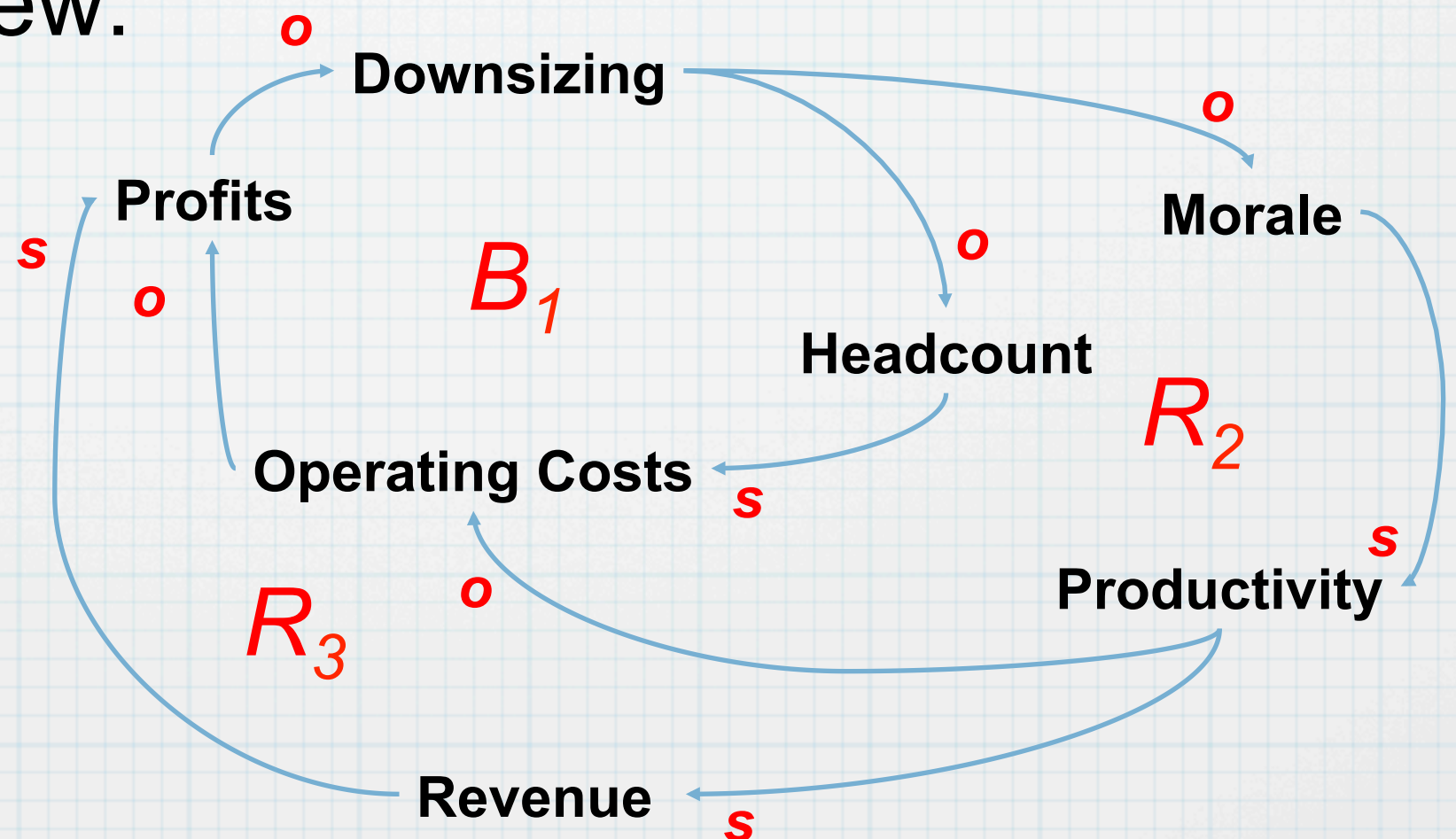


Perspective

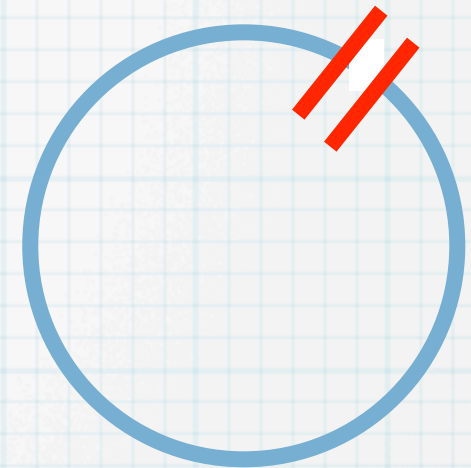
The Linear View:



The Systems View:



Delays



- Physical: measure actual time
- Transactional: process throughput
- Communication: sending and receiving
- Perceptual: receiving and correctly interpreting

Do's and Don'ts of Applying Systems Thinking

GENERAL GUIDELINES

- **Don't** use systems thinking to further your own agenda. Strong advocacy will create resistance -- reserve systems thinking for inquiry, not inquisition.
- **Do** use systems thinking to sift out major issues and factors. Systems thinking is strongest when used to break through the distraction of events to recognize patterns of behavior and structures.
- **Don't** use systems thinking to blame individuals. Chronic unresolved problems are more often the result of systemic breakdowns than individual mistakes. Solutions to these problems lie at the systemic, not the individual level.
- **Do** use systems thinking to promote inquiry and challenge preconceived ideas.

GETTING STARTED

- **Don't** attempt to solve a problem immediately. Don't expect persistent and complex systemic problems to be represented, much less understood, overnight. The time and concentration required should be proportional to the difficulty and scope of the issues involved. A realistic goal is : to increase understanding.
- **Do** start with smaller scale problems.
- **Don't** attempt to diagram the whole system -- it will become overwhelming rapidly.
- **Don't** work with systems thinking techniques "on line," under pressure, or in front of a group that is unprepared or intolerant of the learning process.
- **Do** develop your diagrams gradually and informally to build your confidence slowly. Good practice: diagram current events and share them with friends. Try matching an archetype to a story.
- **Don't** worry about drawing loops right away. Seek to surface good questions.

Do's and Don'ts of Applying Systems Thinking (cont.)

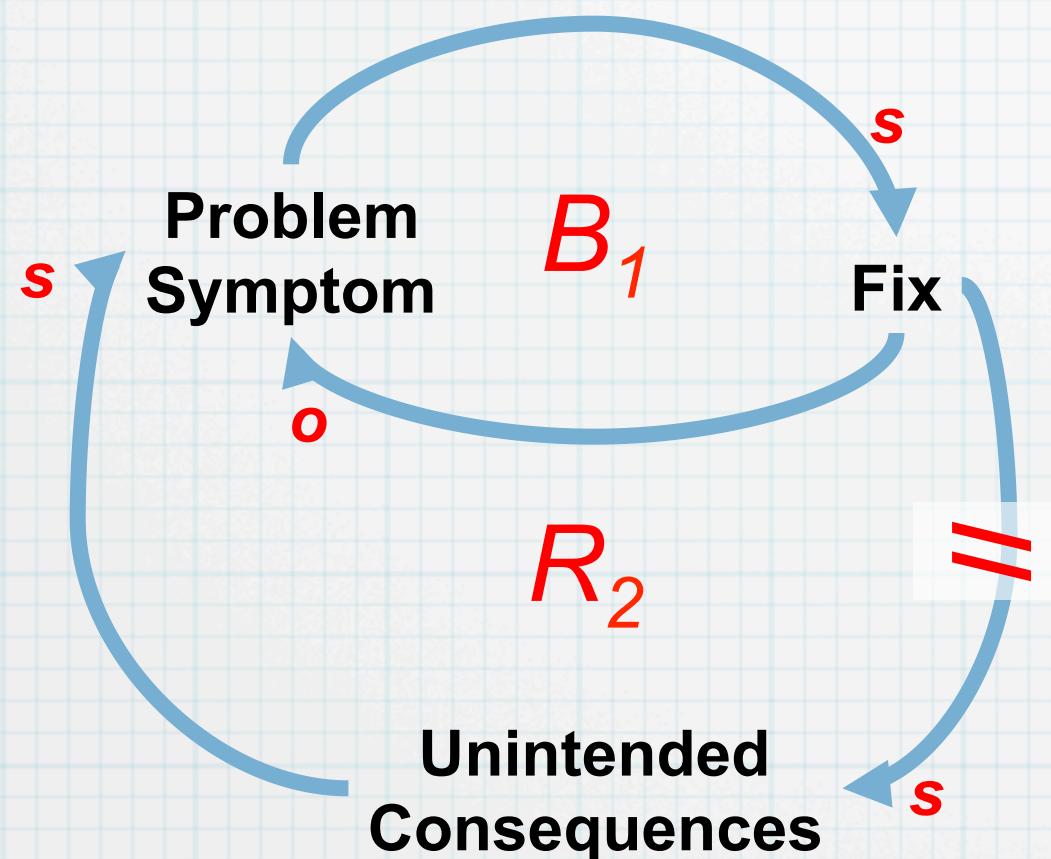
DRAWING DIAGRAMS

- **Do** start with the process of defining variables. Do encourage airing of assumptions.
- **Do** start with a central loop or process. Then add detail as necessary.
- **Don't** get bogged down in details. Start simply, at a high level, but with enough detail to sum up the observed behavior.
- **Do** begin by looking for templates or general structures that clarify the problem.
- **Do** work with partners. Multiple viewpoints add richness and detail to the understanding of a problem.
- **Do** work iteratively. Good diagrams are not drawn, they are redrawn. Looping is a learning process.
- **Don't** present causal loop diagrams as finished products. Present as a tentative and evolving picture of how you are seeing things.

PLANNING SYSTEM INTERVENTIONS

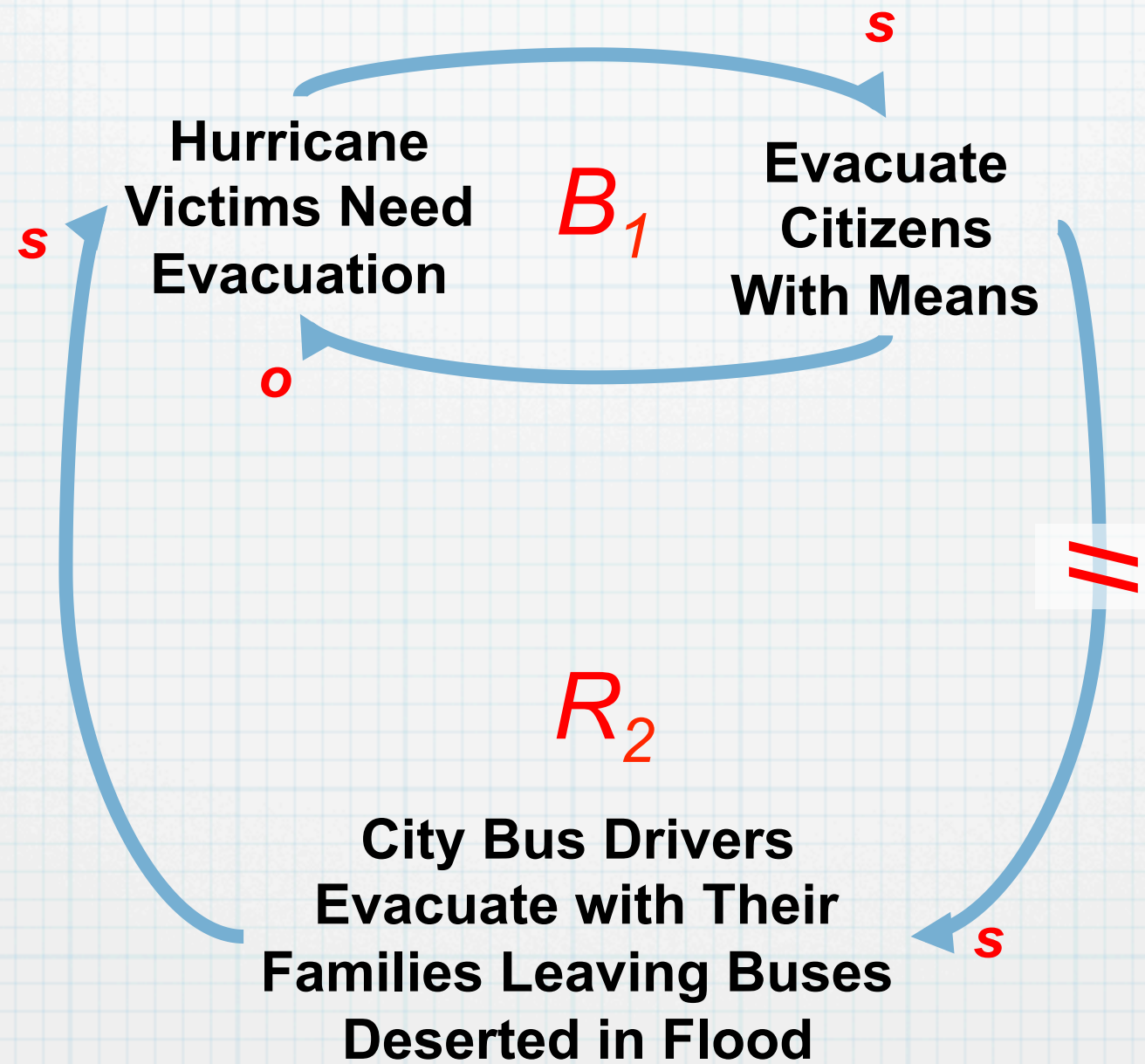
- **Don't** go for general or vague solutions such as "improve communications."
- **Do** get all stakeholders involved in the process.
- **Do** make an intervention specific, measurable, and verifiable.
- **Don't** work with systems thinking techniques "on line," under pressure, or in front of a group that is unprepared or intolerant of the learning process.
- **Don't** be surprised if some situations defy solution, especially if they are chronic problems. Resist the tendency to "solve" the problem by adding yet another layer of a superficial band-aid.

Fixes That Fail Archetype

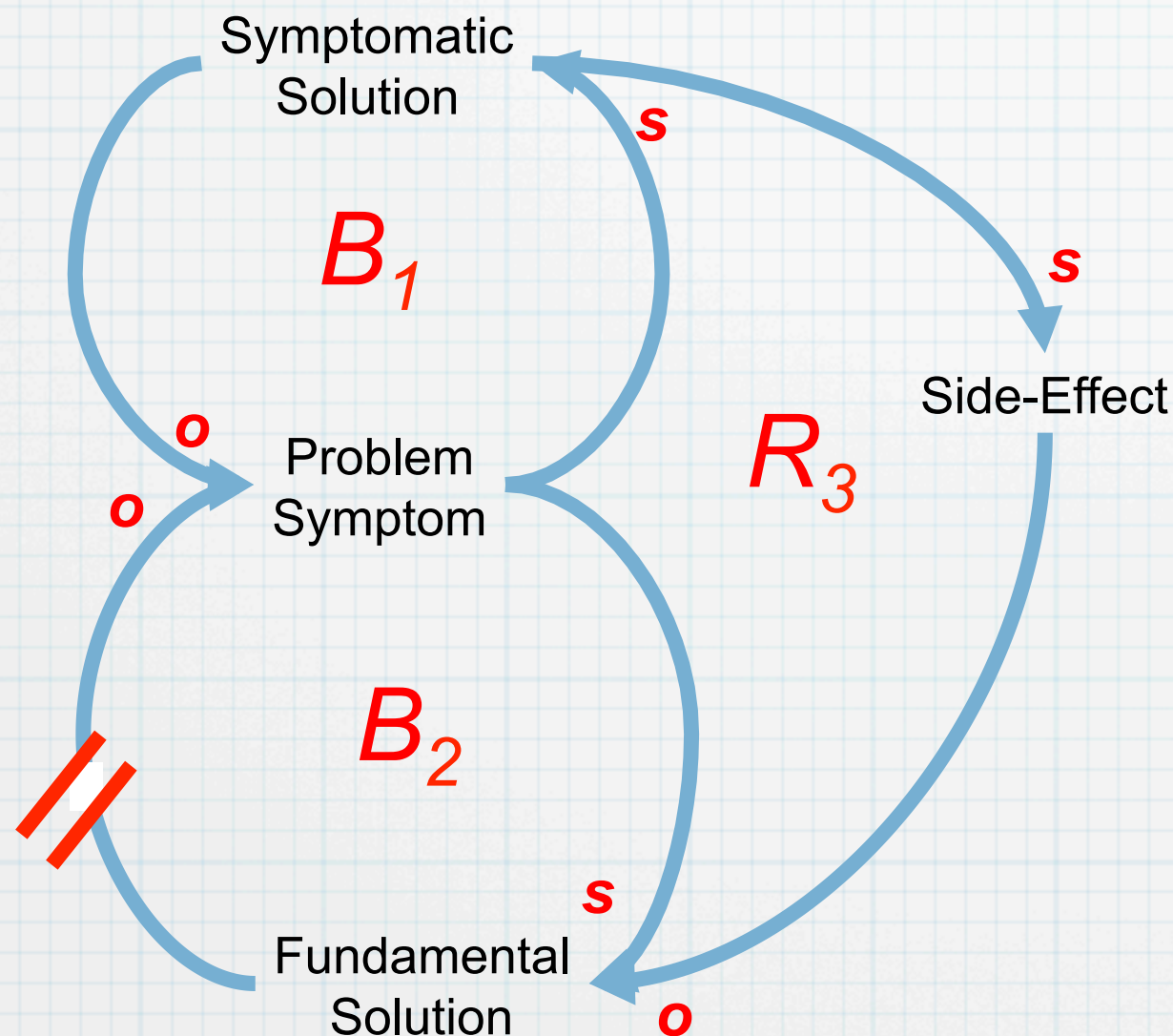


In a “Fixes That Fail” situation, a problem symptom cries out for resolution. A solution is implemented, which alleviates the symptom. However, the solution produces unintended consequences that, after a delay, cause the original problem symptom to return to its previous level or get worse. This development leads us to apply the same fix again.

Fixes That Fail Archetype



Shifting the Burden Archetype



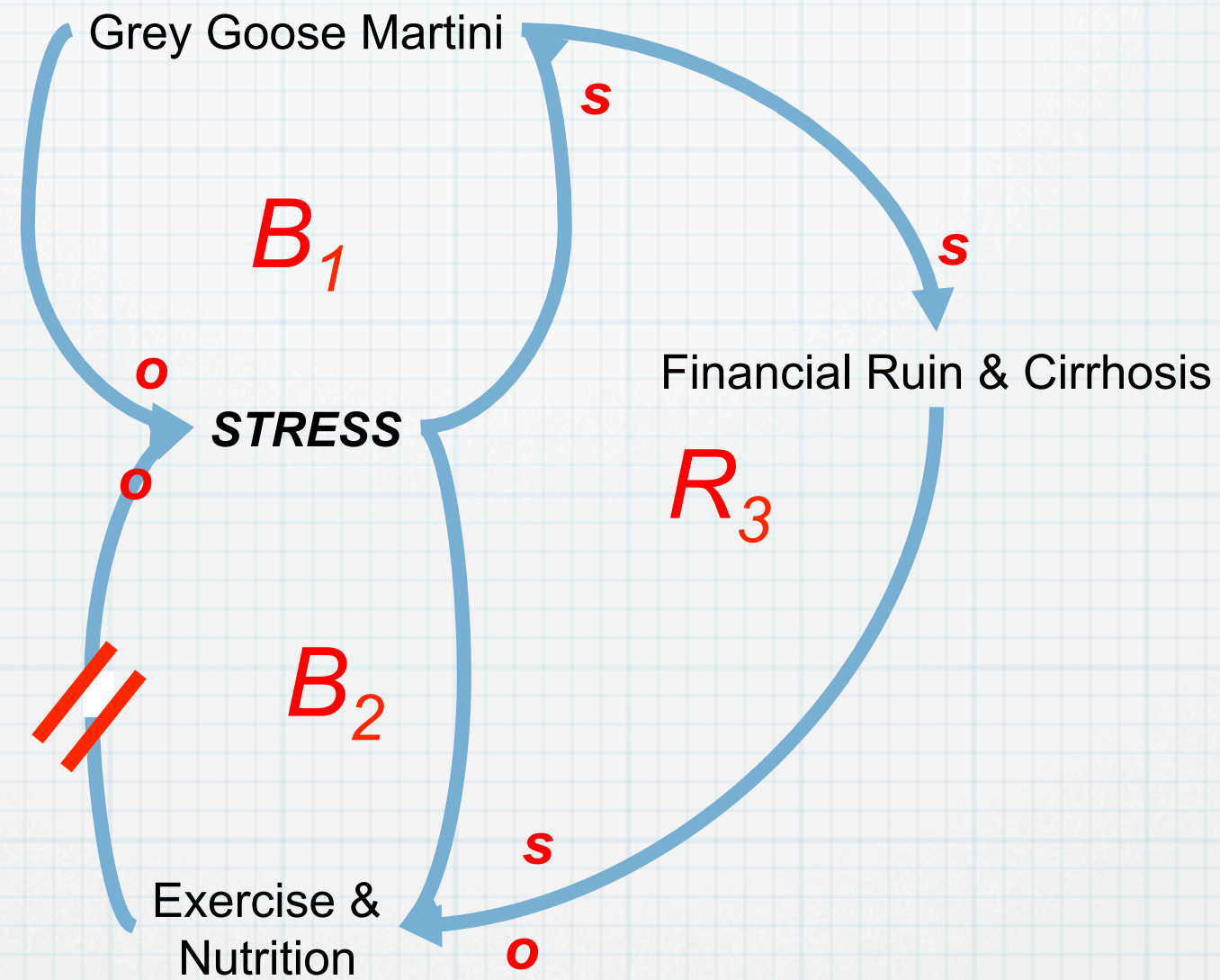
In a “Shifting the Burden” situation, a problem symptom can be addressed by applying a symptomatic solution or a more fundamental solution.

When a symptomatic solution is implemented, the problem is reduced or disappears, which lessens the pressure for implementing a more fundamental solution.

Over time, the symptom resurfaces, and another round of symptomatic solutions is implemented in a vicious, figure-8 reinforcing cycle.

The symptomatic solutions often produce side-effects that further divert attention away from more fundamental solutions.

Shifting the Burden Archetype

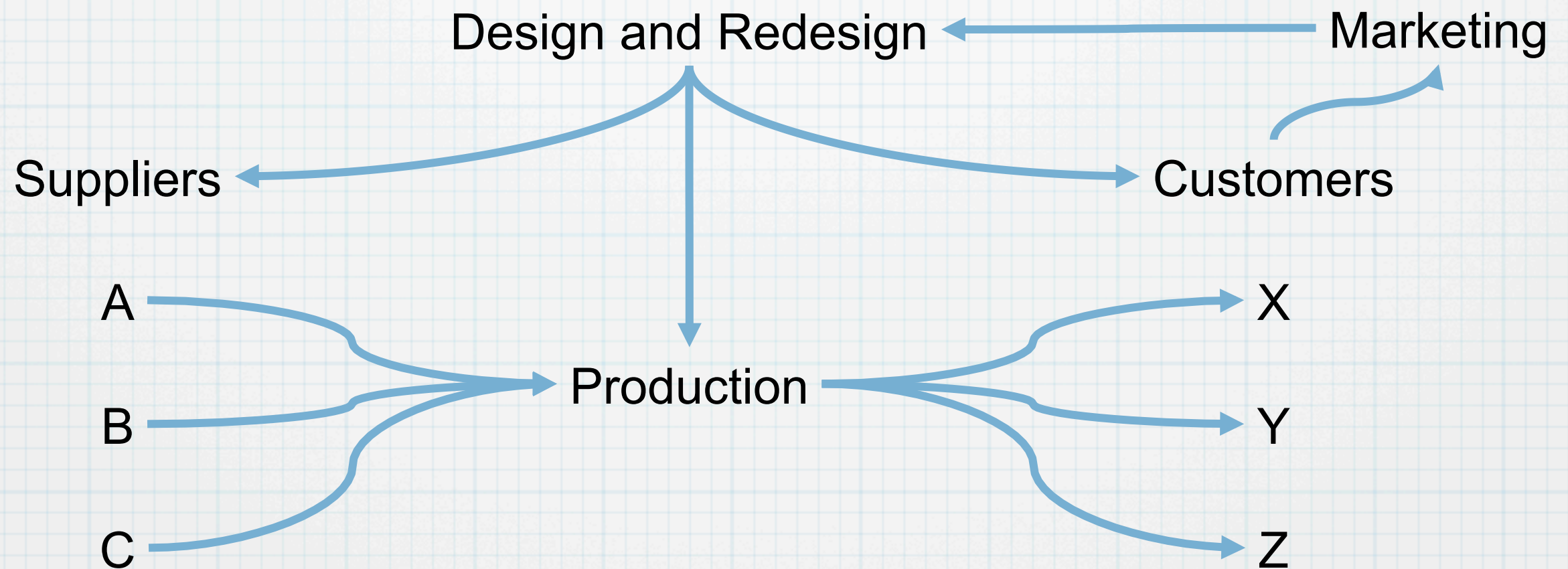


The Toolbox of System Models is Diverse



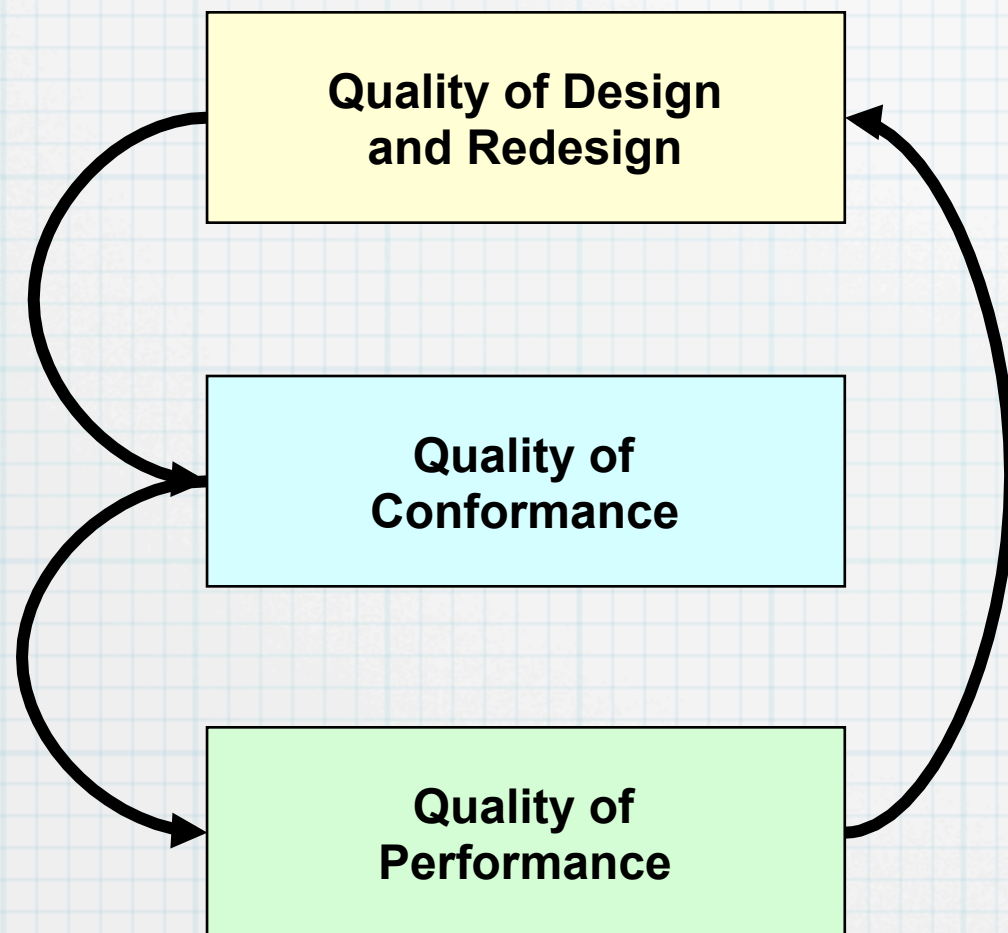
“Say, Jeff—why don’t you pull that thing out and play us a tune?”

Deming's View of the Company as a System



Quality as a System

Three Dimensions of Service Quality

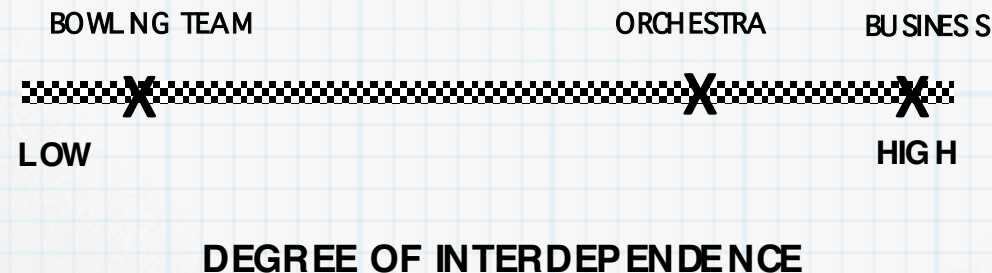


What's important?

How good are we at doing what's important?

Is it having a meaningful effect on business performance?

Dr. Deming on Systems



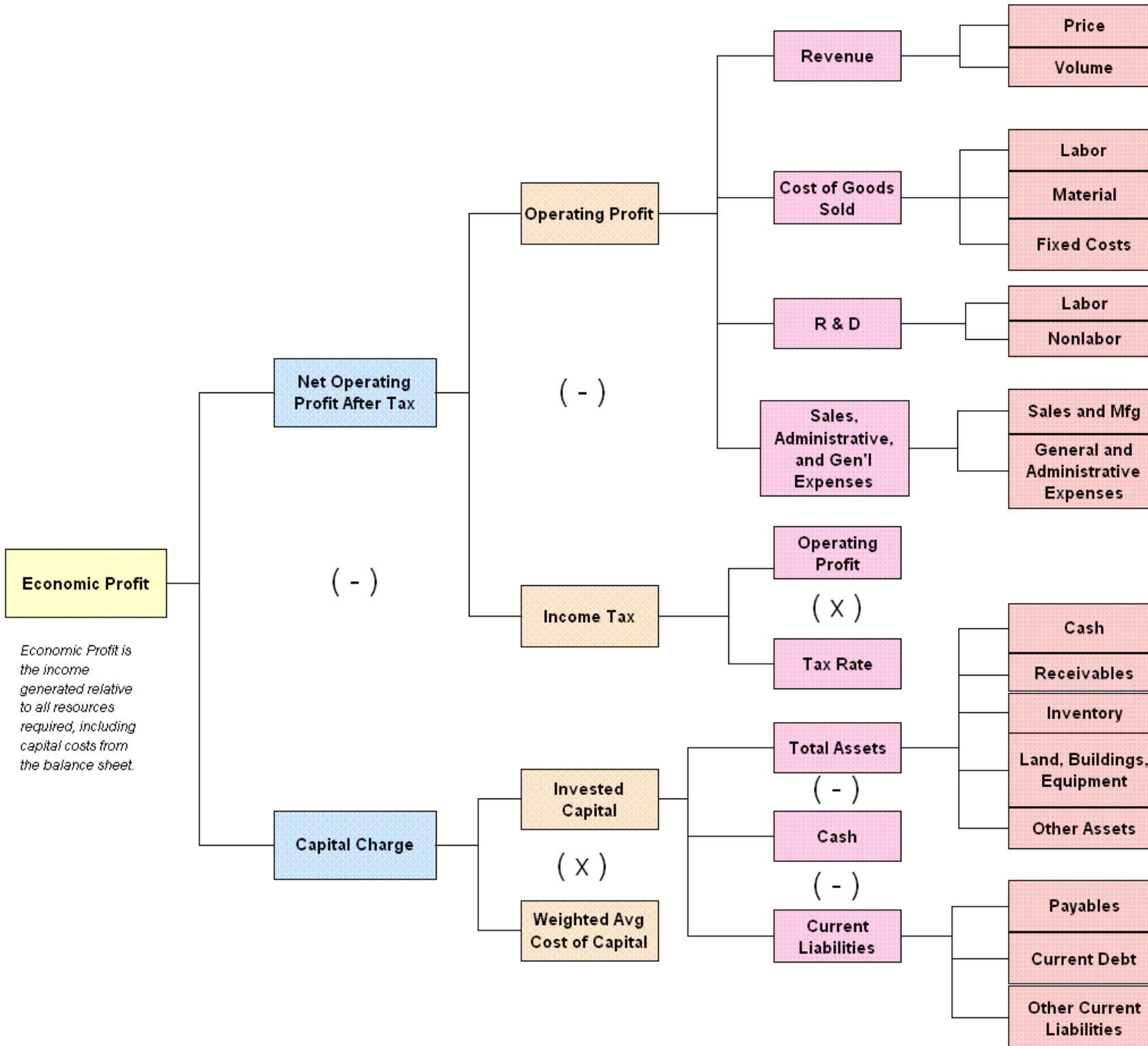
"What is a system?

It is a series of functions or activities (subprocesses or stages) within an organization that work together for the aim of the organization."

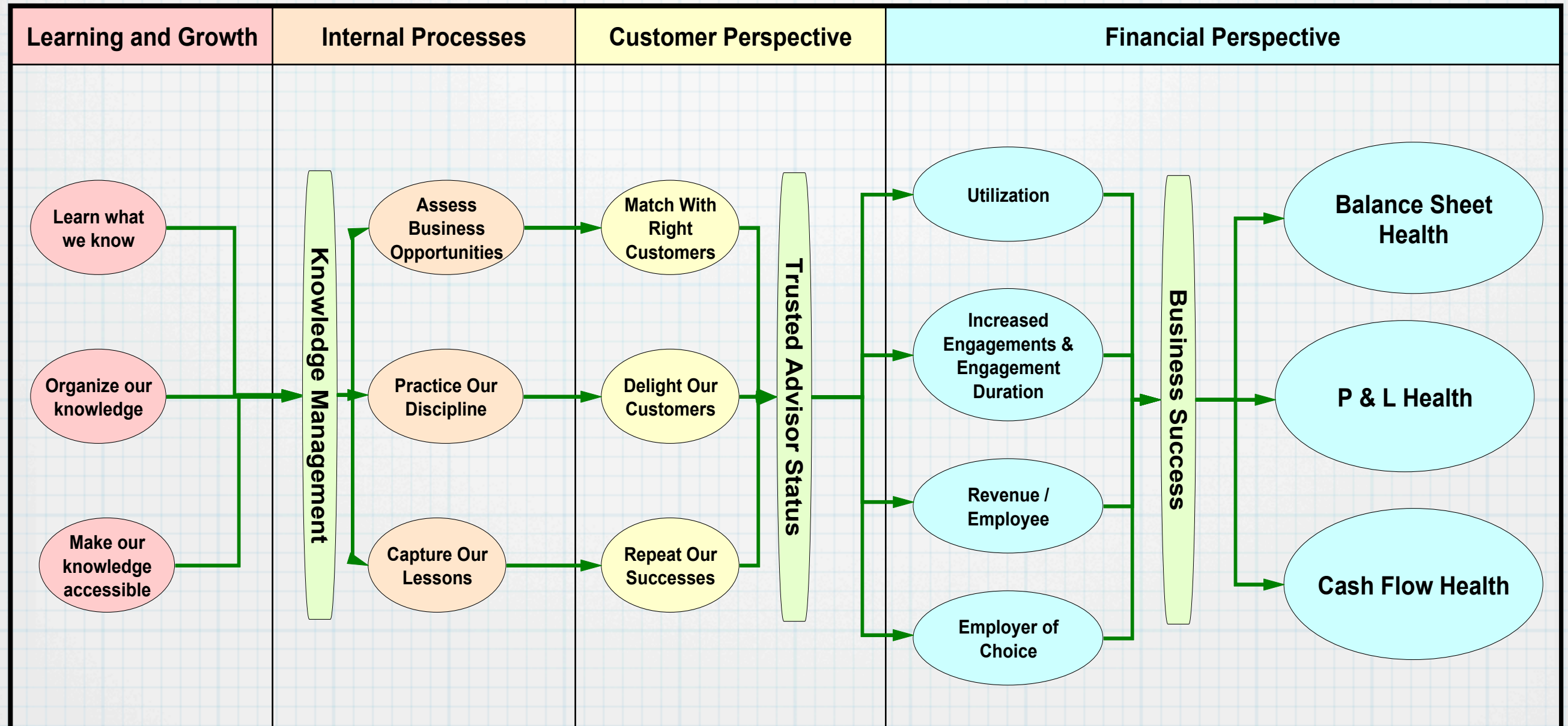
"The performance of any component subprocess is to be evaluated in terms of its contribution to the aim of the system, not for its individual production or profit, nor for any other competitive measure."

"It would be poor management, for example, to purchase materials at lowest price, or to maximize sales, or to minimize cost of manufacture or design of product, or of service, or to minimize cost of incoming supplies, to the exclusion of the effect on other stages of production and sales. All these activities should be coordinated to optimize the whole system."

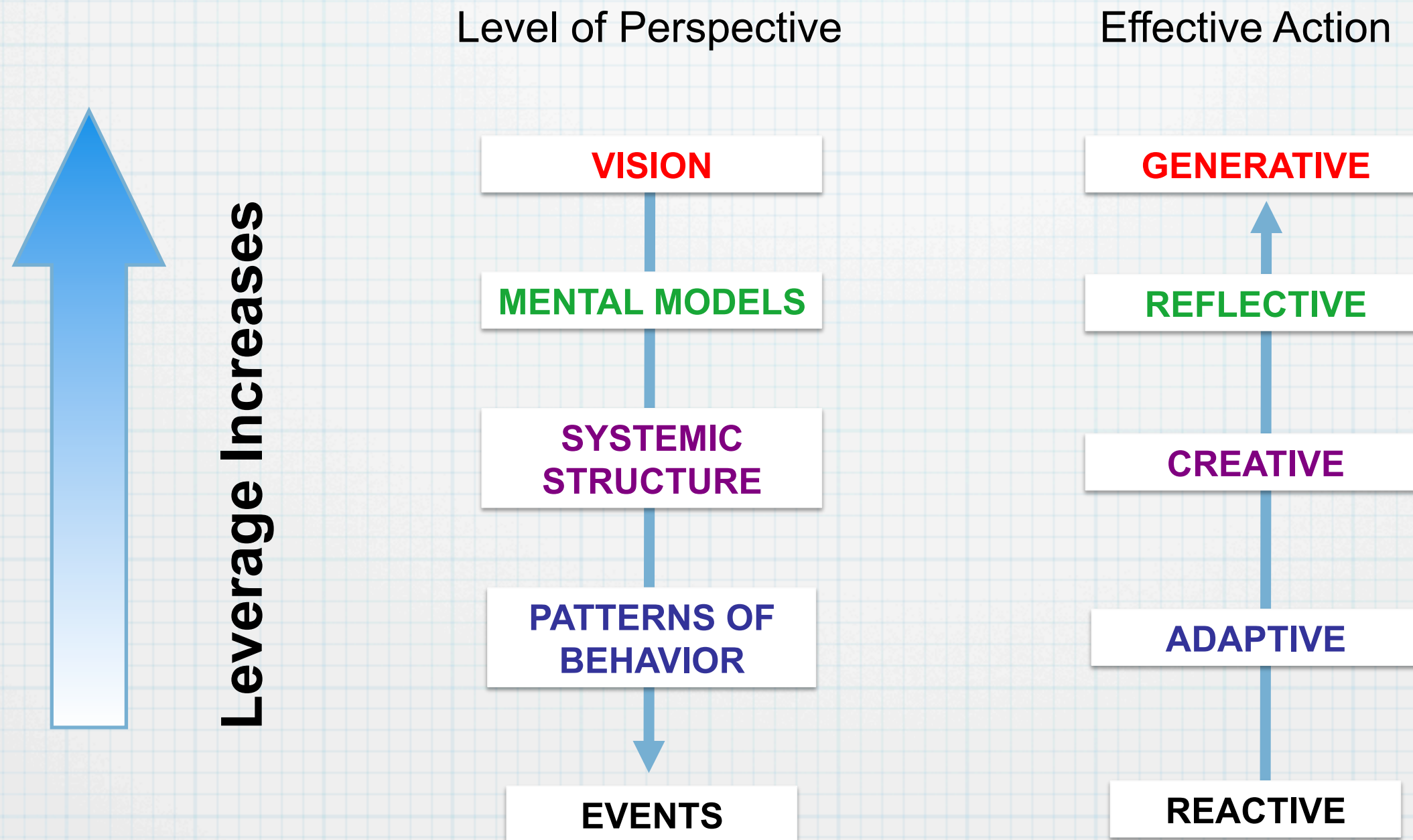
Profit - Cost System



Strategy as a System



Working With Systems



A Vision of Business

- An industrialist has a valuable mission that is no less noble than religion which brings spiritual peace and happiness to people;
- The mission of industries and business is to enrich society and wipe out poverty, and that development and prosperity of individual corporations is socially accepted for the very purpose of them accomplishing such mission;
- Therefore attaining the social mission must come first and prosperity of individual companies second.

- Matsushita Konosuke (founder of Matsushita Electric) in 1932 speech on corporate vision and mission. From Kaminogo, Toshiaki, 1989. *Konosuke Matsushita: My Final Words to the 21st Century*. (Japanese). Kodansha Press.

To make a prairie it takes
a clover and one bee,
One clover, and a bee,
and revery. The revery
alone will do,
If bees are few

-- Emily Dickinson

Homework

Working with at least one other person, draw one CLD from current events and one relating to the Company Business Model.

Be prepared to present next Wednesday (Sept 21).

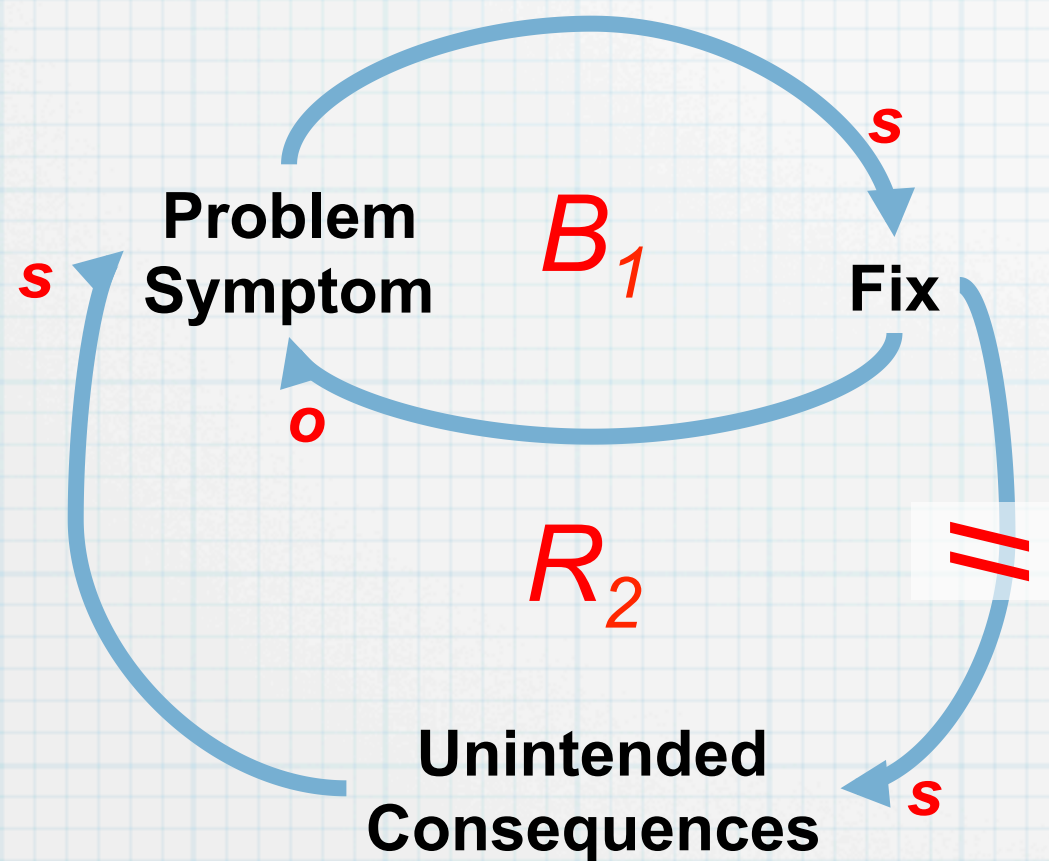
Systems Thinking

Part Deux

Or why cutting a cow in half doesn't produce two little cows

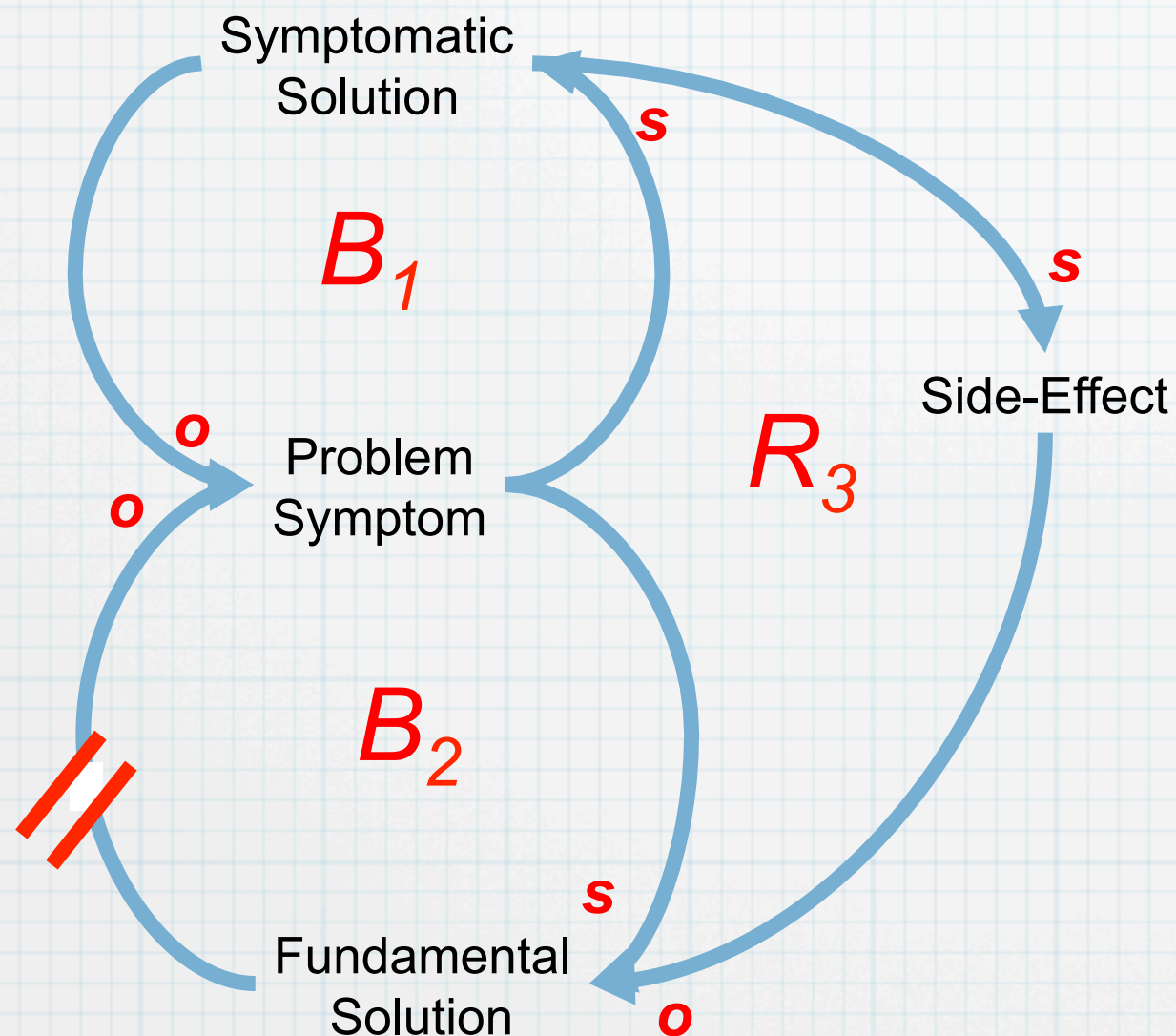
21 September 2005

Fixes That Fail Archetype



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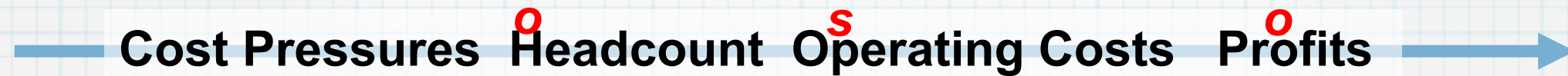
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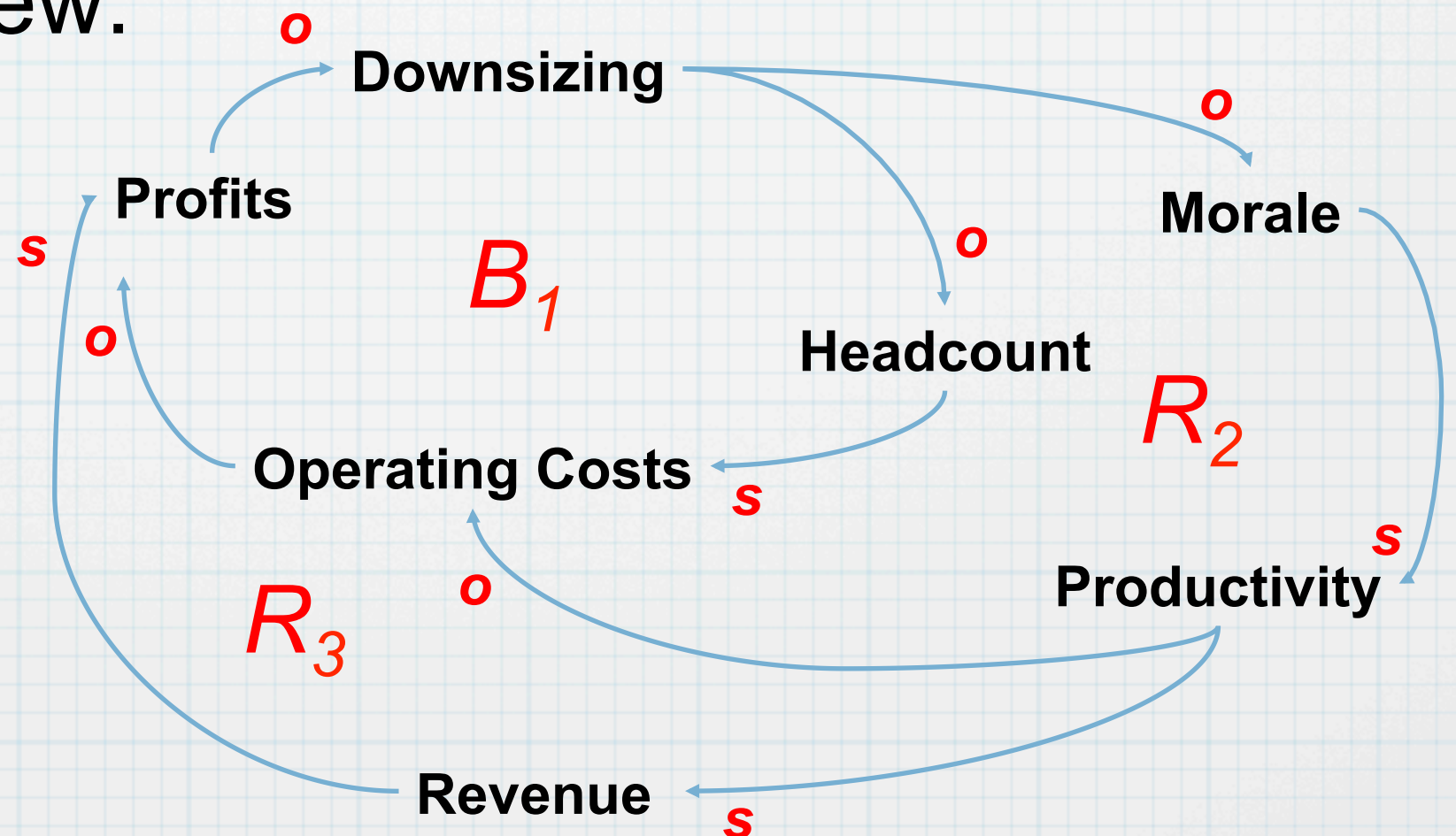
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Perspective on Downsizing

The Linear View:



The Systems View:

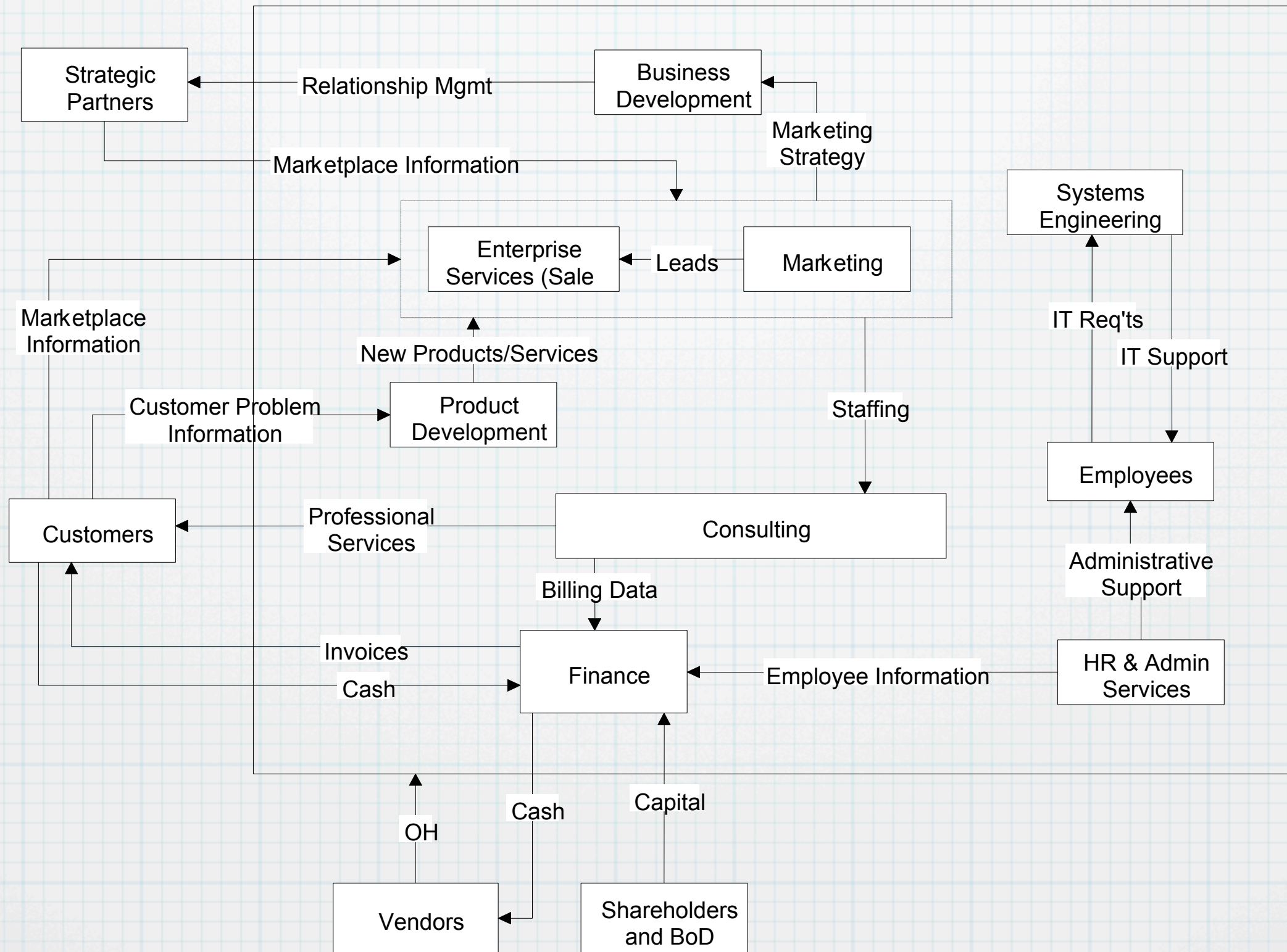


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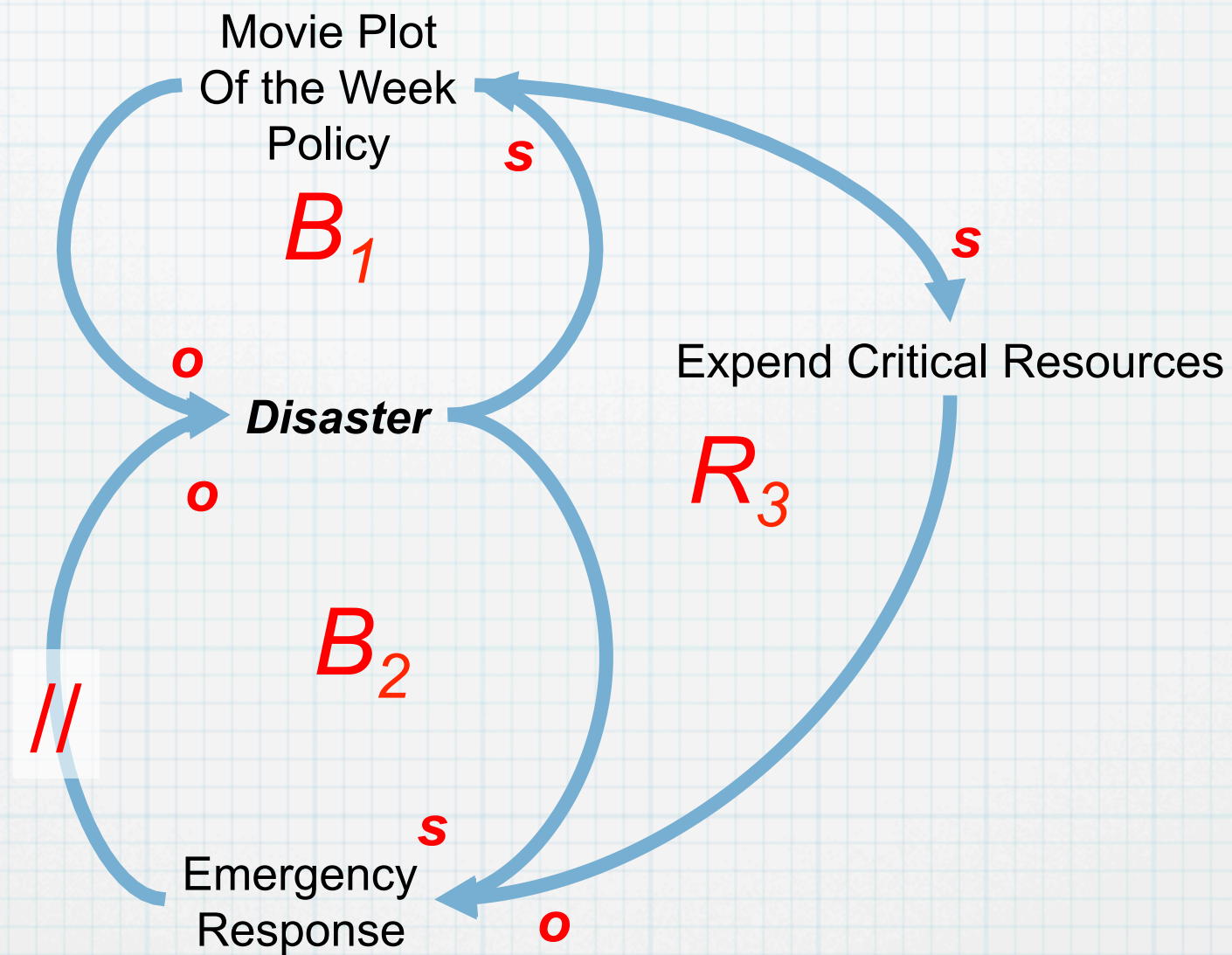
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One View of the CSS System



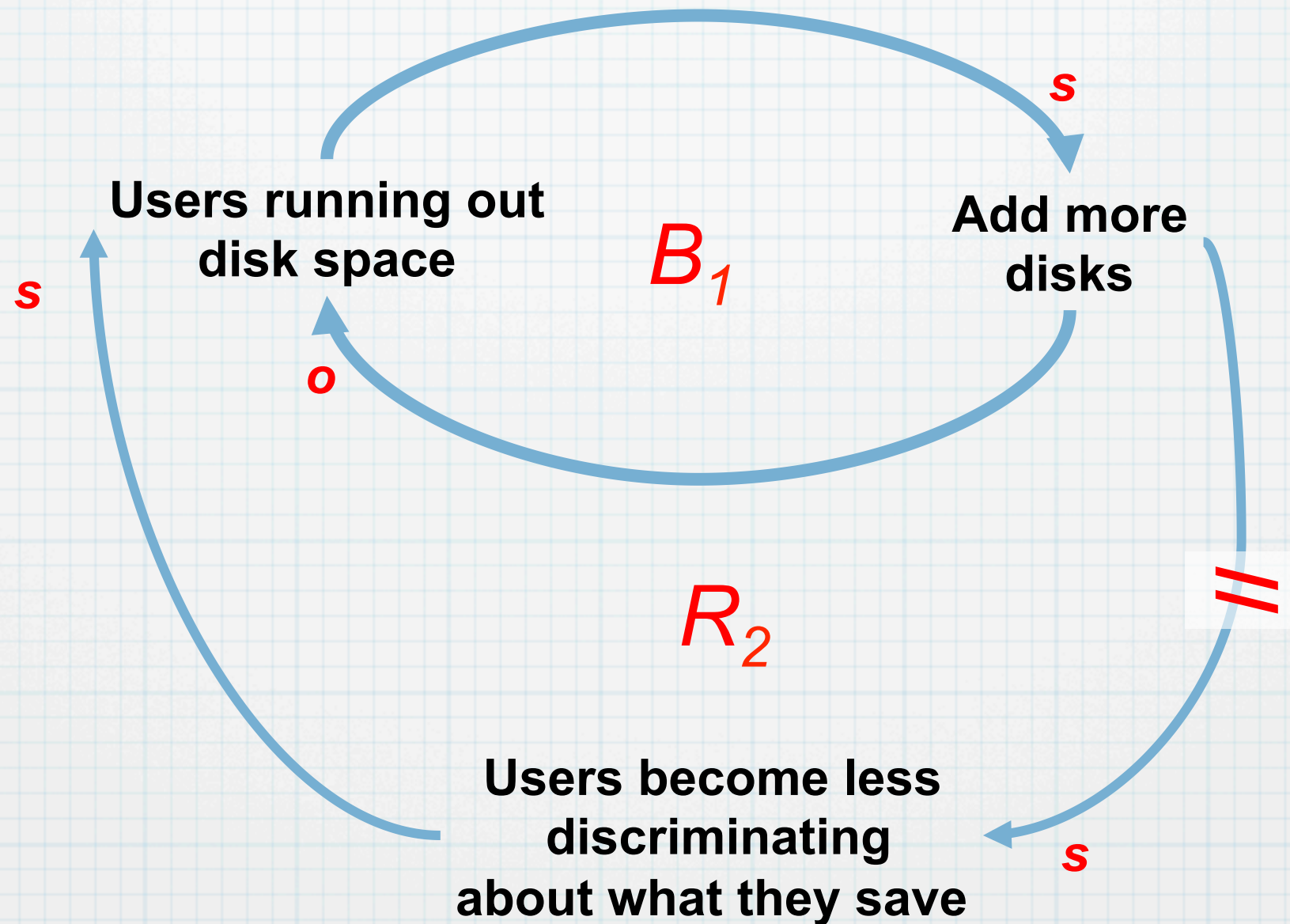
Shifting the Burden Archetype

(Thank you Bruce Schneier)



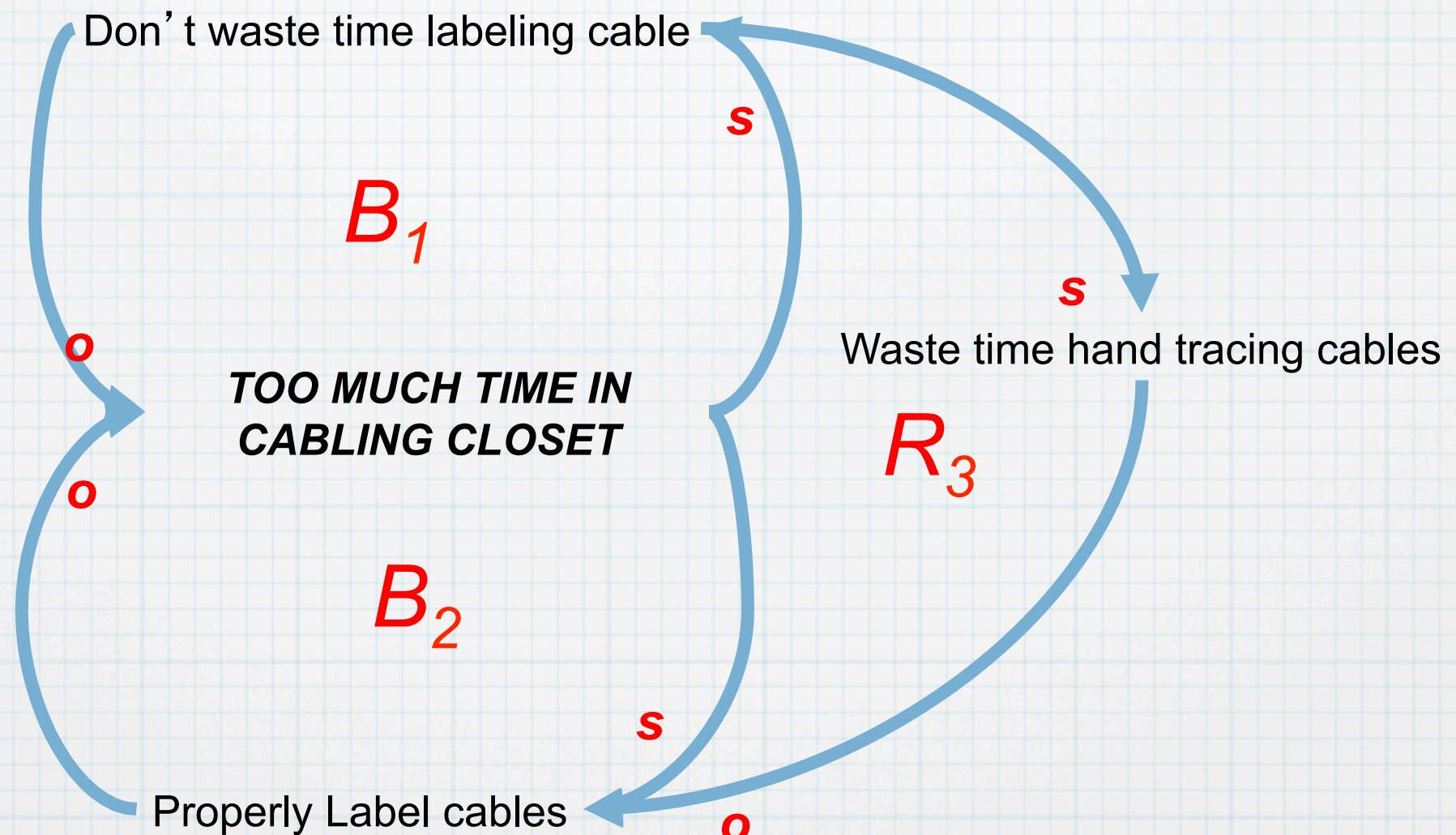
Fixes That Fail Archetype

(Michael Shih and Mark Gamache)



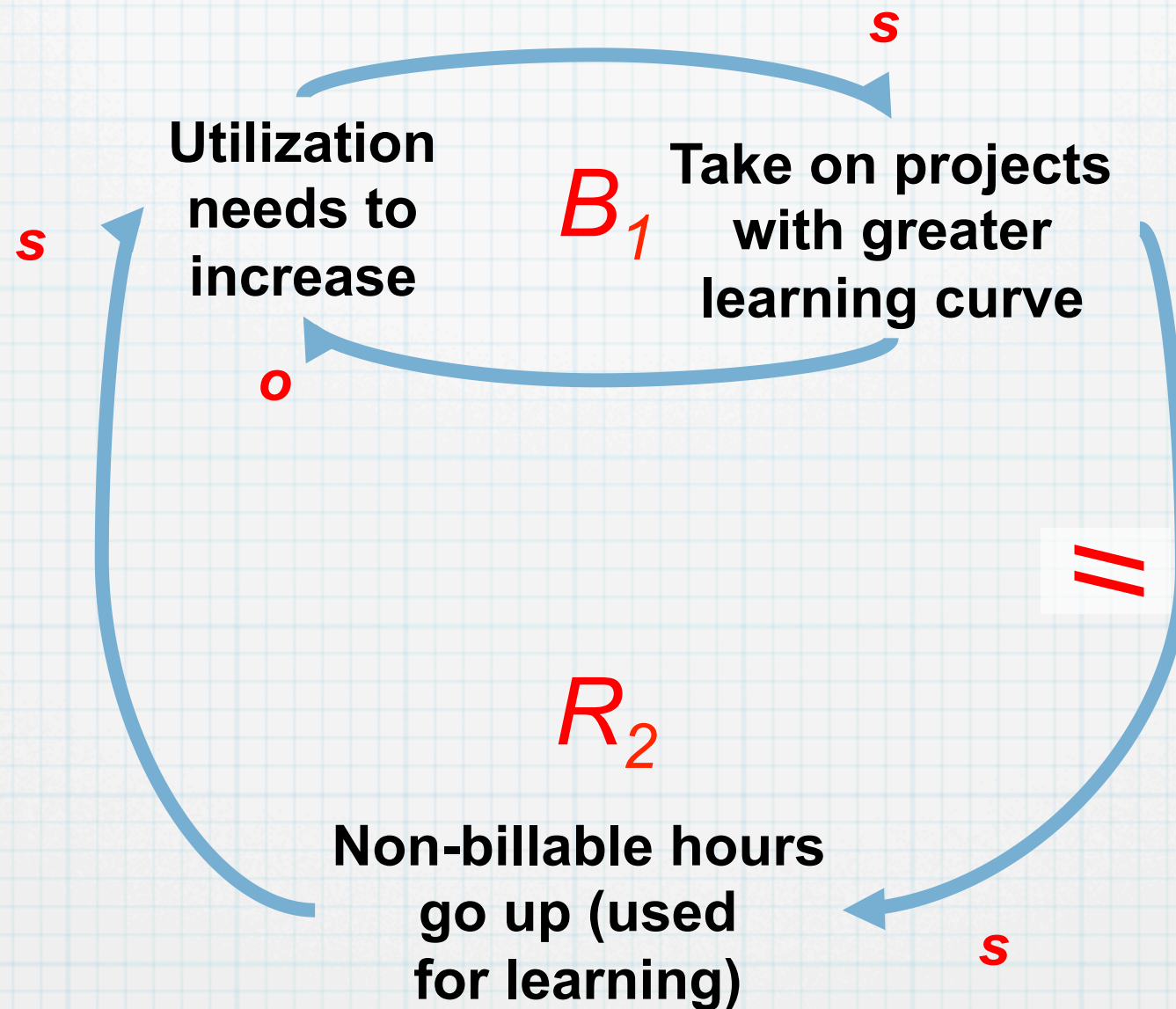
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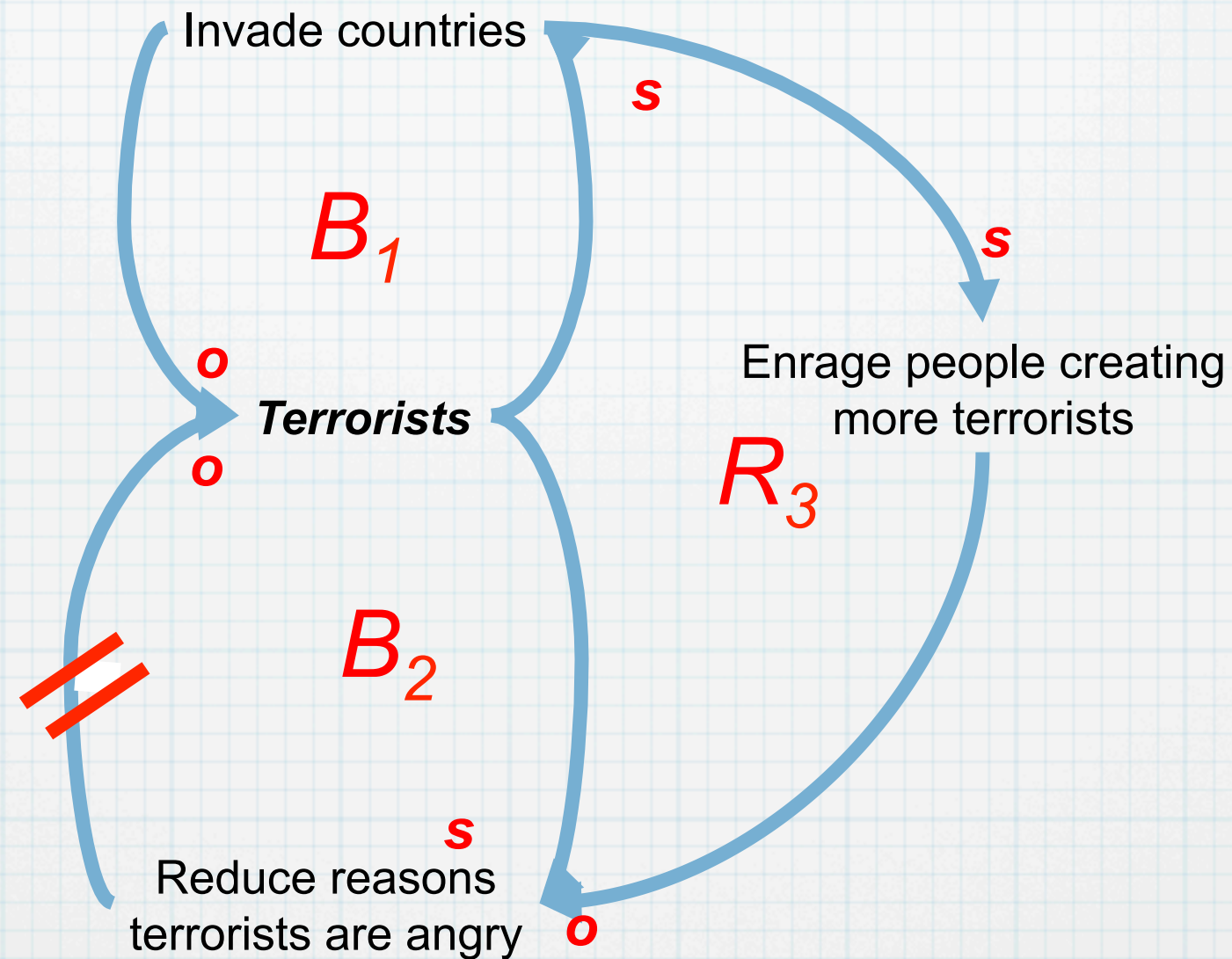
Fixes That Fail Archetype

(Arlene and Doug)

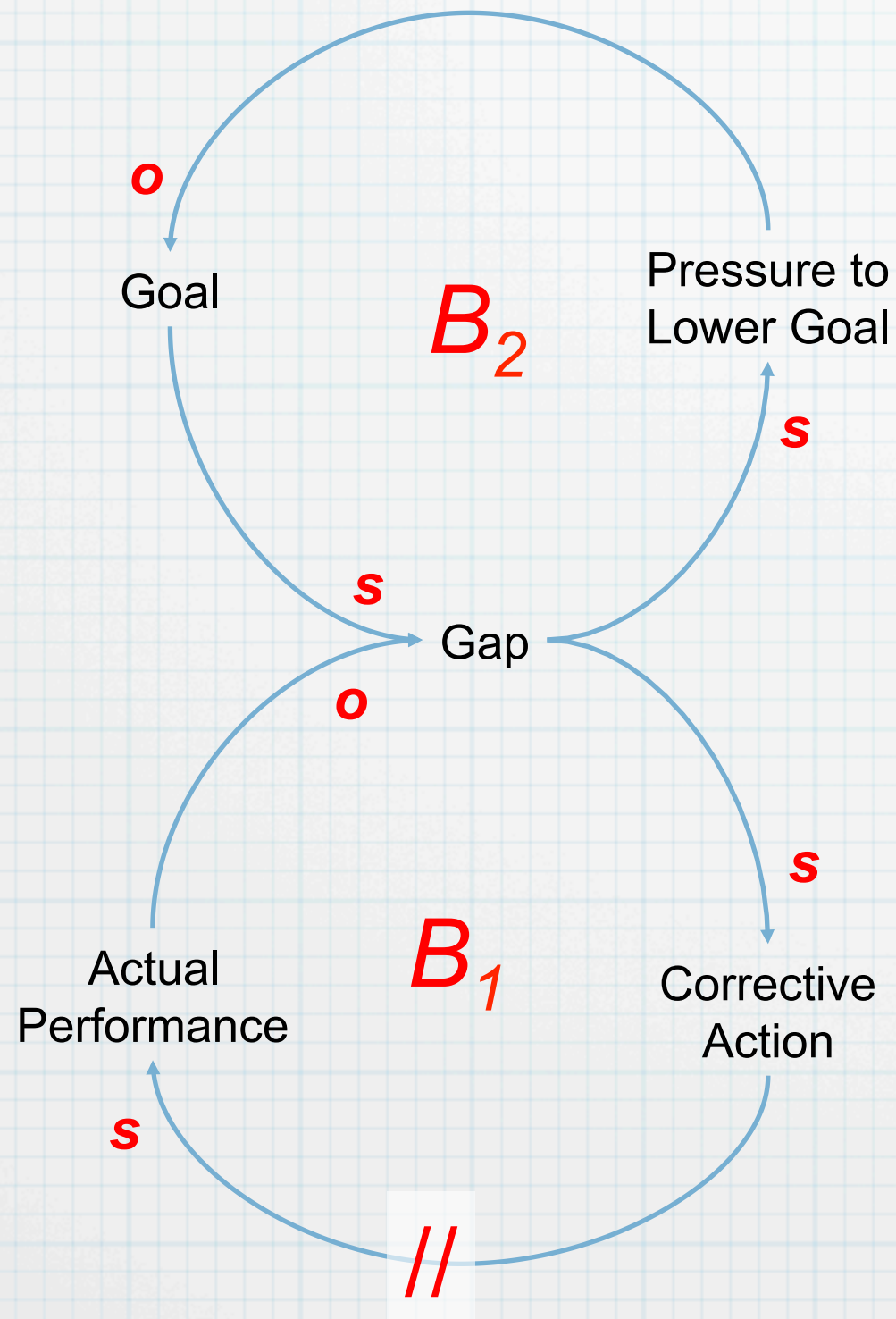


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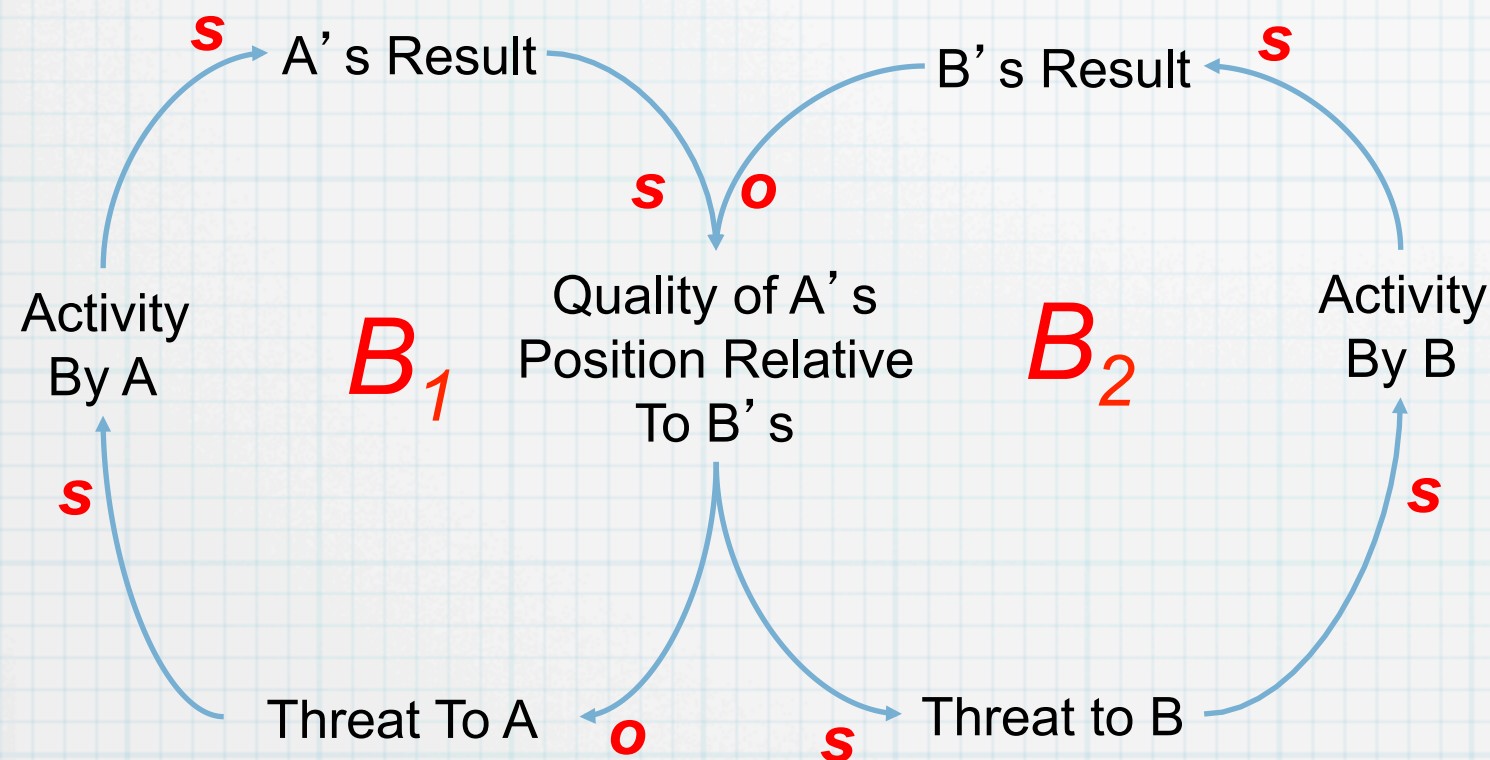
Drifting Goals Archetype



In a “Drifting Goals” situation, a gap between desired performance and current reality can be resolved either by taking corrective action to achieve the goal or by lowering the goal. The gap is often resolved by a gradual lowering of the goal. Over time, the performance level also drifts downward. This drift may happen so gradually, even without deliberate action, that the organization is not even aware of its impact.

A critical aspect of avoiding a potential “Drifting Goals” scenario is to determine what drives the setting of the goals.

Escalation Archetype



In an “Escalation” situation, one party (A) takes actions to counter a perceived threat.

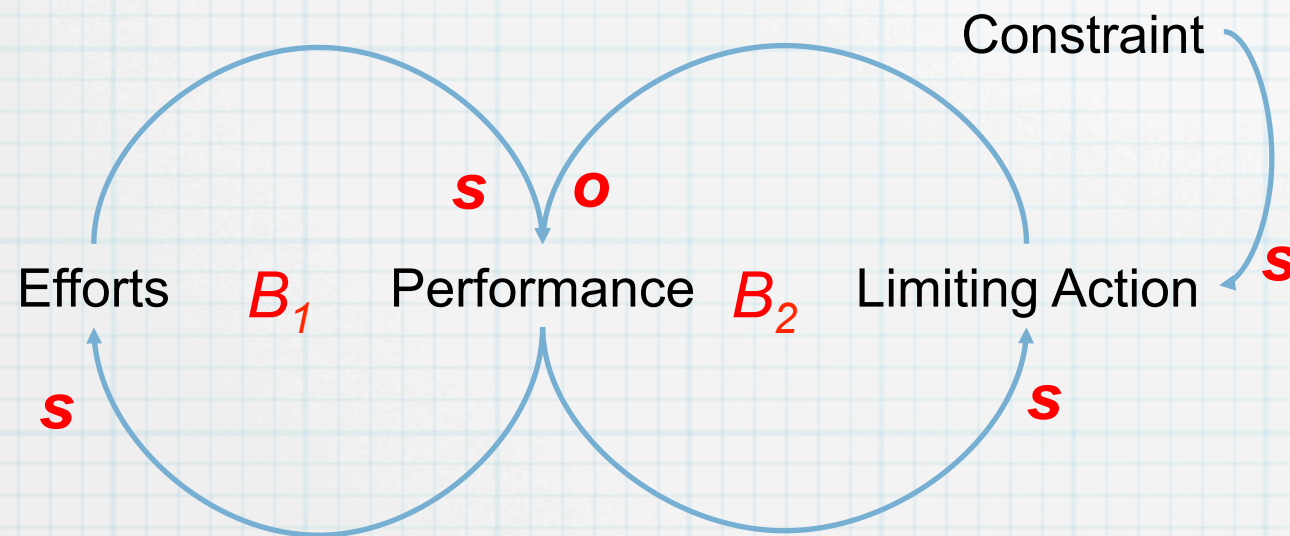
These actions are then perceived by the other party (B) as creating an imbalance in the system that makes them feel threatened.

So B responds to close the gap, creating an imbalance from A's perspective, and on it goes.

The dynamic of the two parties, each trying to achieve a sense of “safety,” becomes an overall reinforcing process that escalates tension on both sides, tracing a figure-8 pattern with the two balancing loops.

This archetype suggests that cutthroat competition serves no one well in the long run.

Limits to Success Archetype



In a “Limits to Success” scenario, growing actions initially lead to success, which encourages even more of those efforts.

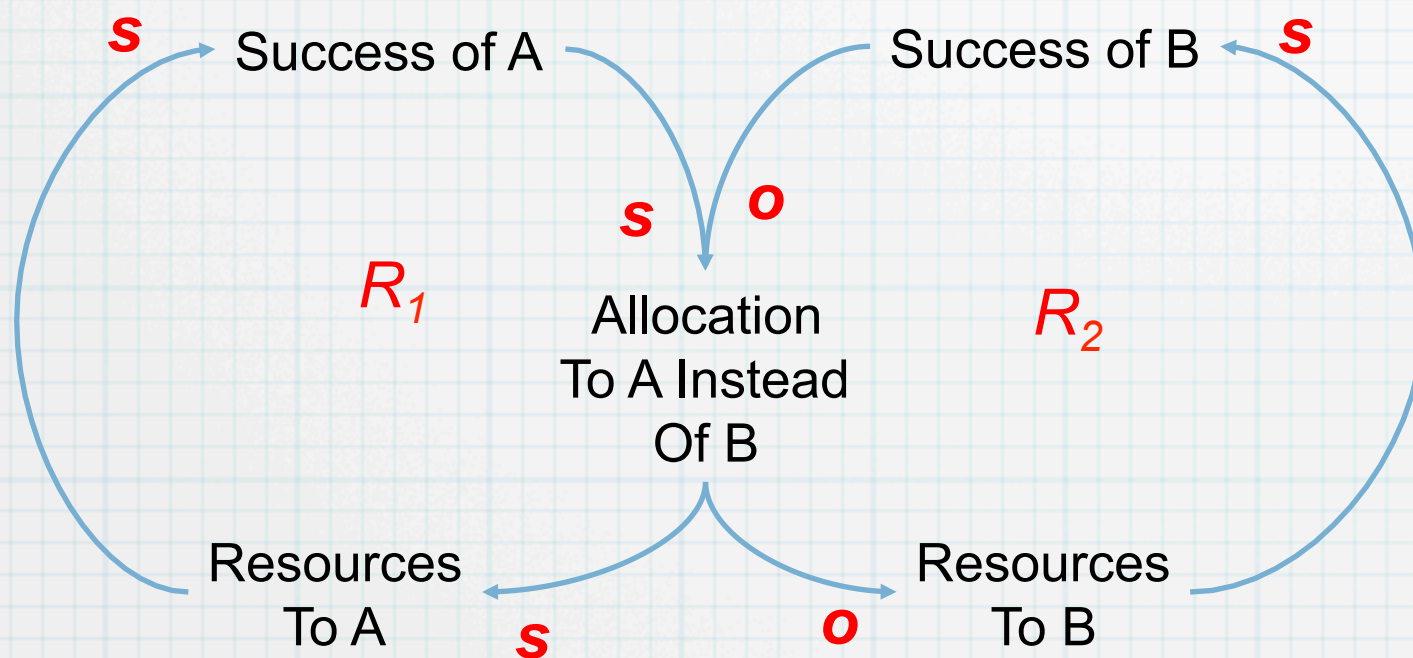
Over time, however, the success itself causes the system to encounter limits, which slows down improvements in results.

As the success triggers the limiting action and performance declines, the tendency is to focus even more on the initial growing actions.

Look for ways to relieve pressures or remove limits before an organizational gasket blows.

If we don't plan for limits, we are planning for failure.

Success to the Successful Archetype



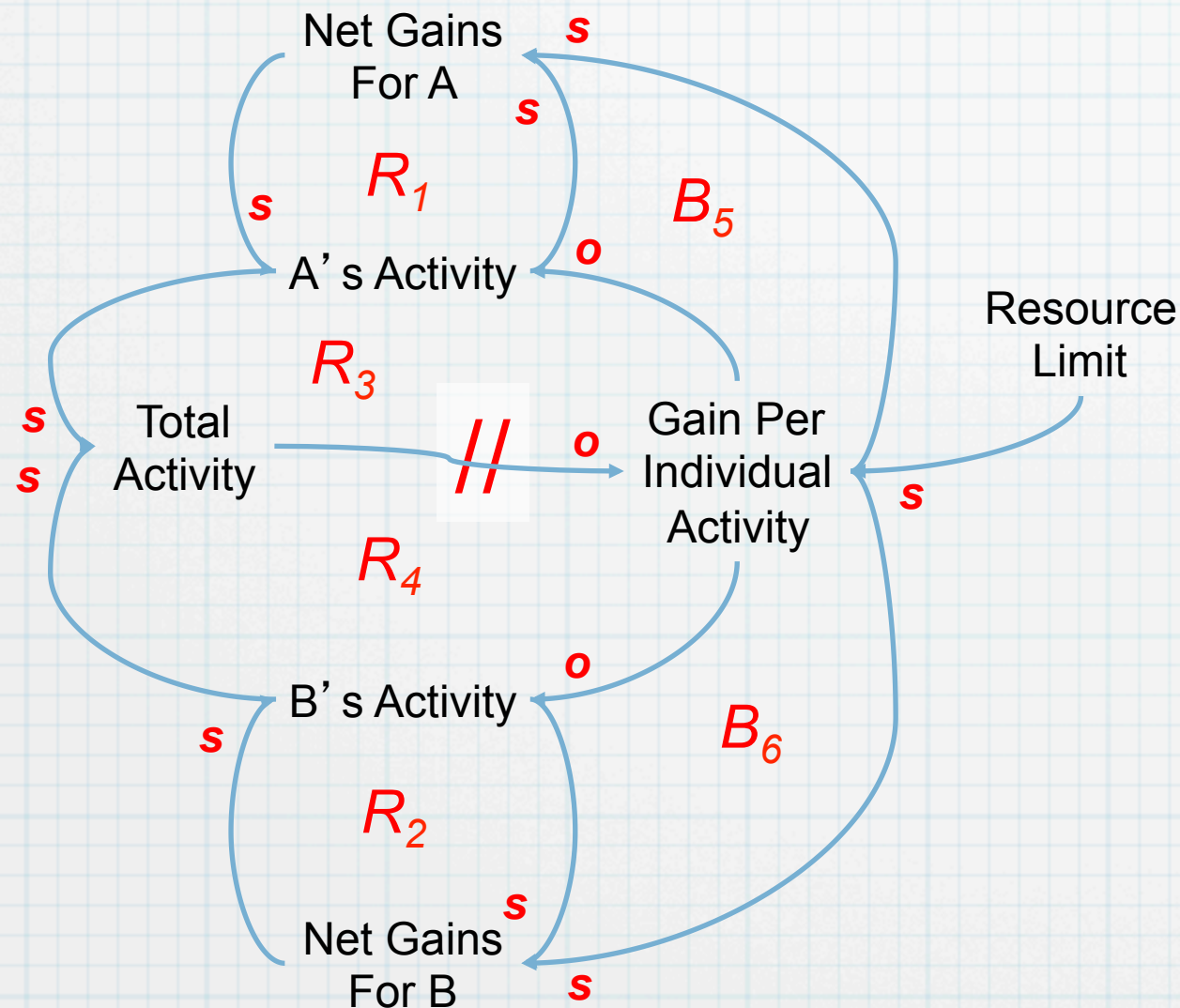
In a “Success to the Successful” situation, two or more groups, projects, initiatives, etc., are vying for a limited pool of resources to achieve success.

If one of them starts to become more successful (or is historically already more successful) than the others, it tends to accrue more resources, thereby increasing the likelihood of continued success.

Its initial success justifies devoting more resources while robbing the other alternatives of resources and opportunities to build their own success, even if the others are superior alternatives.

This archetype explains that success or failure may be due more to initial conditions rather than intrinsic worth. See *Guns, Germs, and Steel* by Jared Diamond.

Tragedy of the Commons Archetype



In a “Tragedy of the Commons” situation, individuals make use of a common resource by pursuing actions for their own benefit, without concern for the collective impact of everyone’s actions.

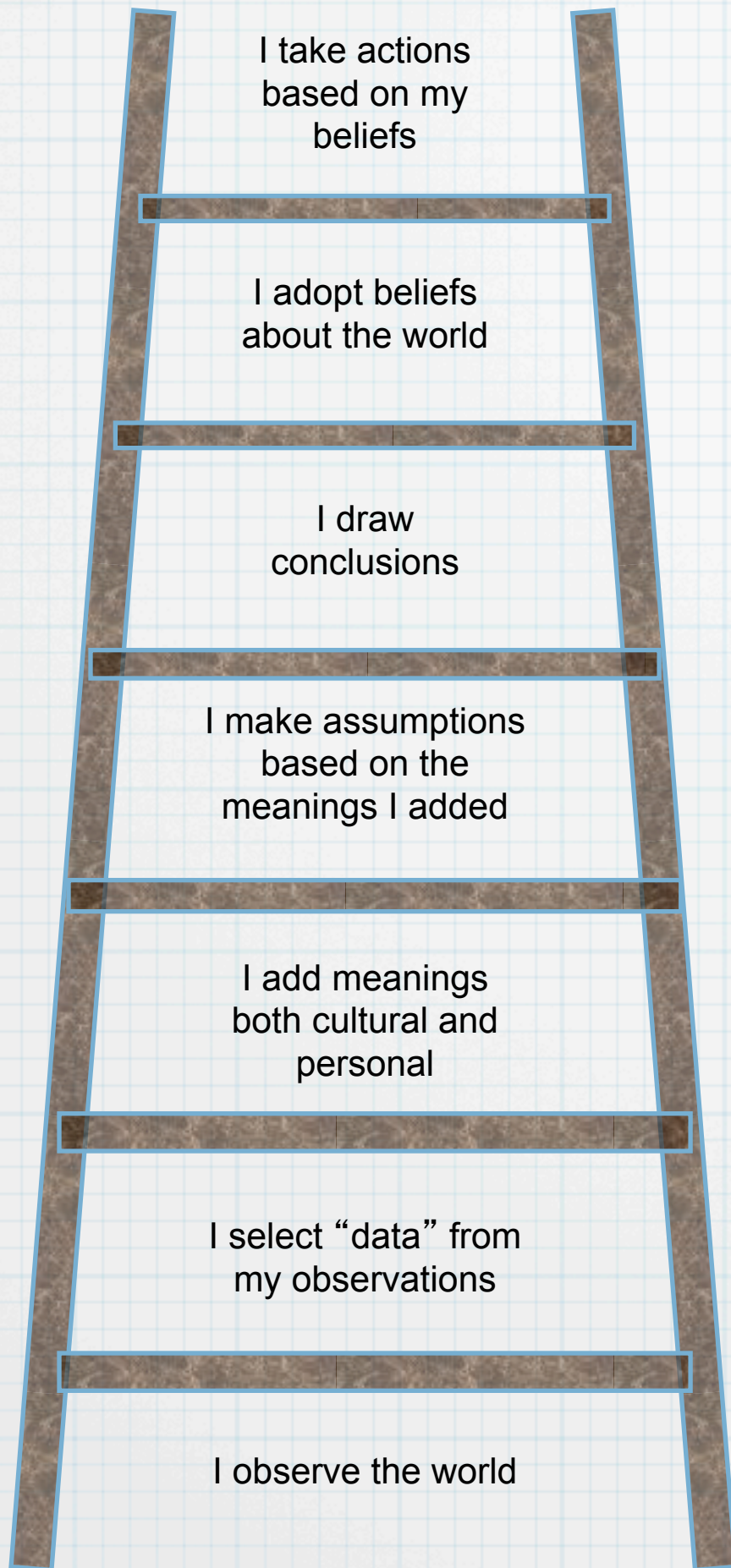
At some point, the sum of all individual activity overloads the “commons,” and all parties involved experience diminishing benefits. The commons eventually collapses.

Effective solutions for this scenario never lie at the individual level.

Find ways to reconcile short-term individual rewards with long-term cumulative consequences.

So much for the “invisible hand of the market.”

The Ladder of Abstraction: Mental Models



We live in a world of self-generating beliefs which remain largely untested.

We adopt those beliefs because they are based on conclusions, which are inferred from what we observe, plus our past experience.

Our ability to achieve the results we truly desire is eroded by our feelings that:

- Our beliefs are the truth
- The truth is obvious
- Our beliefs are based on real data
- The data we select are the real data

Mental Models

- Slumber
- Dream
- Bed
- Quiet
- Nap
- Pillow
- Night
- Blanket
- Pajamas
- Snooze

Mental Models

Working the Left-Hand Side of the Page

What I thought, but didn't say

The Script
(What I said; what he/she said)

Mental Models

Coaching the Left-Hand Side of the Page

The job of the coach is to help the other person gain some insight by asking good questions.

Don't try to fix them or straighten them out.

Ask:

1. What led you not to say what you thought?
2. What do you think would have happened if you had said that?
3. What were the costs of not saying that?
4. What is the guiding image behind your behavior?

To Learn More...

- *The Fifth Discipline* by Peter Senge
- *The Fifth Discipline Fieldbook*, by Peter Senge, et al
- *Systems Thinking, Systems Practice* by Peter Checkland
- *The Art of Systems Thinking* by Joseph O' Conner and Ian McDermott
- *The Art of Problem Solving* by Russell L. Ackoff
- *Systemantics: How Systems Really Work and How They Fail* by John Gall
- *Fuzzy Thinking* by Bart Kosko
- *The New Economics* by W. Edwards Deming

Statistical Thinking

Or why $2 + 2 = 3$ (for very small values of 2)

4 October 2005

Statistical Thinking

A way of thinking and talking about the world that separates signals from noise using graphical and numerical analysis.

A statistician is a purveyor of the scientific method.

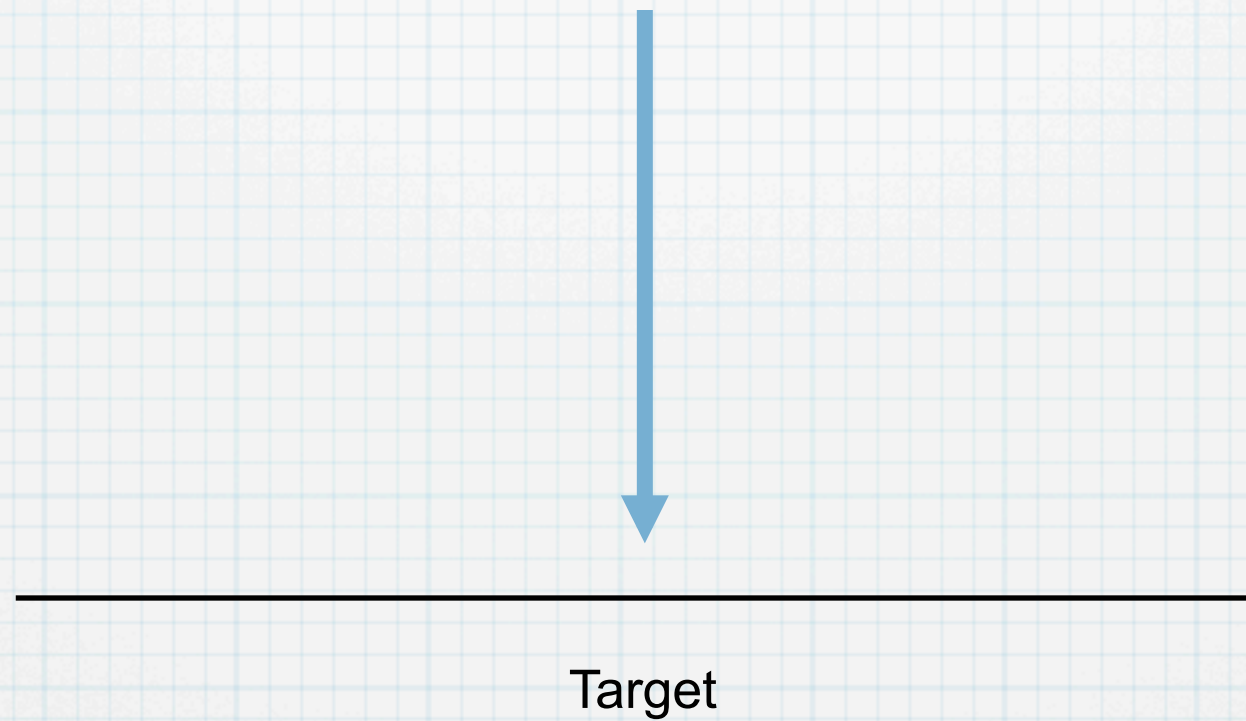
Today's Menu

- Some Principles
- Some Descriptive Statistics
- Analytic Tools: Control Charts
- Enumerative Tools: Hypothesis Tests
- Some Extras

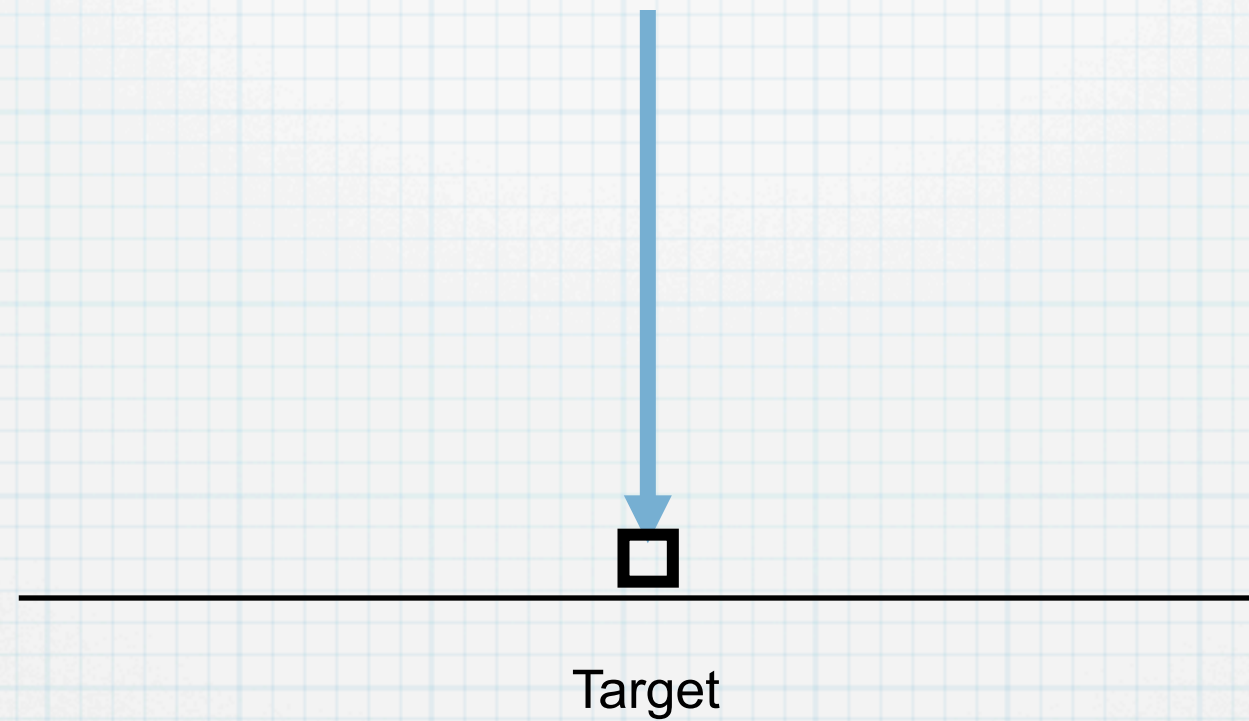
Principles of Variation

- Variation is present in all processes
- Usually the system is the source of variation, not the people
- Without knowledge of the expected variation, we are unable to intelligently interact with the system
- Without knowledge of the usual variation we are not able to distinguish between tampering with or improving the system.

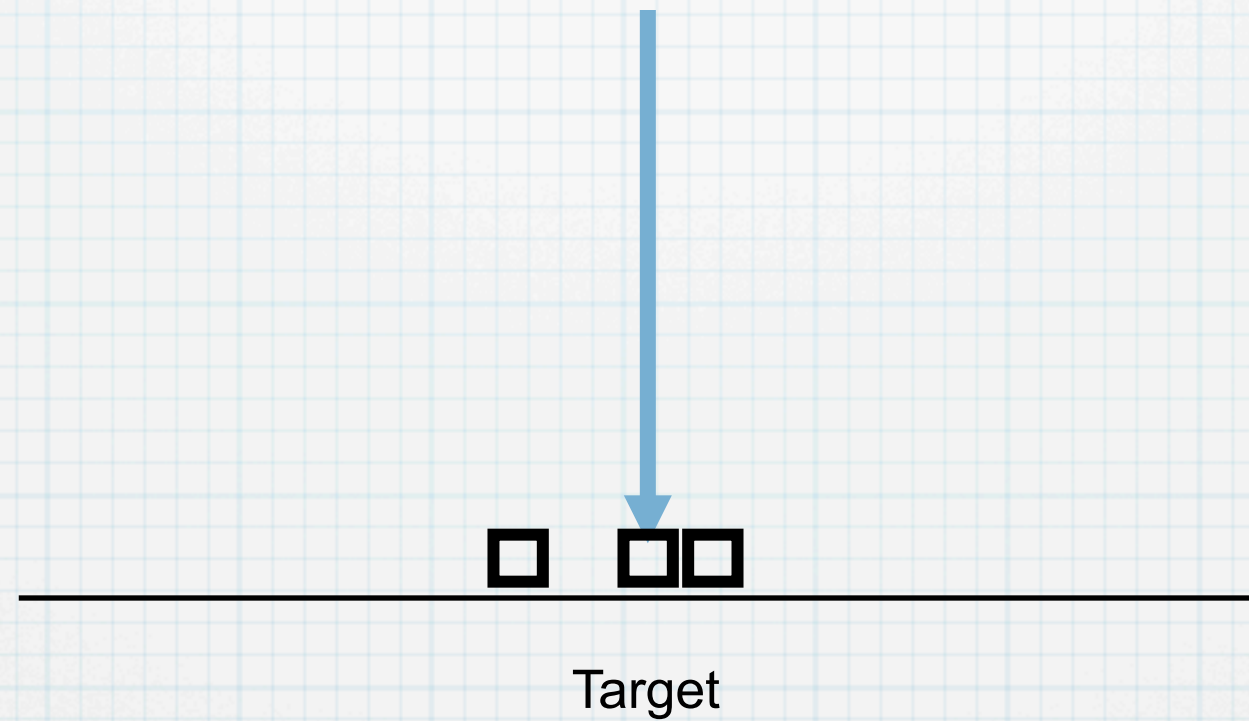
The Normal World



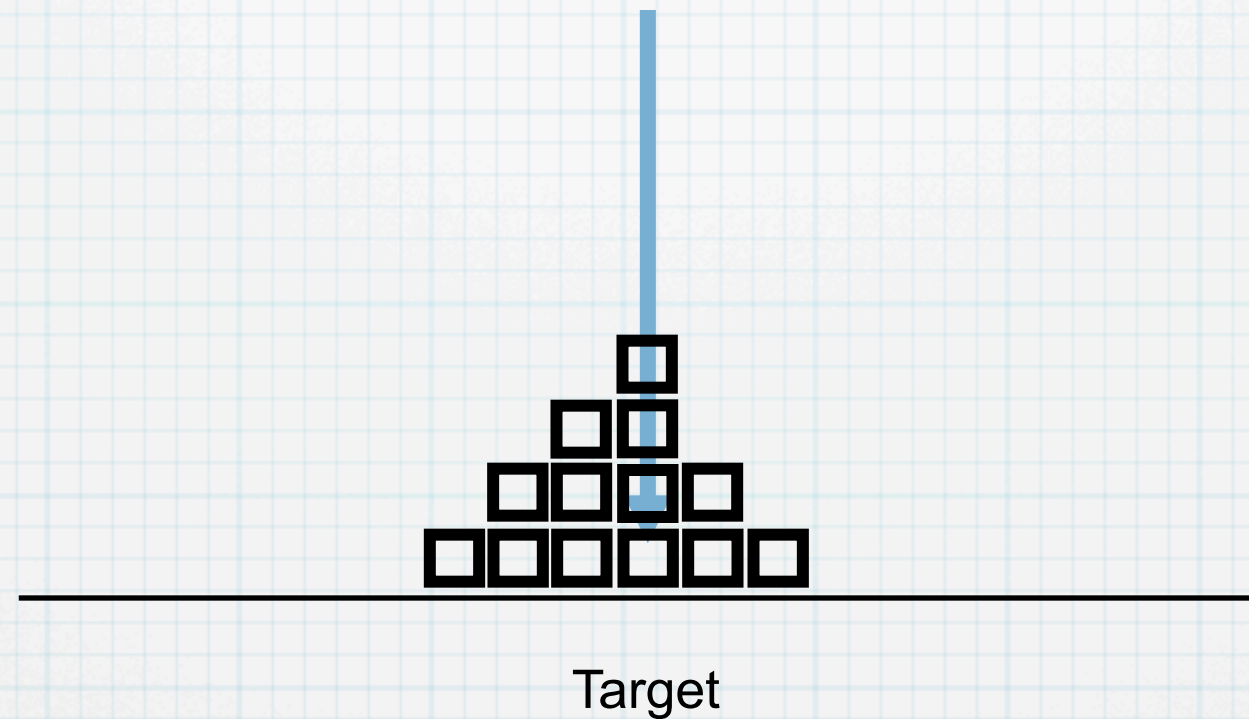
The Normal World



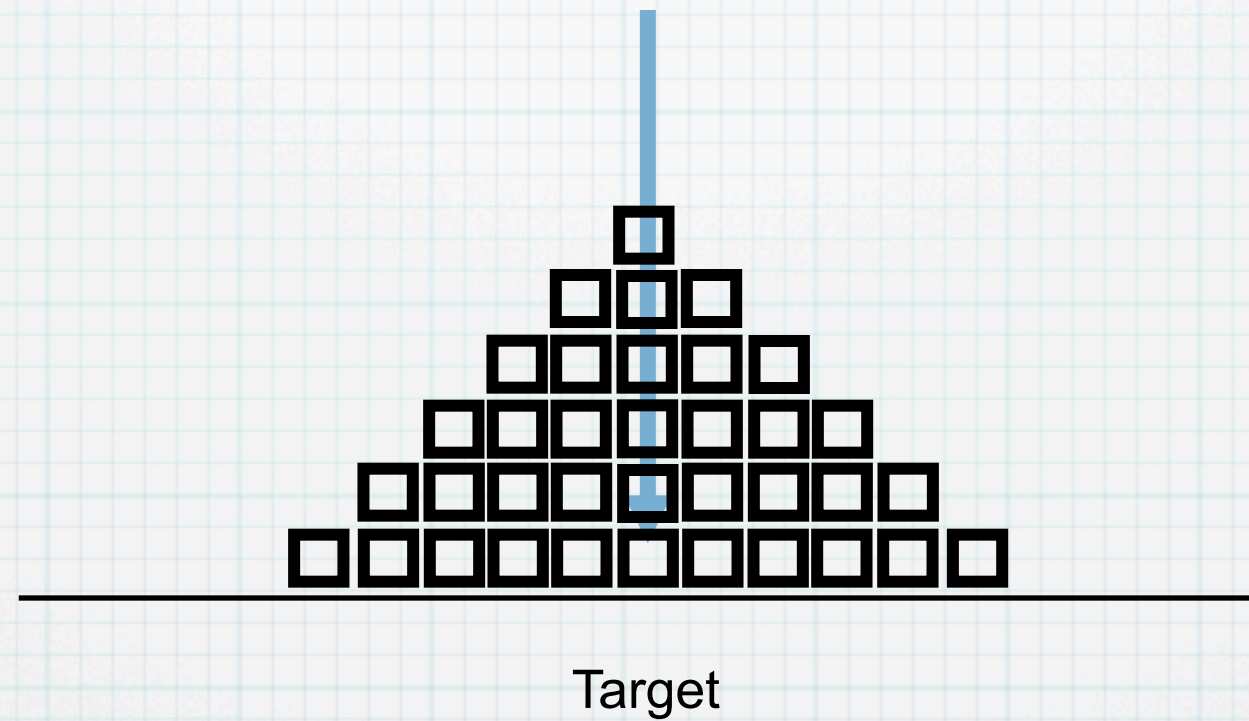
The Normal World



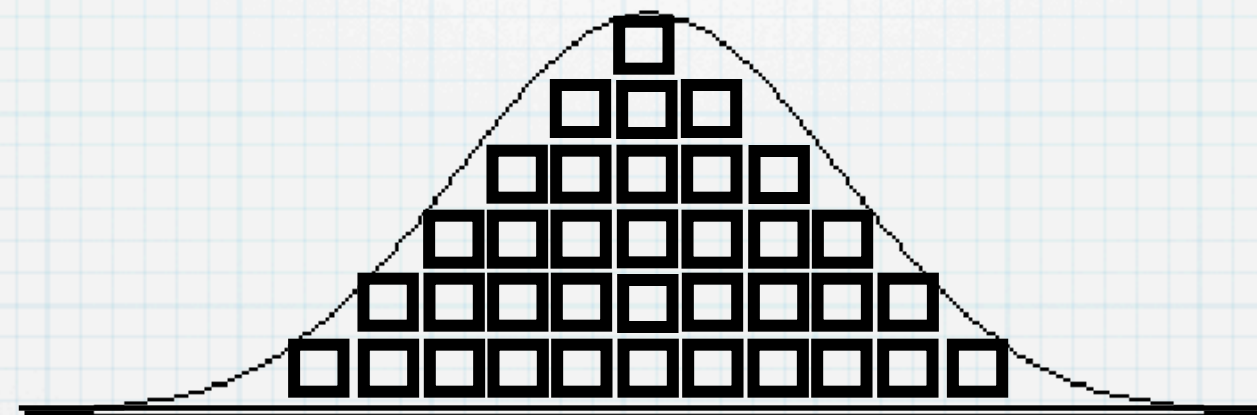
The Normal World



The Normal World



The Normal World

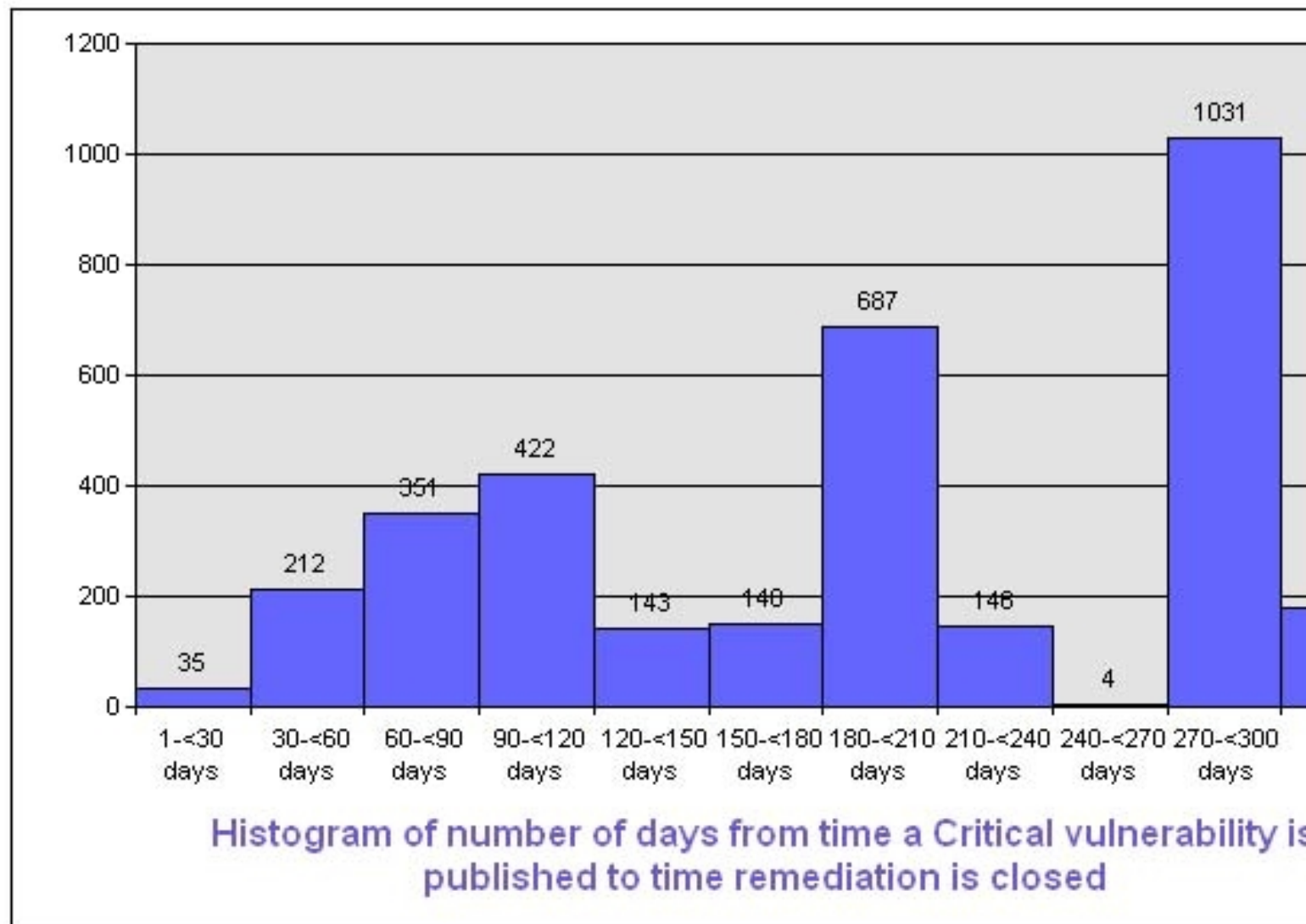


Target

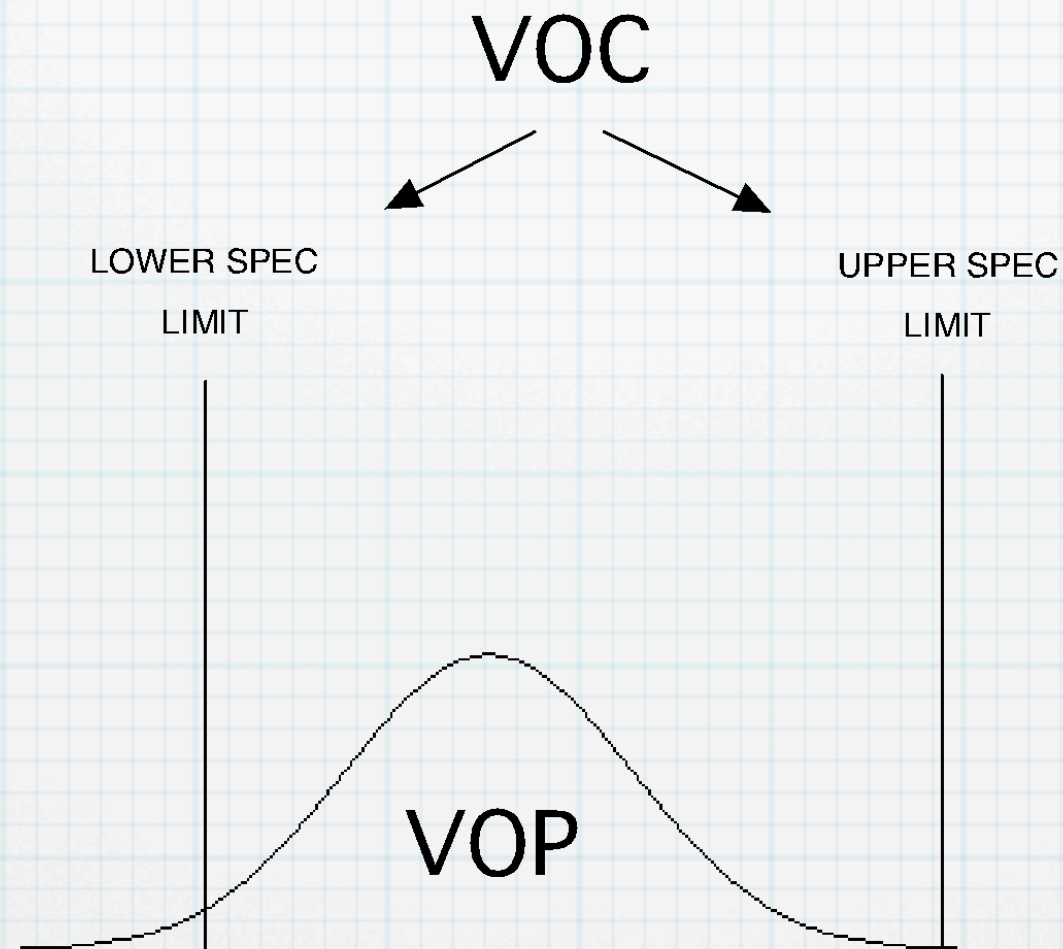
What Can I Tell From Shape?

EXPOSURE - PERFORMANCE TO TARGET

“What is our exposure to vulnerabilities in the network
And how well are we performing to target?”



Voice of the Customer and Voice of the Process



Unless you can distinguish between the voice of the customer
And the voice of the process, you can never hope to align them.

Meeting the spec is the starting line, not the finish line.



Walter Shewhart

“Broadly speaking, the object of industry is to set up economic ways and means of satisfying human wants and in so doing to reduce everything possible to routines requiring a minimum amount of human effort.

Through the use of the scientific method, extended to take account of modern statistical concepts, it has been found possible to set up limits within which the results of routine efforts must lie if they are to be economical. Deviations in the results of a routine process outside such limits indicate that the routine has broken down and will no longer be economical until the cause of trouble is removed.”

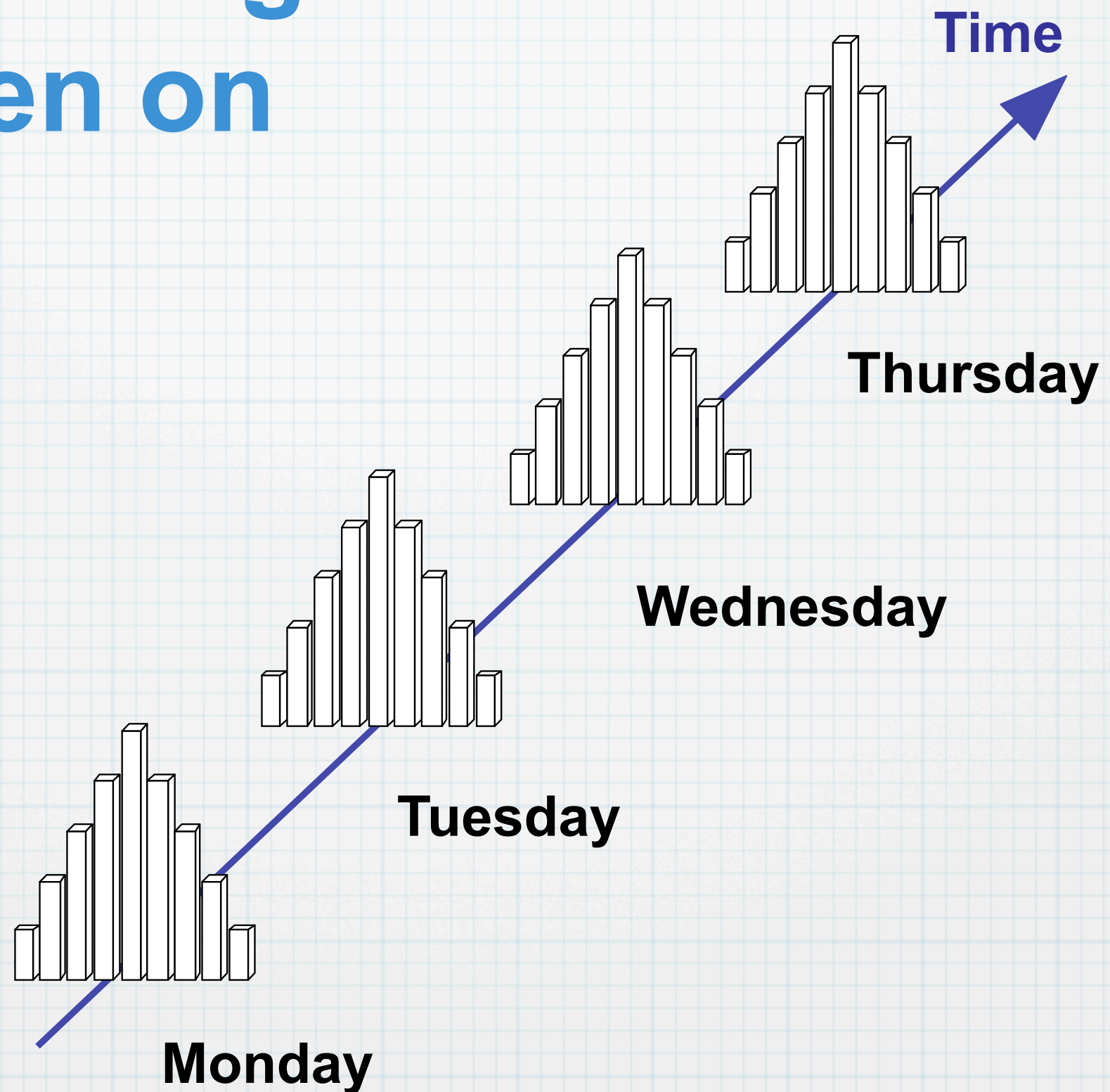
– W. A. Shewhart, inventor of the control chart, from the Preface to *Economic Control of Quality of Manufactured Product*, 1931

Statistical Inference

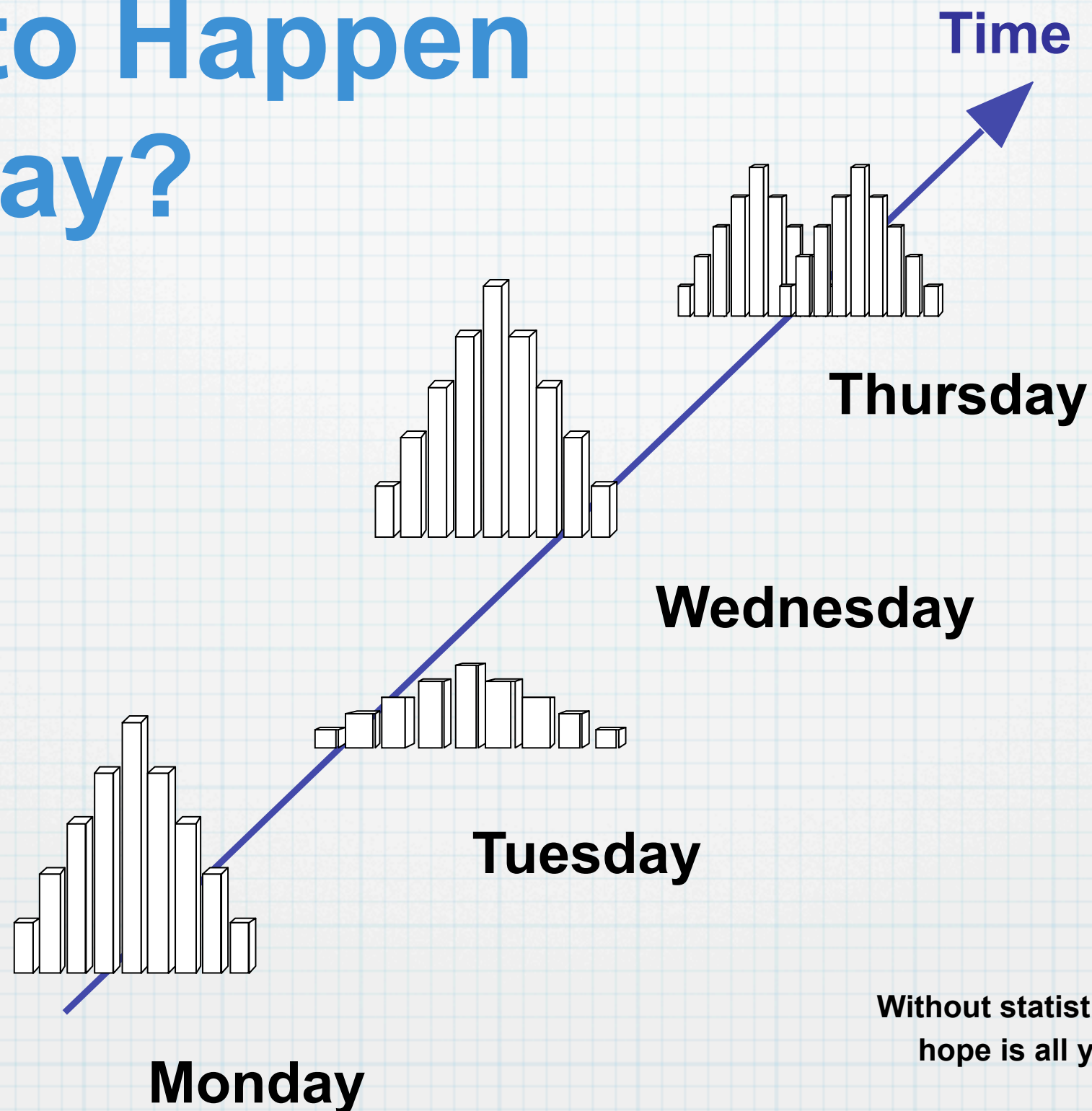
		Action on The Process <i>Should be</i> Taken	
		Yes	No
Action on The Process <i>IS</i> Taken	Yes	No Mistake	Type I Error
	No	Type II Error	No Mistake

The purpose of the control chart is to minimize the net economic loss from making Type I and Type II errors

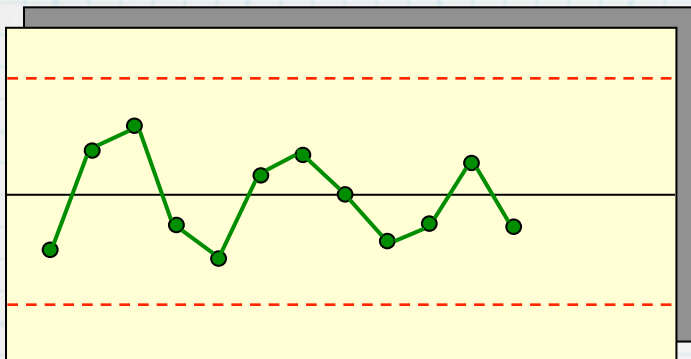
What's Going to Happen on Friday?



Now What's Going to Happen on Friday?



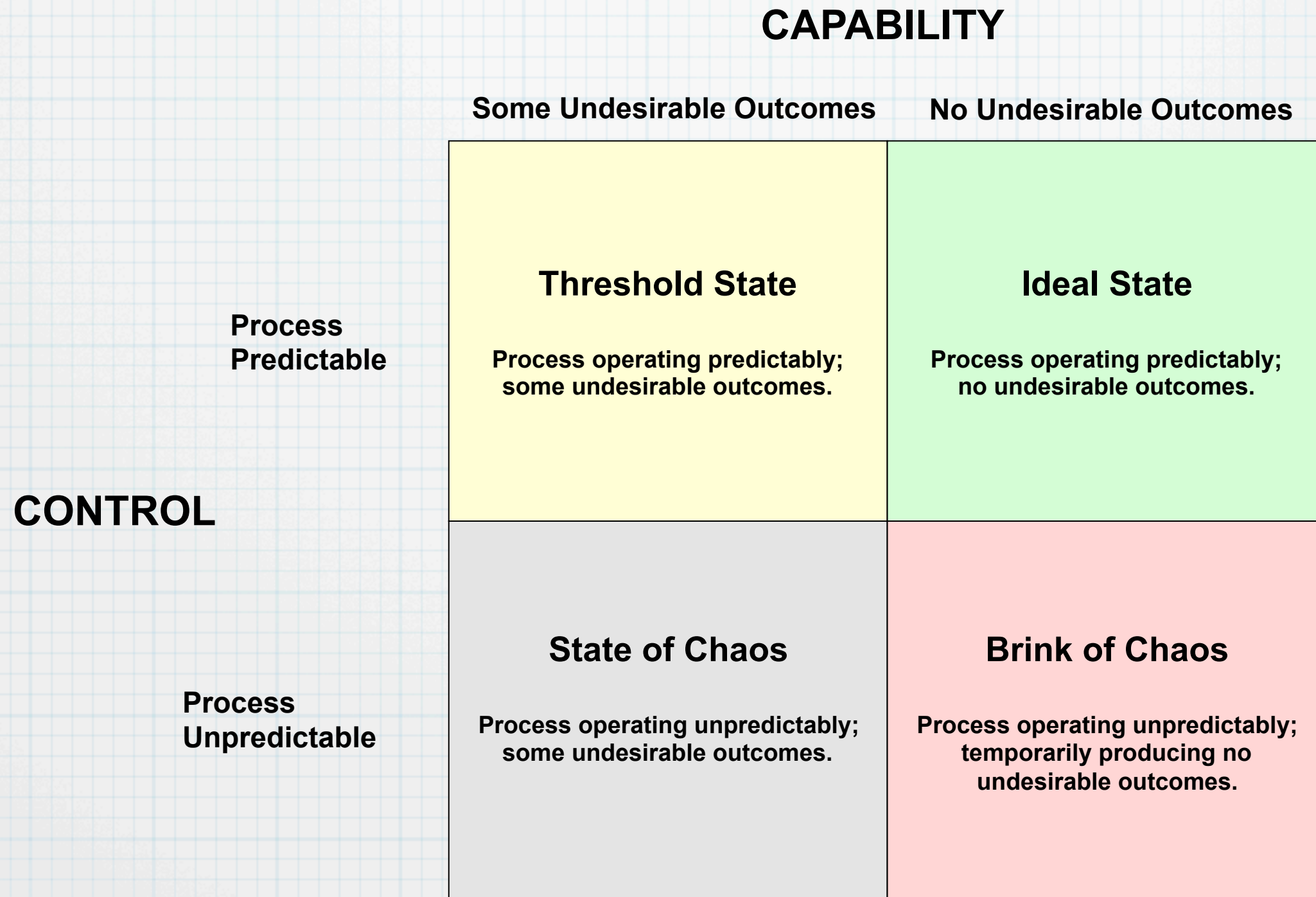
A Stable Process



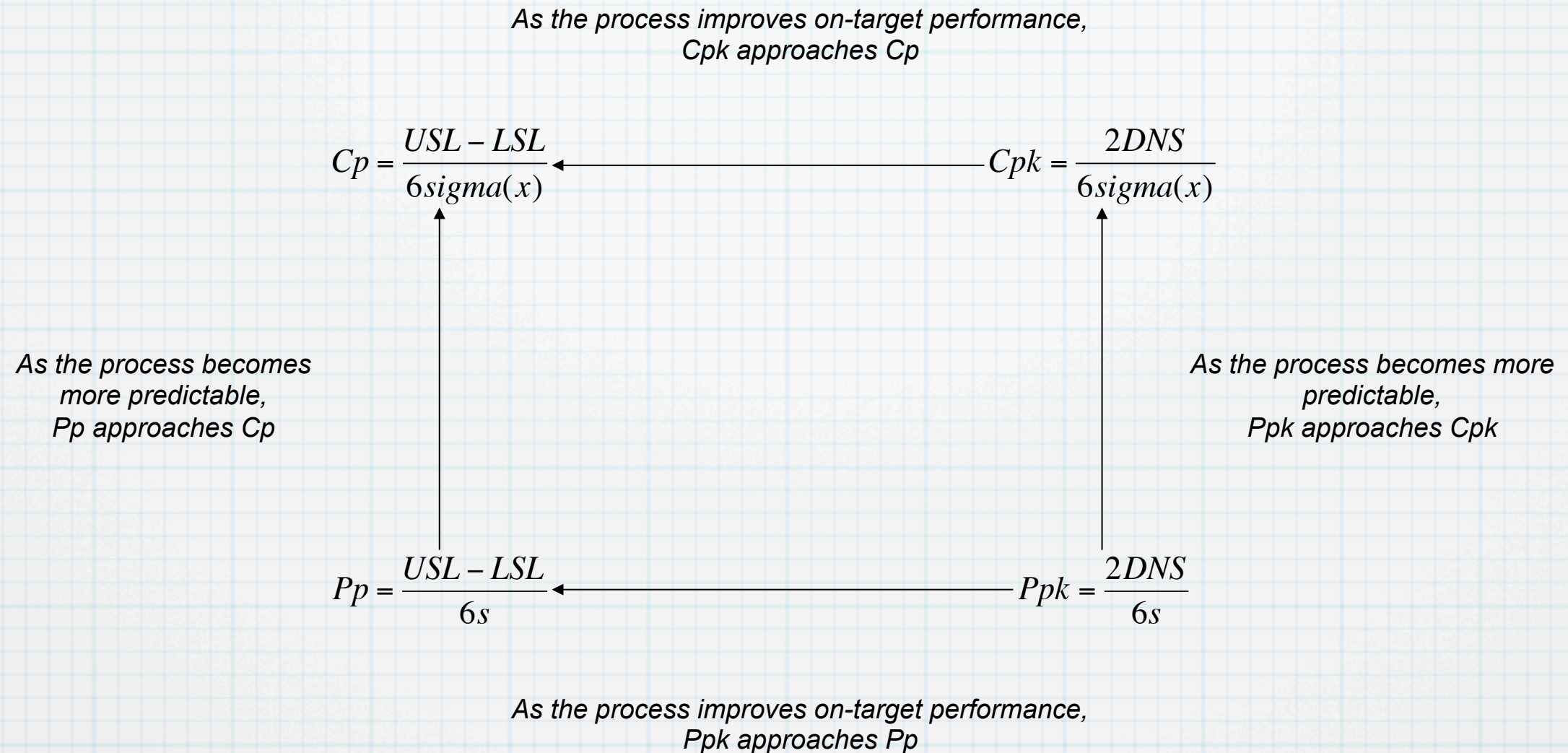
If a process is in a state of “statistical control...”

- The behavior in the near future may be forecast
- The costs of performance are accountable
- The process can be evaluated for capability
- The control limits define the process as a system

Characterizing a Process



Dr. Wheeler's Process Capability Explanation



$6\sigma(x)$ = local measure $\frac{\bar{R}}{d_2}$

$6s$ = global measure

***To the extent to which these numbers diverge,
The process is under-performing.***

***To the extent to which these numbers converge,
The process is optimized.***

Five Ways to Improve an Existing Process

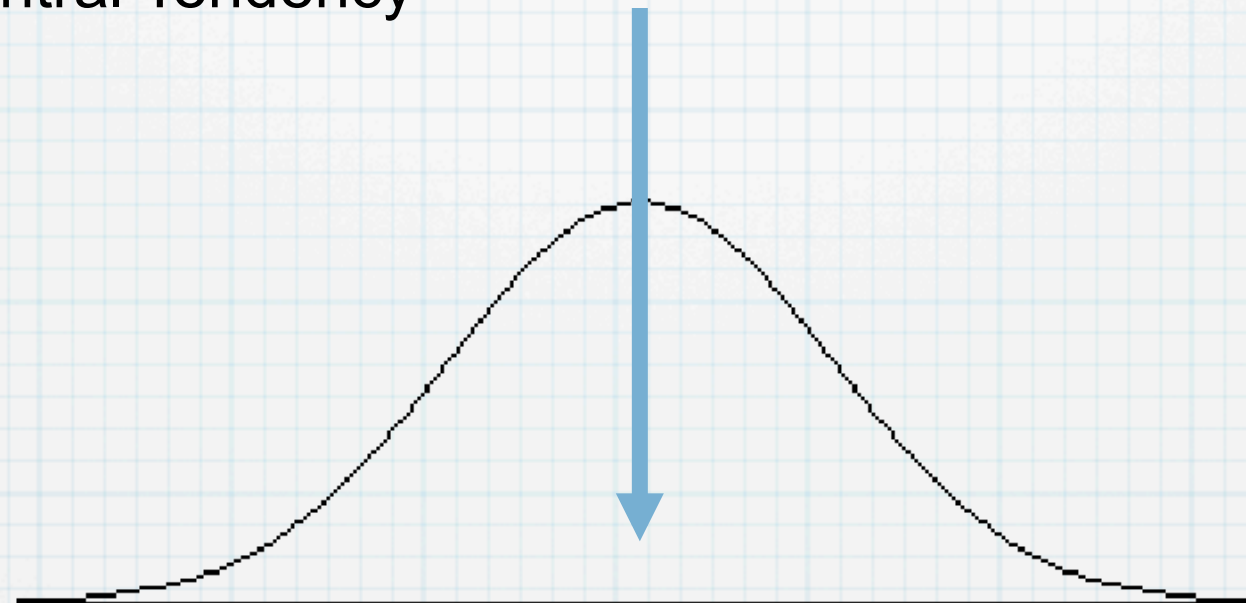
(In order of increasing difficulty)

1. Operate the existing process on target
2. Operate the existing process predictably
3. Operate the existing process on target and predictably
4. Try to optimize the existing process by changing the target values for various process inputs
5. Take the existing process out and shoot it, and start all over with a new process or technology upgrade.

The Normal World

Measures of Central Tendency

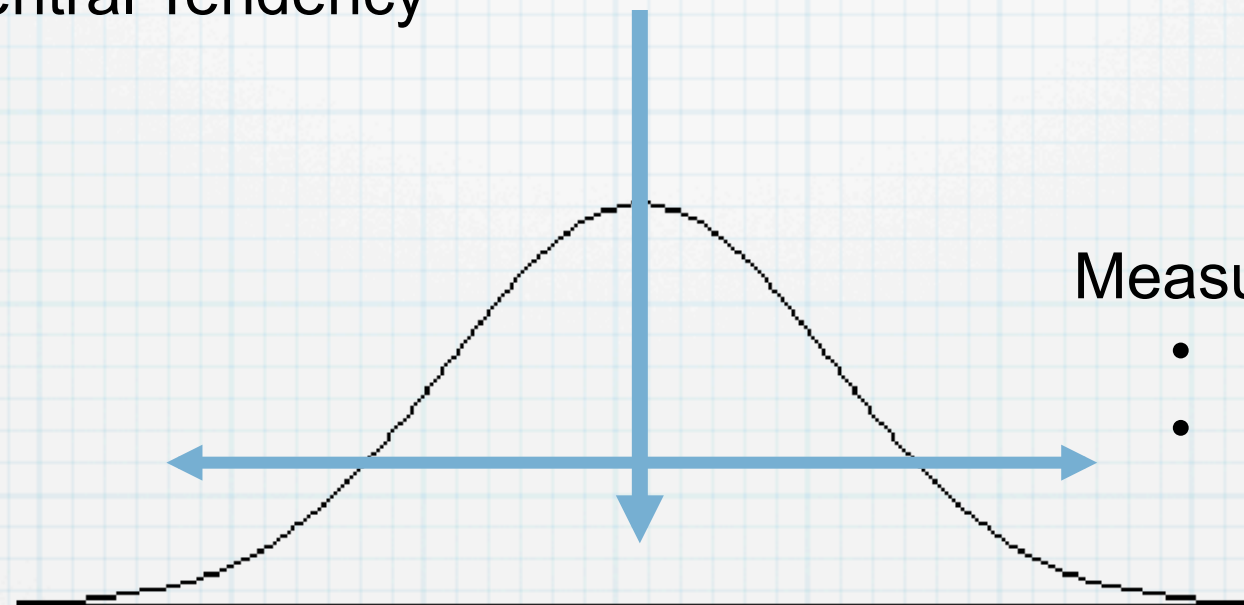
- Mean
- Median
- Mode



The Normal World

Measures of Central Tendency

- Mean
- Median
- Mode



Measures of Dispersion

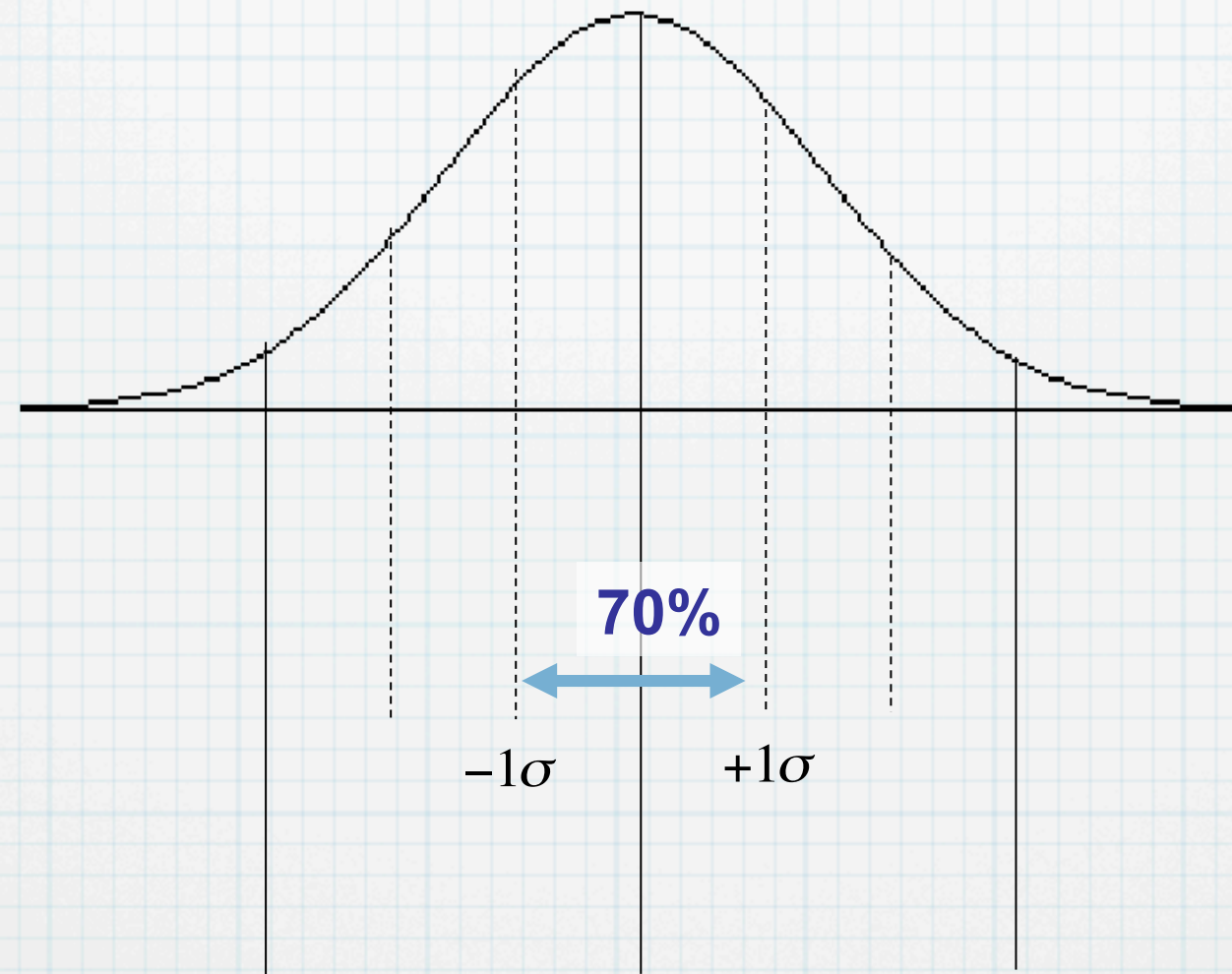
- Range
- Standard Deviation

Calculating Mean and Std Deviation

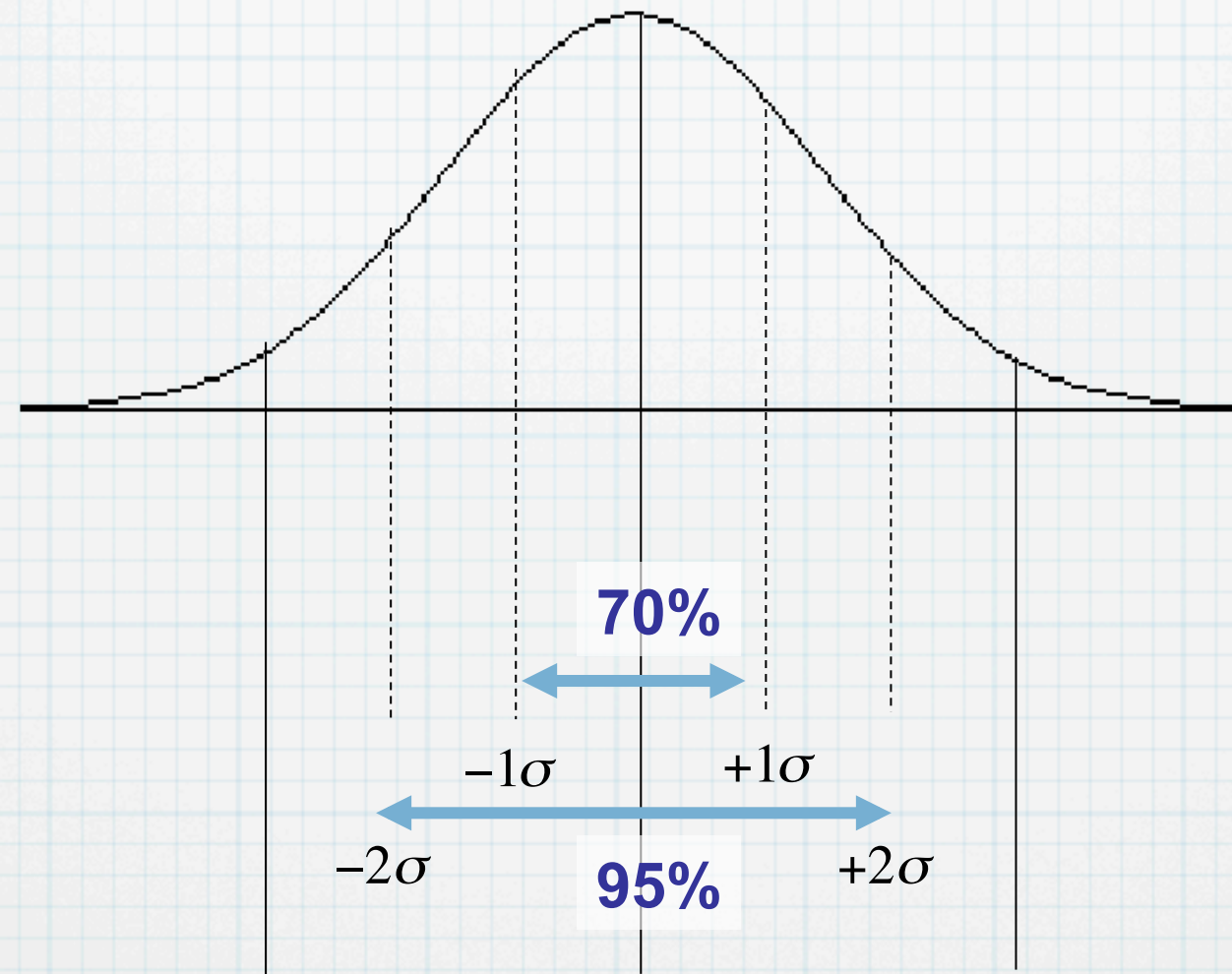
$$\text{Mean} = \bar{X} = \sum \frac{X_i}{n}$$

$$\text{StdDeviation} = \sigma_X = \sum \sqrt{\frac{(X_i - \bar{X})^2}{n}}$$

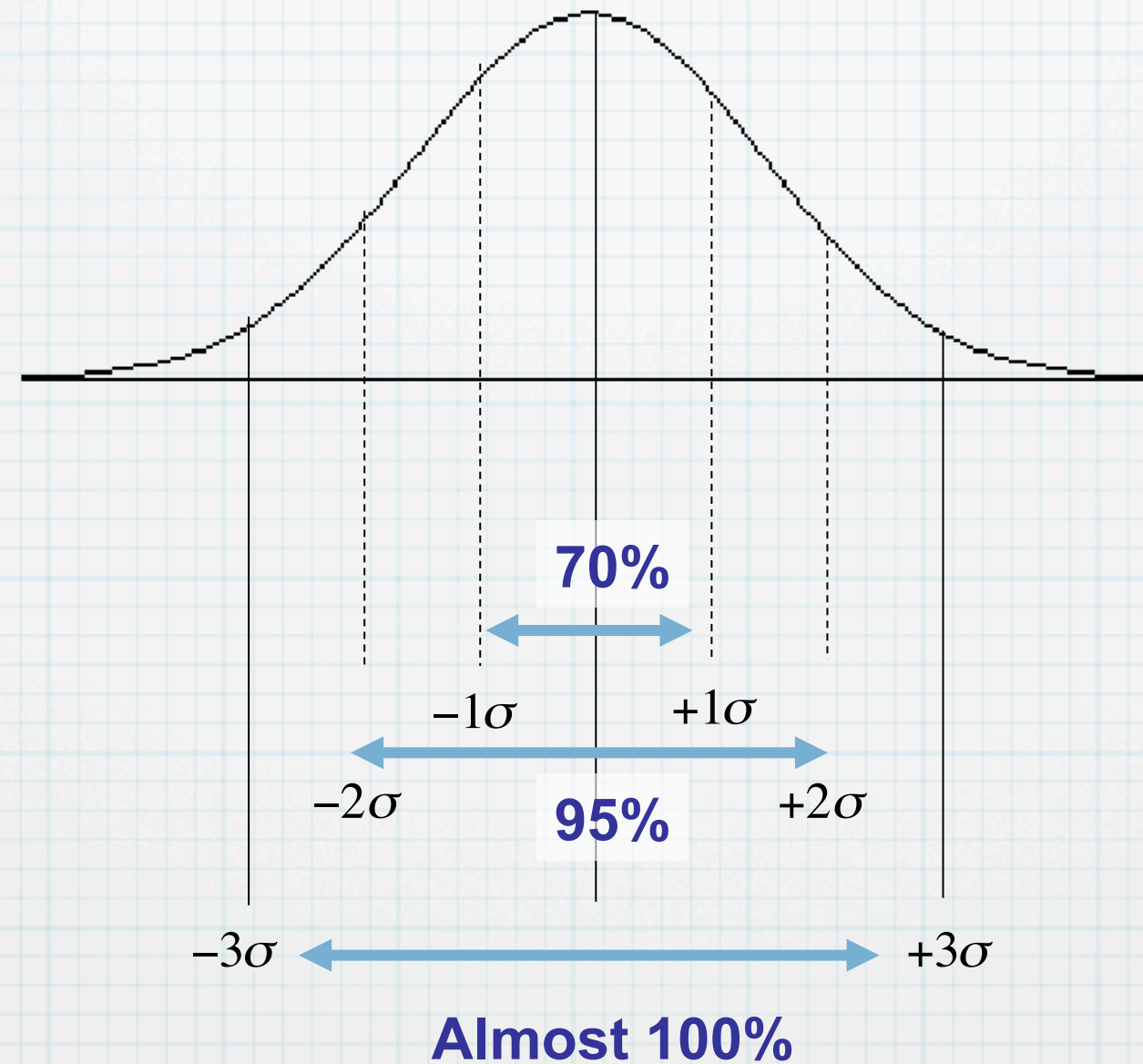
Coolness of the Standard Deviation



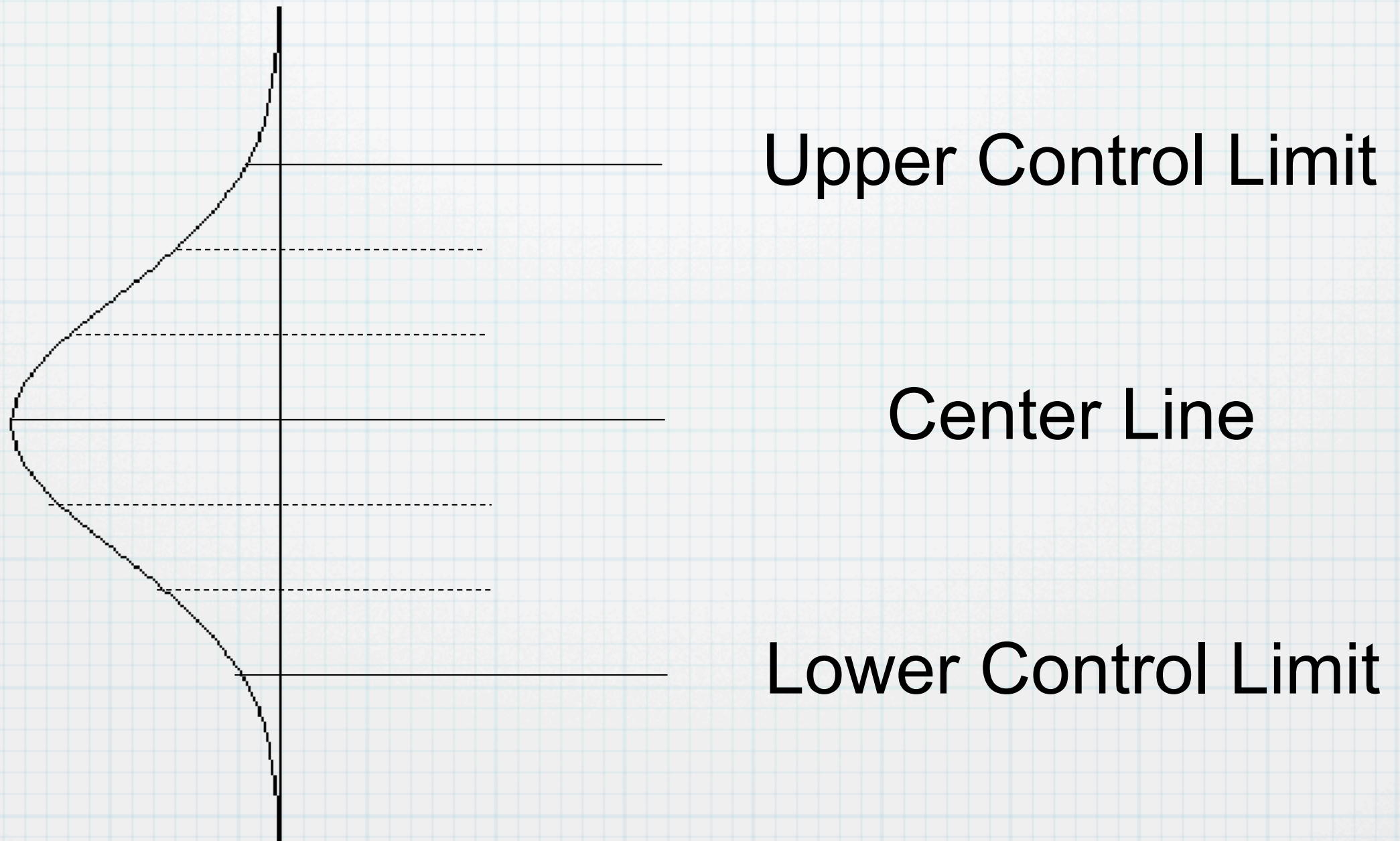
Coolness of the Standard Deviation



Coolness of the Standard Deviation



Anatomy of the Control Chart



XmR Chart

$$CL = \bar{X}$$

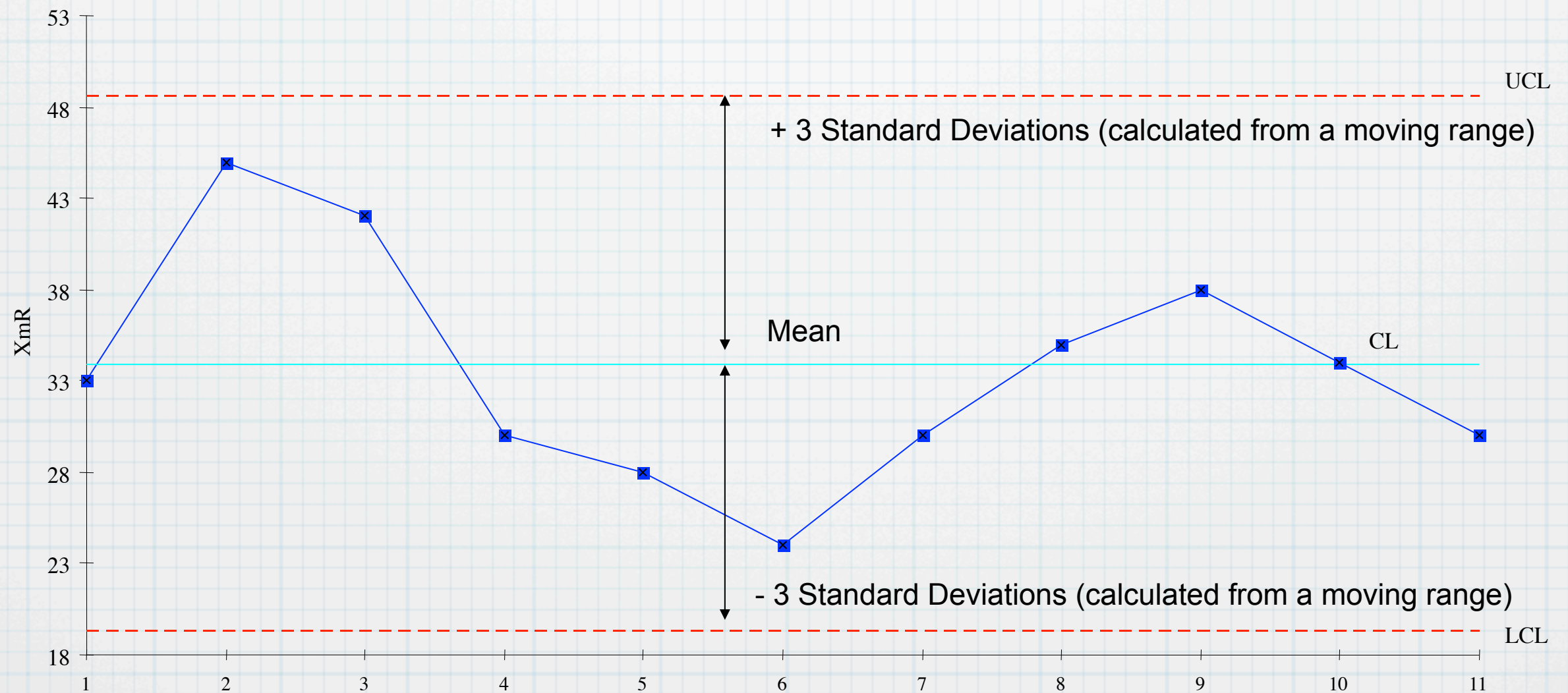
$$UCL = \bar{X} + m\bar{R} \times (2.66)$$

$$LCL = \bar{X} - m\bar{R} \times (2.66)$$

“How is the process performing over time?”

“How predictable is the process?”

“How much variation can I expect in the future if nothing changes?”



Calculating the Moving Range

Measured values: 5, 7, 10, 4, 9

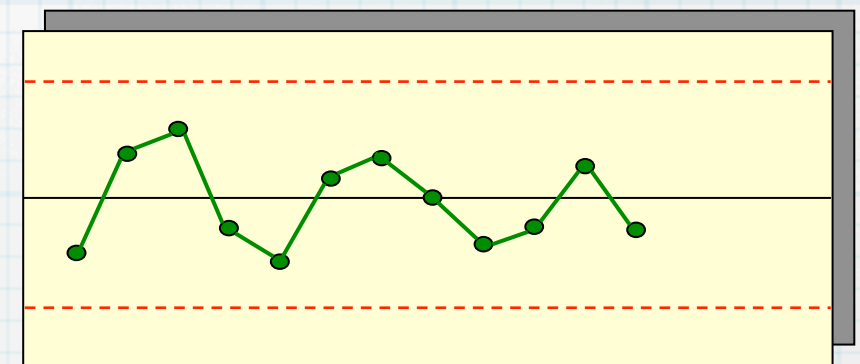
Moving Ranges 2, 3, 6, 5

The diagram illustrates the calculation of moving ranges from a set of measured values. The measured values are 5, 7, 10, 4, and 9. The moving ranges are 2, 3, 6, and 5. Blue lines connect the measured values to their corresponding moving ranges: 5 to 2, 7 to 2 and 3, 10 to 3 and 6, 4 to 6 and 5, and 9 to 5.

Measured values	Moving Ranges
5	2
7	2, 3
10	3, 6
4	6, 5
9	5

Why Control Charts?

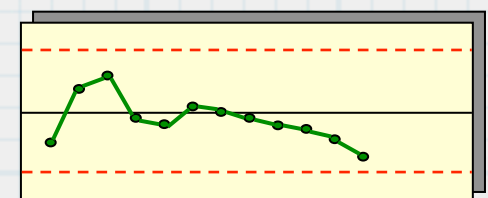
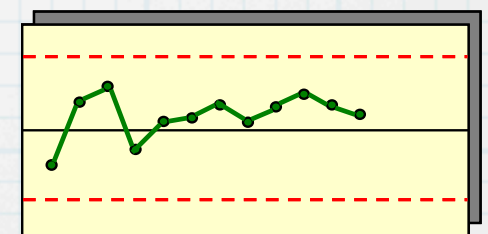
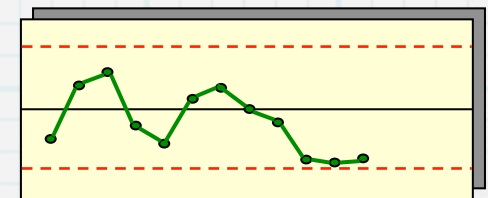
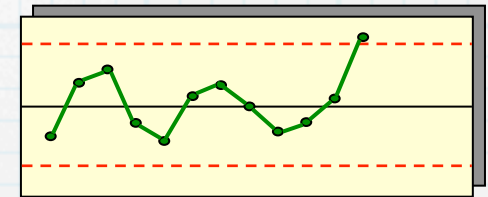
- Provides a context for the current level of performance
- Conveys the overall level of performance by the vertical scale
- Shows the amount by which performance rates vary over time
- Assesses homogeneity of the data set
- Detects meaningful trends and shifts
- Identifies opportunities to learn about cause and effect
- Provides an economic guide to action.



Reading Control Charts

A special cause of variation is indicated by:

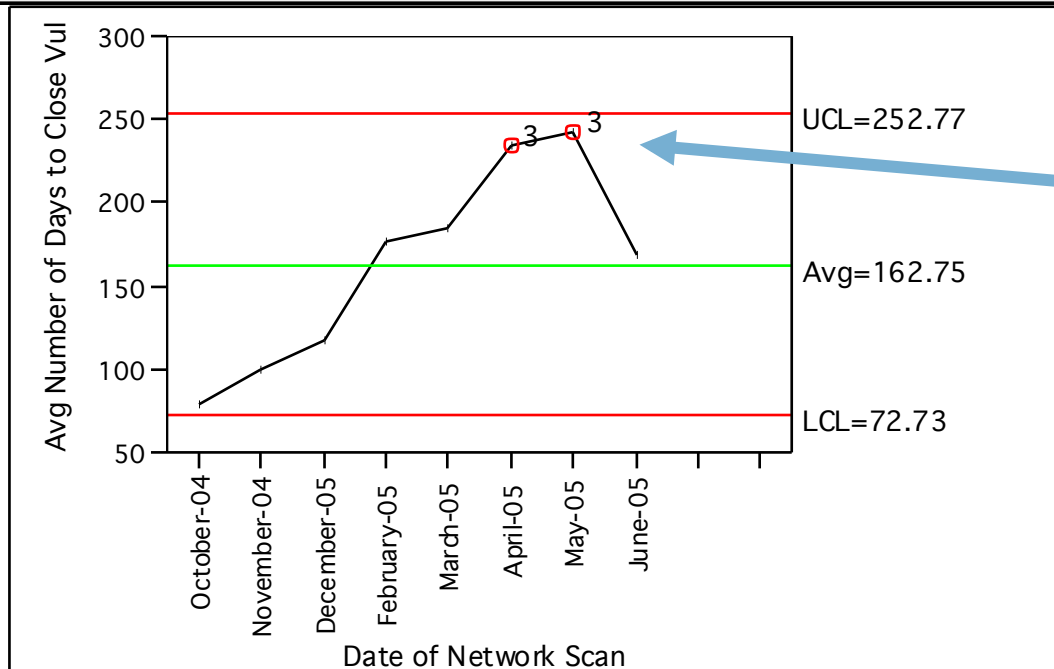
1. A single point outside the computed limits – *dominant effect*
2. Three out of three, or three out of four successive values in the upper or lower 25% of the area between the limits – *moderate but sustained effect*
3. Eight successive values on the same side of the central line – *weak, but sustained effect*
4. Six points in a row increasing or decreasing – *weak, but sustained trend*.



XmR Chart of Vulnerability Closures

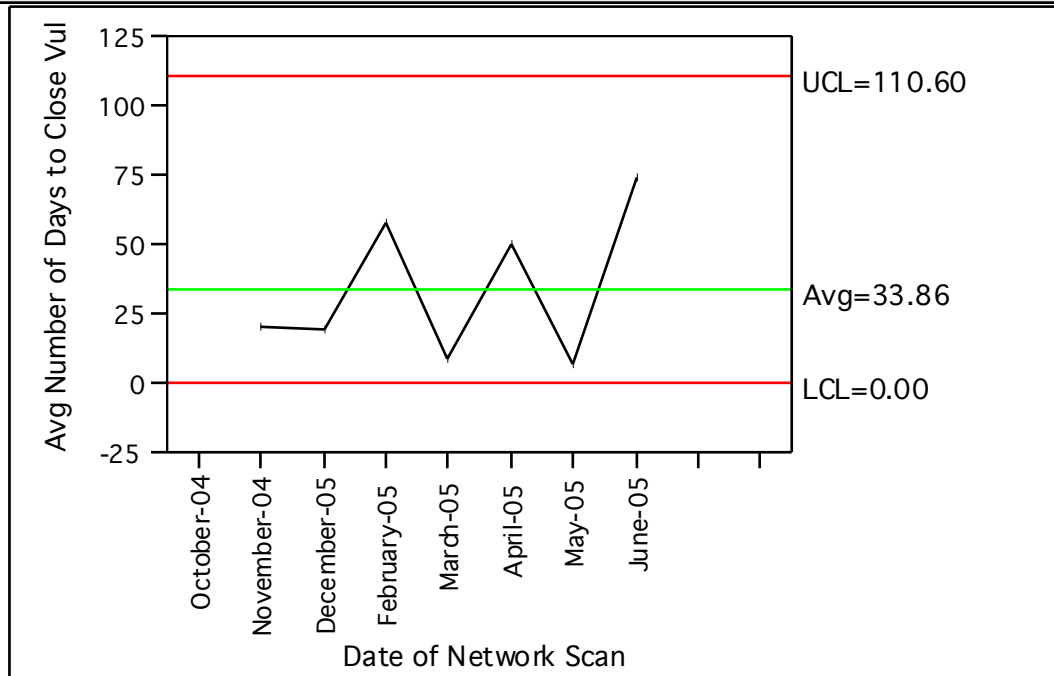
Control Chart

Individual Measurement of Avg Number of Days to Close Vul



Six points in a row all headed up

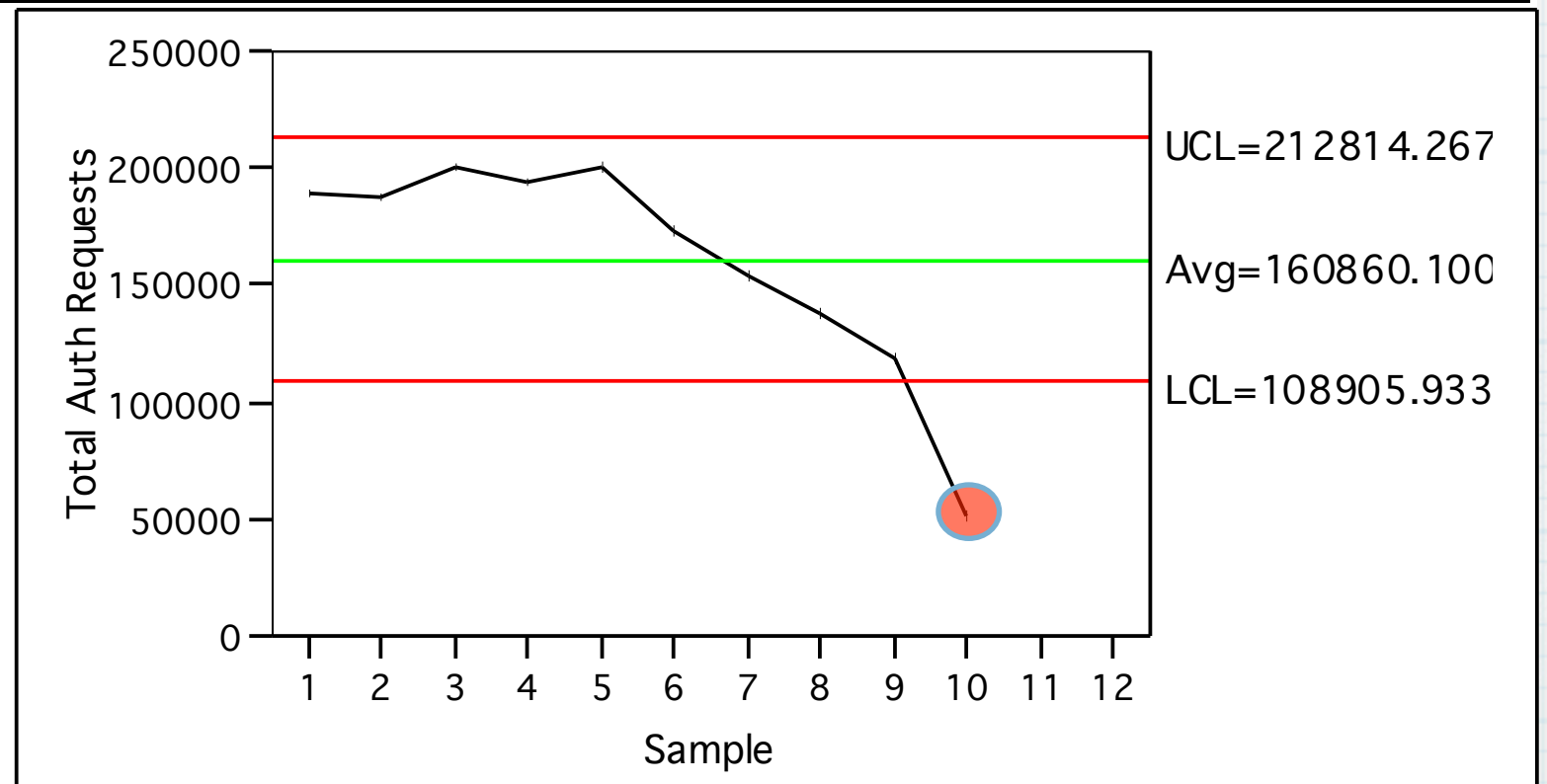
Moving Range of Avg Number of Days to Close Vul



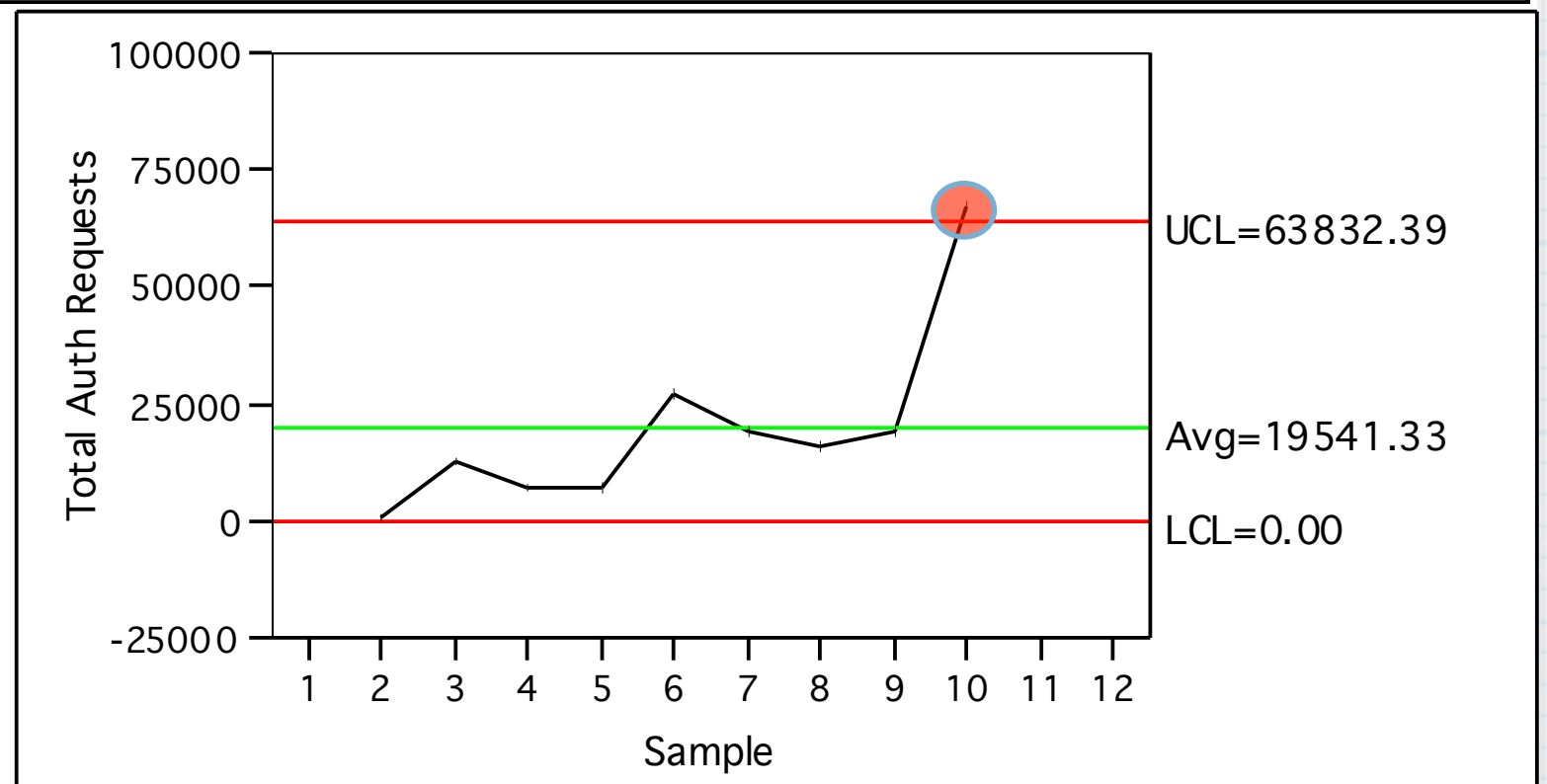
Using the Range Chart to Validate the X Chart

Control Chart

Individual Measurement of Total Auth Requests



Moving Range of Total Auth Requests



A Brief Look at Hypothesis Testing

- Statistically determine if there is a significant difference between two sets of values
- Limited to the frame under study -- can **not** extrapolate to the future
- Type I Errors are controlled by confidence level; Type II errors are controlled by sample size
- Numerical analysis is determined by:
 - The magnitude of the difference you want to detect
 - The amount of variation (pooled standard deviation)
 - Sample size
 - Confidence level to control Type I Errors
- Signal-to-noise ratio is converted to a p-value = confidence level

Comparing Treatments A and B

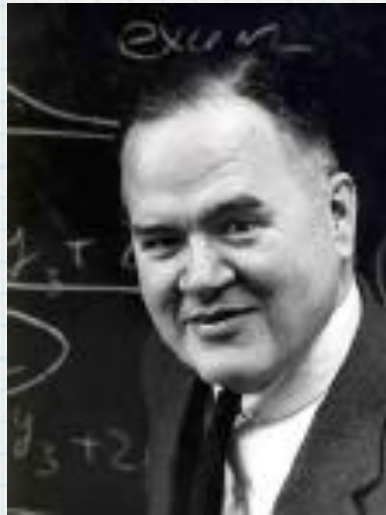
Is There Really a Difference?

<u>A</u>	<u>B</u>
68.2	72.4
70.0	69.3
69.3	69.8
70.4	70.4
67.5	71.3
69.0	70.7
71.5	73.7
68.8	72.1
70.7	71.3
68.4	70.1

Numerical Technique with Excel (Not Recommended)

t-Test: Two-Sample Assuming Equal Variances

	<i>Column 1</i>	<i>Column 2</i>
Mean	69.38	71.11
Variance	1.559555556	1.789888889
Observations	10	10
Pooled Variance	1.674722222	
Hypothesized Mean Difference	0	
df	18	
t Stat	-2.98923263	
P(T<=t) one-tail	0.003933712	
t Critical one-tail	1.734063592	
P(T<=t) two-tail	0.007867423	
t Critical two-tail	2.100922037	



John Tukey, The Picasso of Mathematics

John W. Tukey, 1915-2000

John Wilder Tukey, National Medal of science winner and the statistician who coined the word "software" died July 26, 2000 in New Brunswick, NJ at the age of 85. Tukey, considered one of the most influential figures in the mathematical sciences of the past half century had suffered a heart attack.

Born in New Bedford, Massachusetts in 1915, Tukey was the only child of Ralph and Adah Tasker Tukey, who had met as members of the Class of 1898 of Bates College in Maine. Adah had been the class valedictorian, and her future husband Ralph graduated as class salutatorian. The Tukeys were teachers, Ralph an instructor of Latin and Adah a private tutor, who educated her son almost completely as a home student. Tukey received his first degree, a bachelor in chemistry in 1936, and by the age of 24 held 3 graduate degrees: 1 in chemistry from Brown, and 2 graduate degrees in mathematics from Princeton.

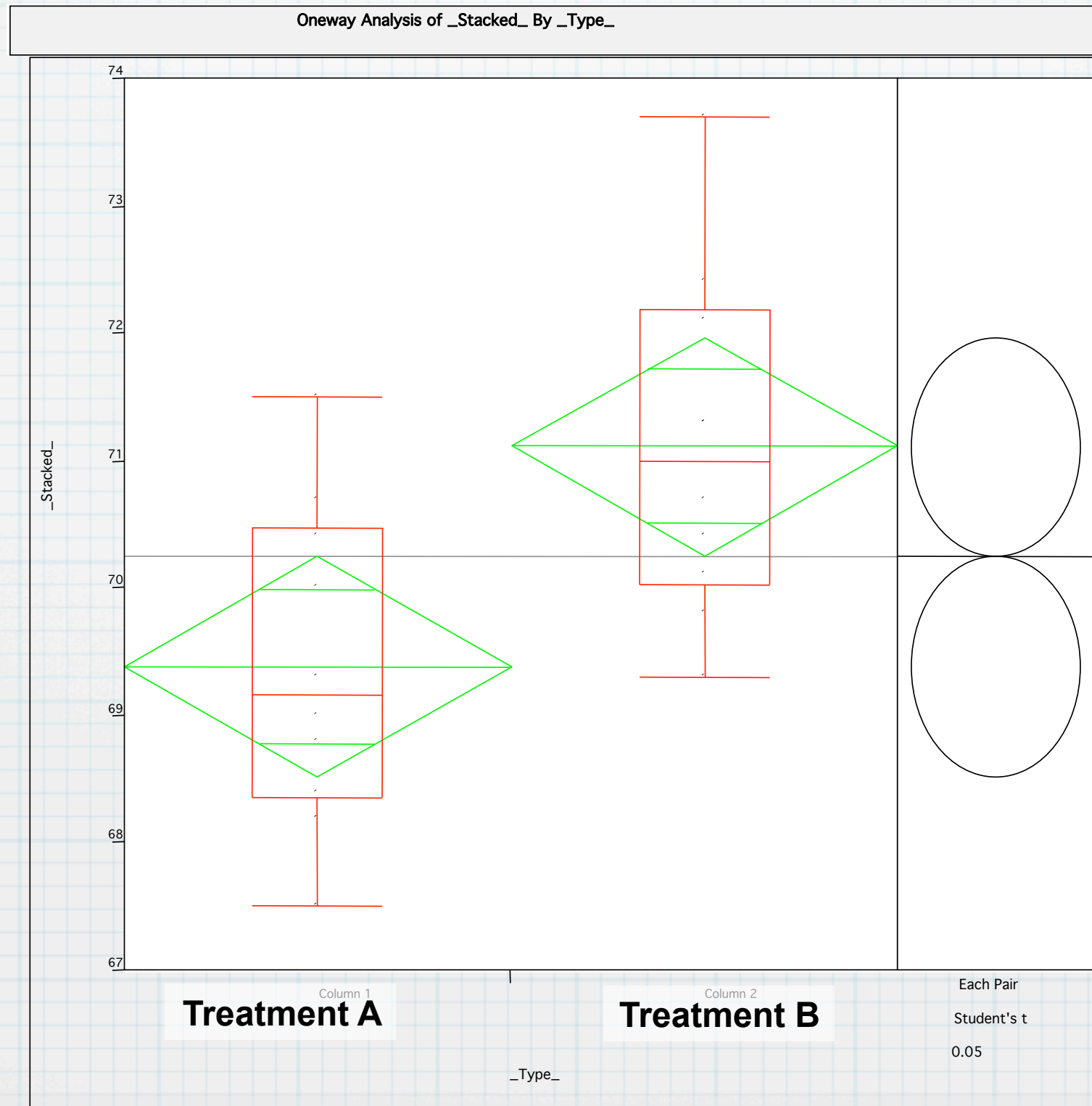
Tukey never left Princeton, assuming first a teaching position and by the age of 35 a full professorship at the university. Tukey was the founding chairman of the Princeton statistics department. While instructing at the university, Tukey made a name for himself as a versatile and expert consultant, acting as a researcher at AT&T Bell Laboratories and through an appointment by the National Research Council, as evaluator of the Kinsey Report on the sexual habits of Americans. Alfred C. Kinsey hotly defended his analysis of American sexual preferences and practices, which Tukey claimed were flawed owing to the bias of the test group (Kinsey's personally selected 300 subjects were all known to each other directly or indirectly). Kinsey additionally insisted that Tukey would sing Gilbert and Sullivan tunes while they worked strictly to annoy him.

Tukey's projects and contributions were numerous and varied. Tukey and fellow researcher James Cooley developed the Fast Fourier Transform, an algorithm with numerous uses in the physical sciences, particularly astronomy. The Fast Fourier paper continues to be one of the most widely cited works in both mathematical and computer sciences. Before 1960, Tukey had defined "software" and its importance to computing, and coined the term "bits" as an abbreviation for "binary digit", the sequences of 1s and zeroes upon which computer binary code is based.

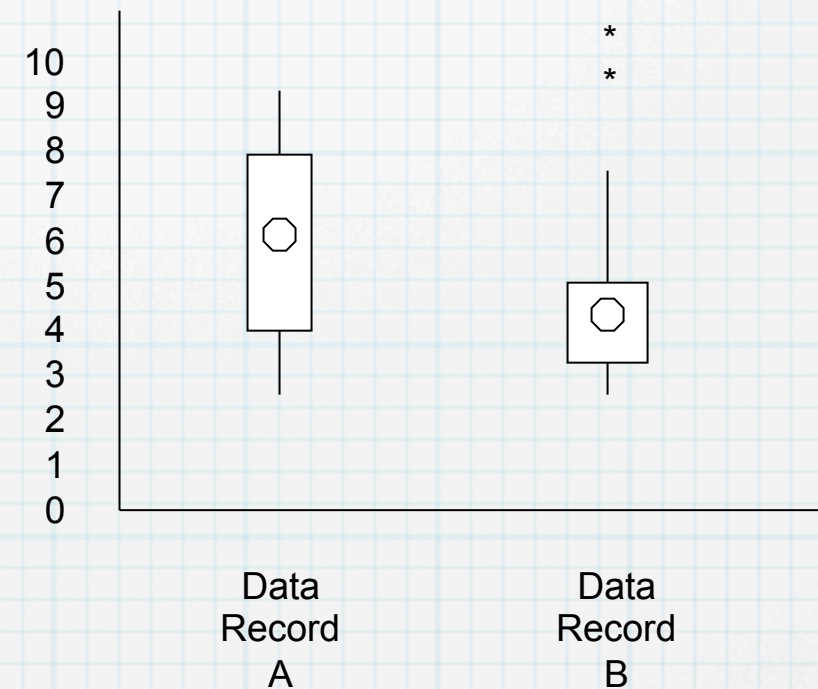
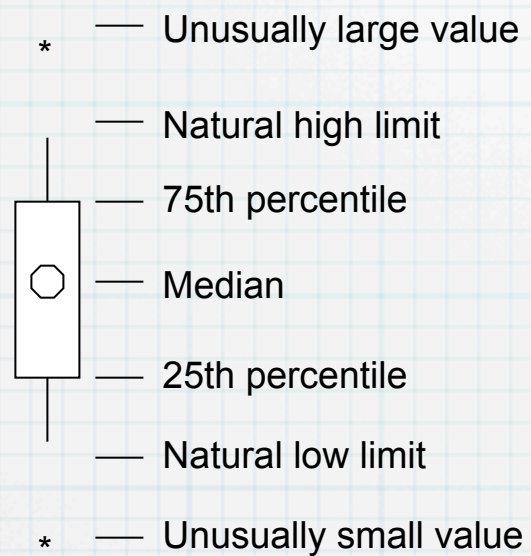
During WW II, Tukey had been employed by the US government and his work was instrumental in the development of the U-2 Spy Plane. After publishing numerous books and papers, proving deterioration of the Ozone layer, developing Robust Analysis theorems which help researchers validate conclusions despite flawed data and essentially designing the basis for the electronic poll system for predicting and analyzing election results, Tukey was awarded the National Medal of Science in 1973.

John Wilder Tukey was preceded in death by his wife of 48 years, Ellen Rapp Tukey, who passed away in 1998. John W. Tukey leaves no immediate survivors.

Box Plot Technique (With Real Statistical Software)

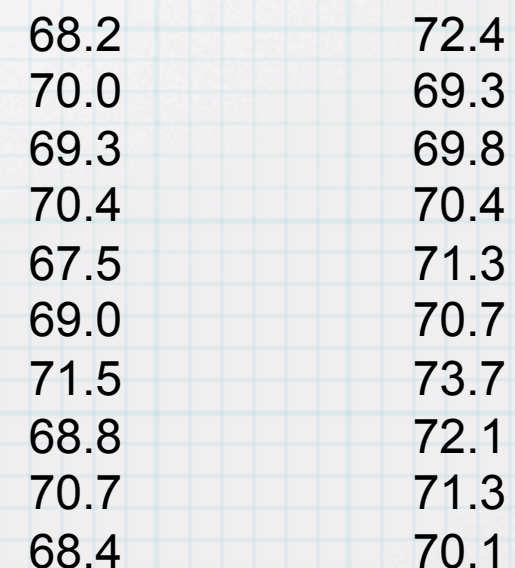
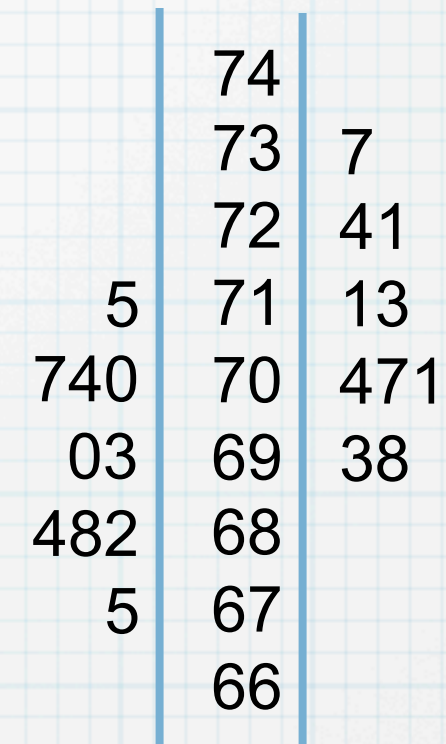


Interpreting the Box Plot



Graphical Technique: Tukey's Stem and Leaf Chart

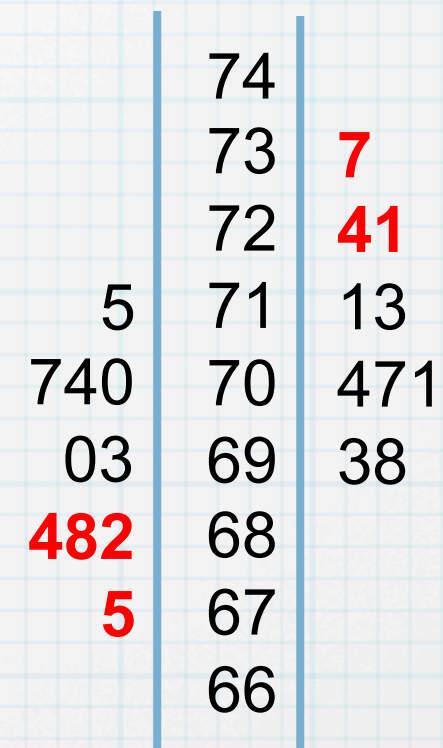
Stem: the scale to contain all values
Leaf: the values to be compared



Graphical Technique: Tukey's Stem and Leaf Chart

Test: Count the Exceedences

7 = .95 confidence
10 = .99 confidence
13 = .999 confidence

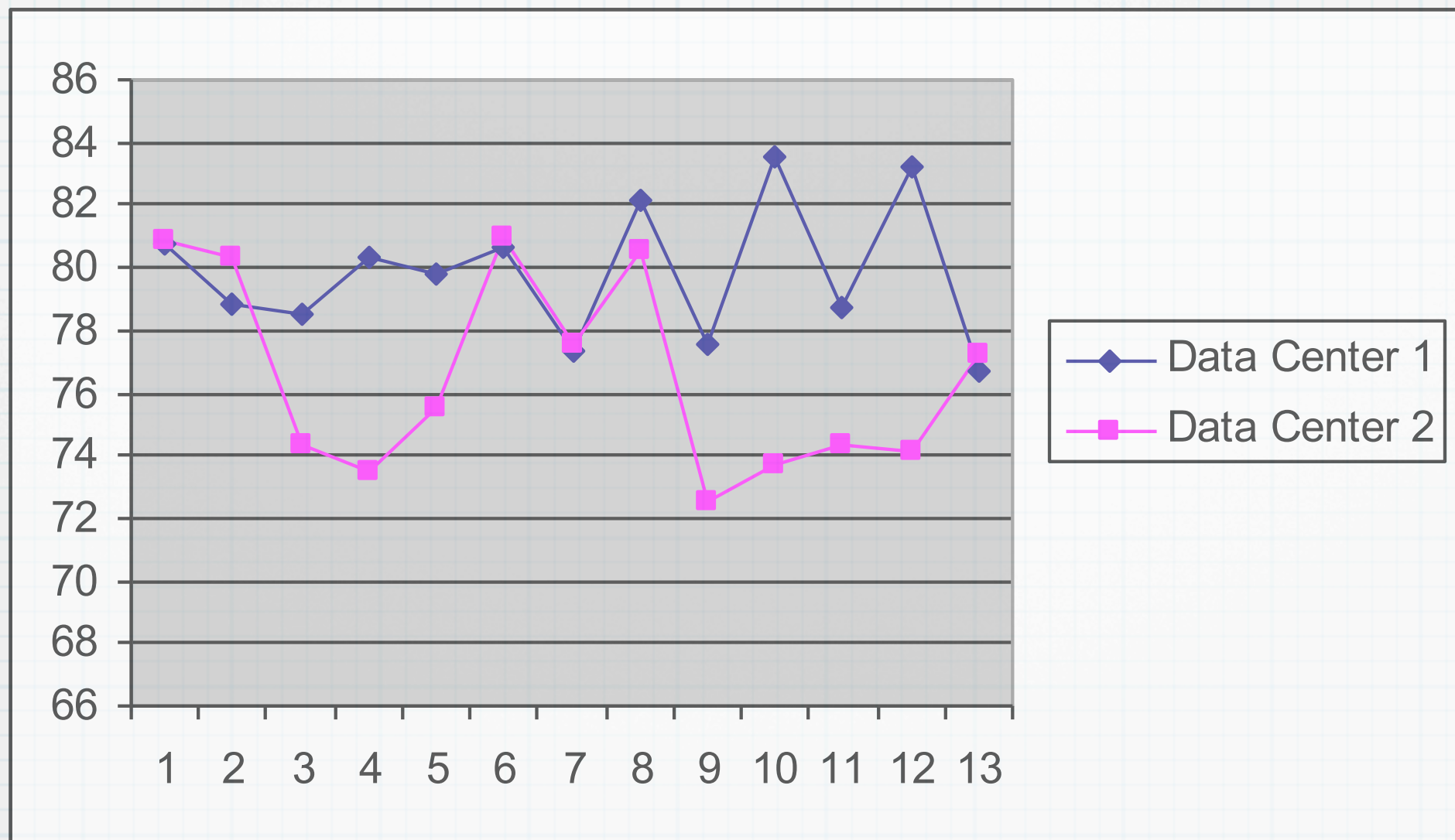


OK, You Try It

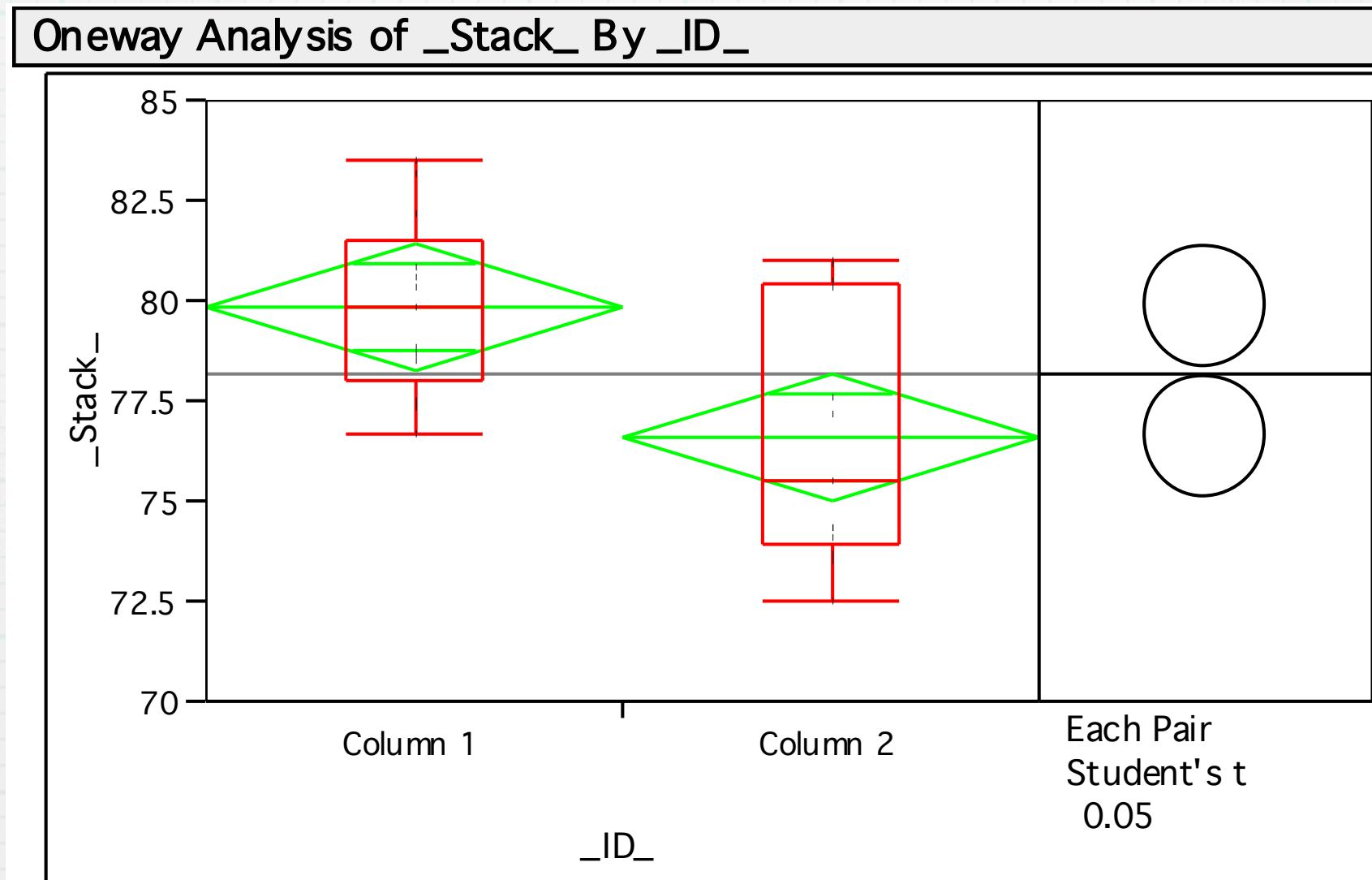
MH Spent on Soft Vulnerabilities

Data Center 1	Data Center 2
80.8	80.9
78.8	80.3
78.5	74.3
80.3	73.5
79.8	75.5
80.6	81
77.3	77.6
82.2	80.5
77.5	72.5
83.5	73.7
78.7	74.3
83.2	74.1
76.7	77.2

What Does This Tell You?



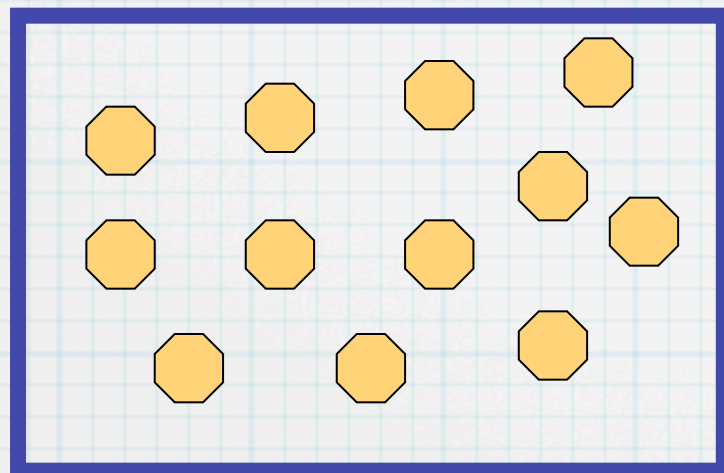
What Is Clear Now?



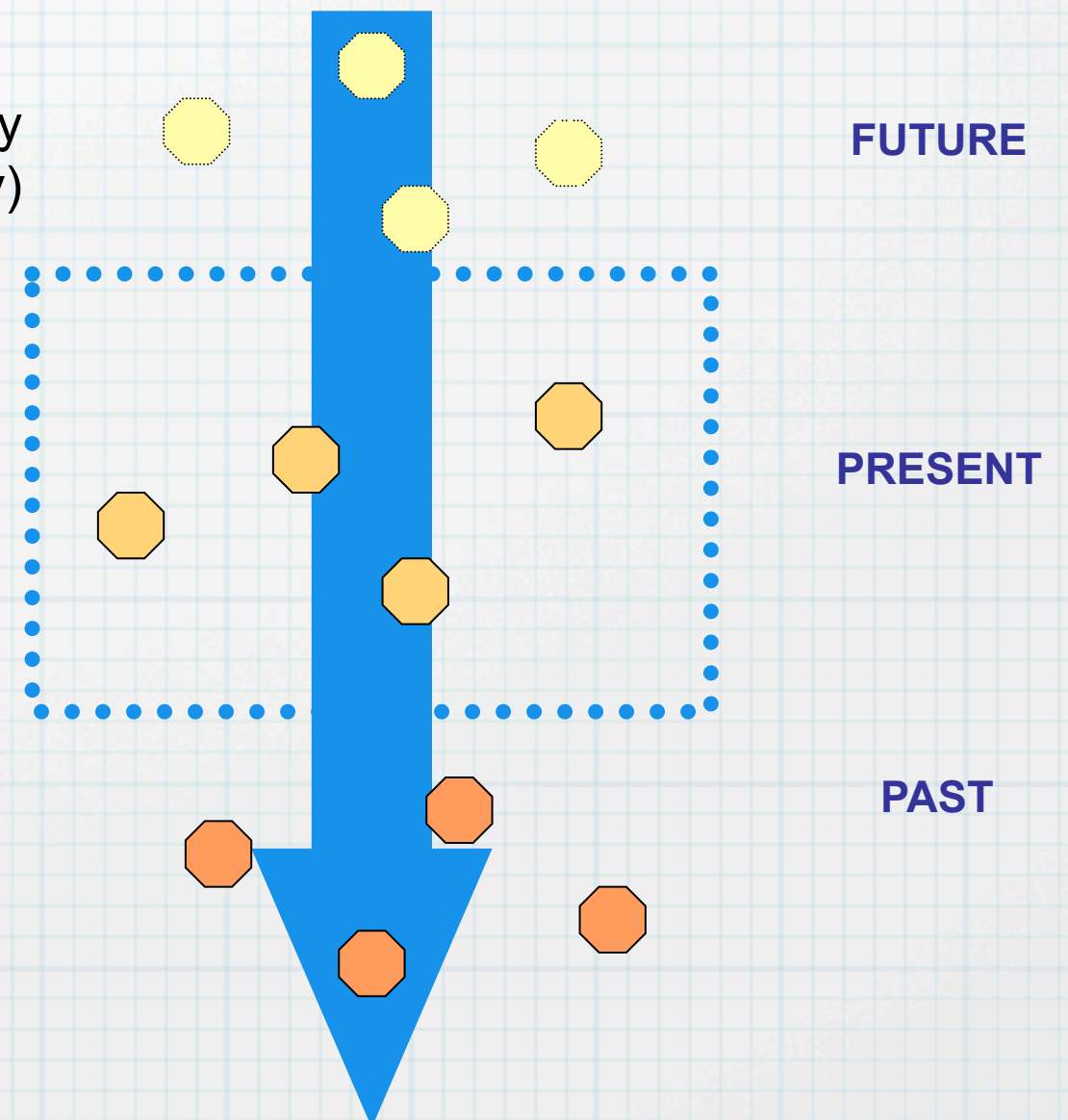
Enumerative and Analytical Studies

Statistical inference with a quantifiable degree of belief can only be made with respect to a frame—and there is no frame in an analytical study

Enumerative Study
(what)

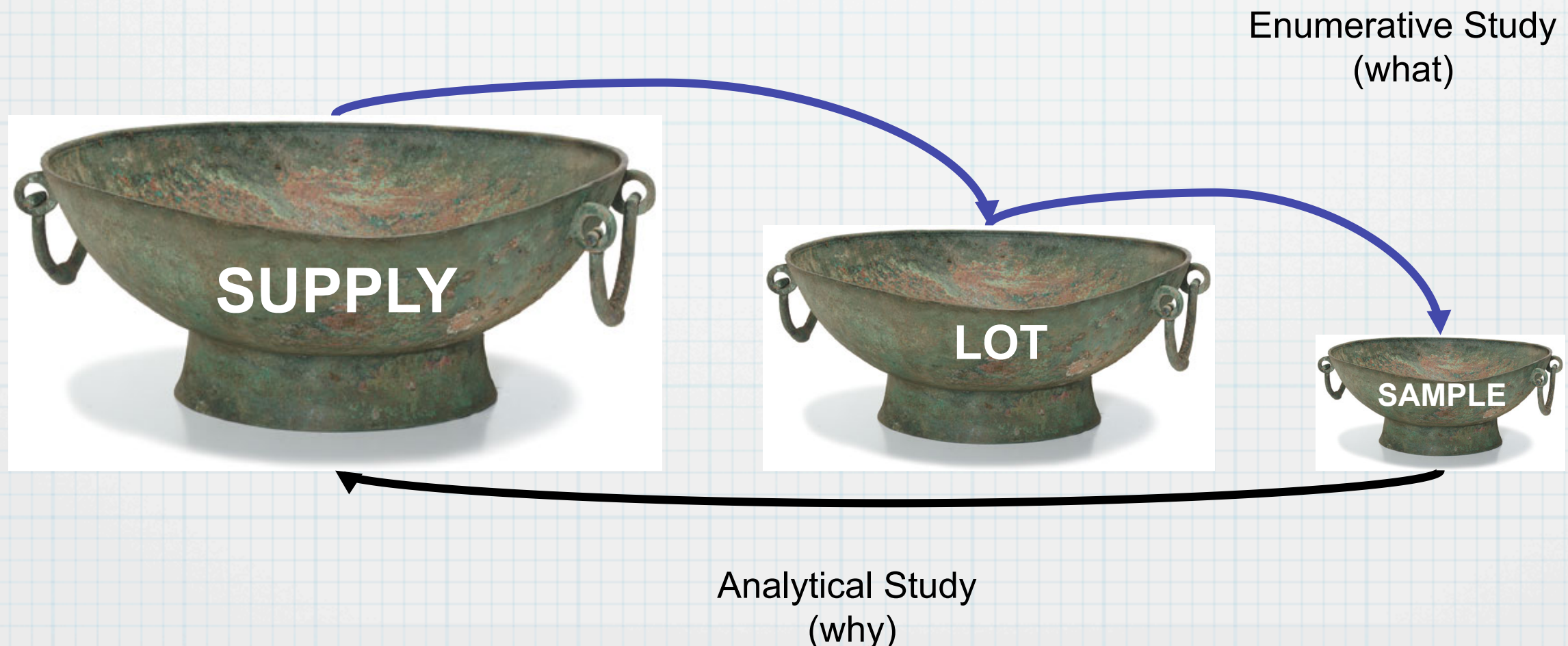


Analytical Study
(why)



Model of Enumerative and Analytical Study

Statistical inference with a quantifiable degree of belief can only be made with respect to a frame—and there is no frame in an analytical study



Comparison of Study Features

<i>Statistical Studies</i>	ENUMERATIVE	ANALYTIC
FOCUS	Description of material in frame	Prediction of process output
METHODS OF ACCESS	Frame	Models of the process - Flowcharts/CLDs Diagrams
MAJOR SOURCES OF UNCERTAINTY	Sampling Error	Extrapolation to the future
IS THE MAJOR SOURCE OF UNCERTAINTY QUANTIFIABLE?	Yes	No
ENVIRONMENT OF THE STUDY	Static	Dynamic
TYPE OF SAMPLE	Random	Judgement

Without Statistical Insight...

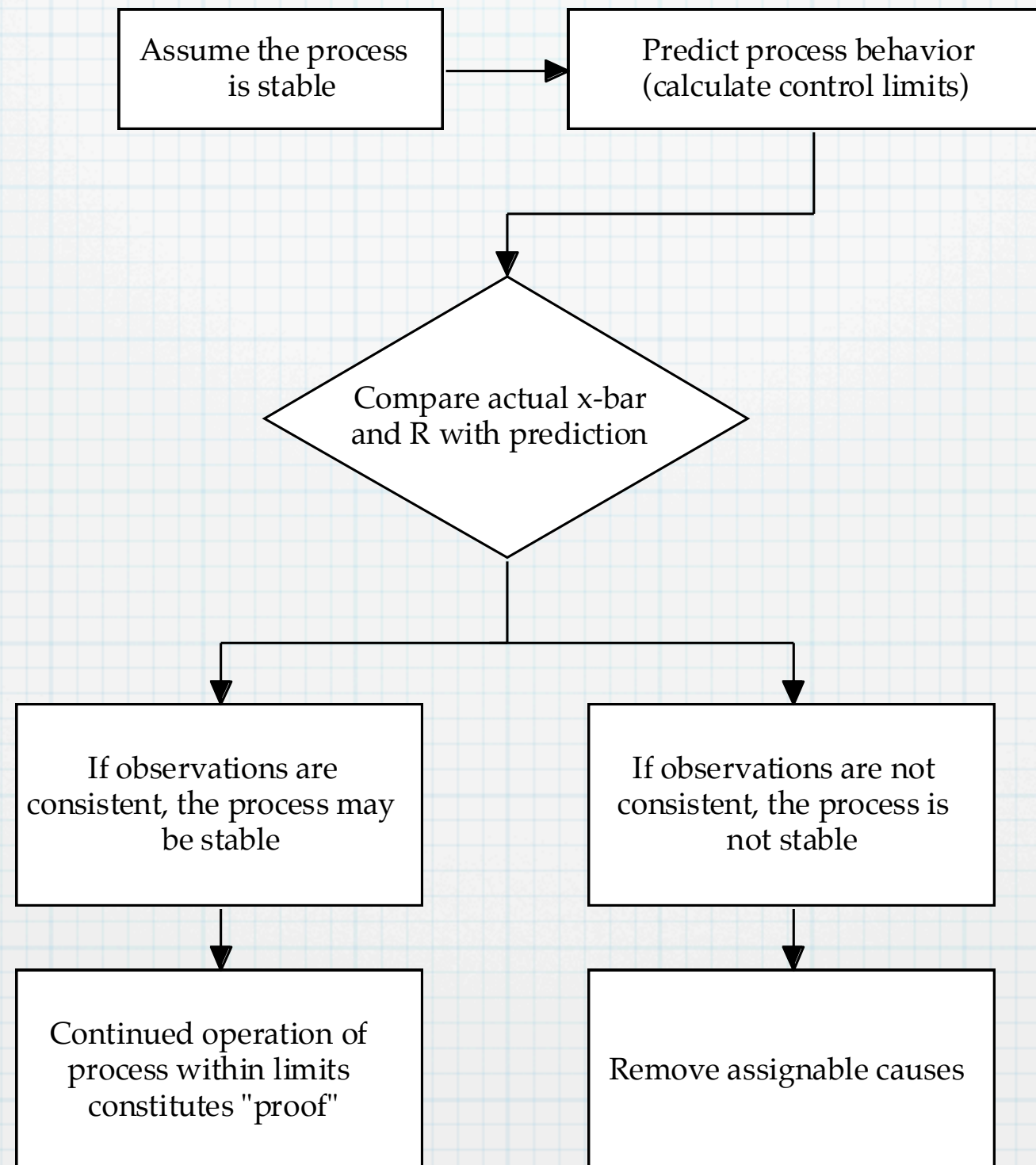
- We see trends when there are no trends
- We miss trends when there are trends
- We blame others for things over which they have no control
- We credit others for things over which they have no control
- We can't understand past performance
- We can't plan for the future
- Our ability to manage or lead is severely impaired.

What You Should Start Doing Tomorrow

1. Write out a list of the data you routinely see
2. From that list, pick the ones you actually use for decisions
3. Plot them on a time-series line graph (BOT)
4. Ask yourself if you are collecting the right data
5. Ensure the data context is preserved and understood
6. Filter out the noise before interpreting any value by calculating XmR limits
7. Don't try to explain noise
8. Distinguish between the VOC and the VOP
9. Take local action on assignable causes
10. Take systemic action on common causes.

Some Extras...

Control Chart Procedure

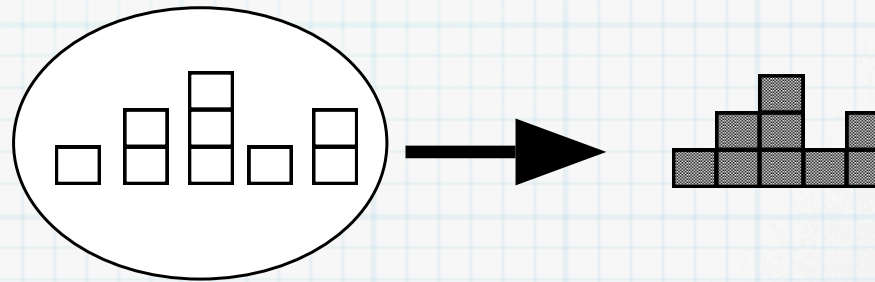


Four Foundations of Shewhart's Charts

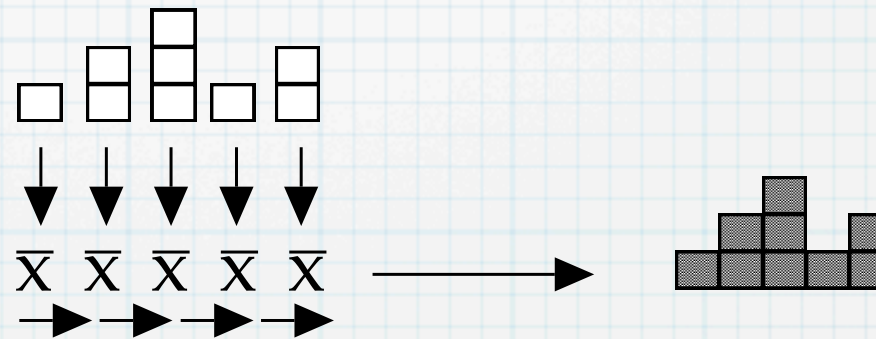
- I. Shewhart's control charts will always use control limits which are set at a distance of three standard deviations on either side of the central line.
- II. Every standard deviation used to compute these limits must be estimated by using the average variation within the subgroups. No other estimates of the standard deviation are acceptable.
- III. The data shall be obtained by a rational sampling scheme and shall be organized into subgroups in a rational manner. The organization of the data into subgroups must respect both the context of the data and the questions to be addressed by the charts.
- IV. The organization can and will utilize the knowledge gained from the charts. An organization must have the ability to respond to knowledge by changing the organization's actions as appropriate before Shewhart's control charts will be as effective as they can be.

Three Ways to Estimate Dispersion Statistics

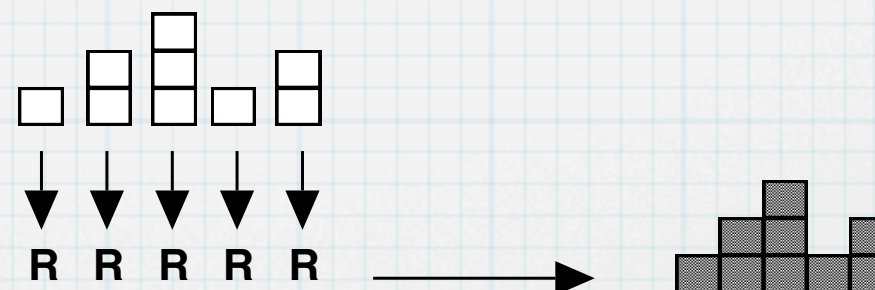
1. Aggregate first, then measure dispersion – Treat all data as one sample.



2. Estimate a dispersion statistic directly from subgroup averages.



3. Treat each subgroup as a separate sample and calculate a dispersion statistic for each subgroup. The average of subgroup dispersion statistics is then used to estimate a dispersion parameter for the distribution of x .



When the data is in statistical control, all three methods yield the same number (about). But, when the data is out of control, only method 3 will reveal a signal.

Statistical Thinking: Eight Axioms of Data Analysis

What numbers to compute

1. No statistic has any meaning apart from the context for the original data - the data have to display a reasonable degree of homogeneity before summary statistics can be used to extrapolate beyond the data to the underlying process that generated the data.

The test of homogeneity is a comparison of a local measure of dispersion with a global measure of dispersion. If a collection of values comes from two or more universes the global measures of dispersion will be inflated by the differences between those universes while local measures will not be inflated in the same way or to the same degree.

Statistical Thinking: Eight Axioms of Data Analysis

The origins of data

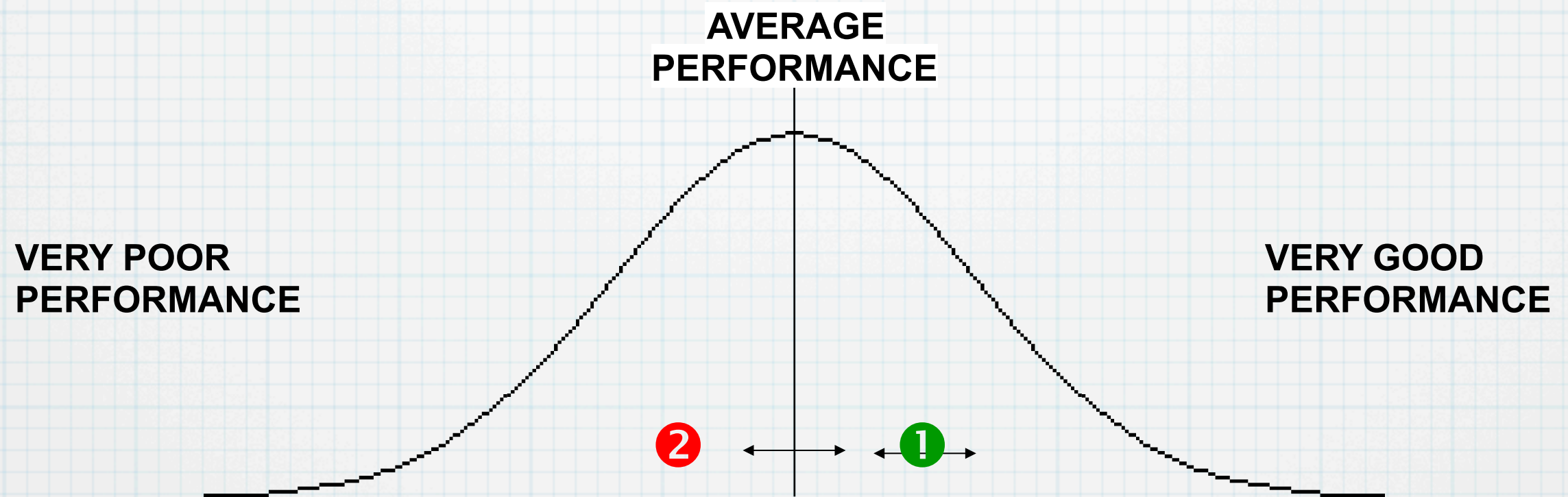
2. Probability models do not generate your data - probability models are approximations of reality -- they live on the plane of mathematical theory where measurements are frequently continuous and observations are independently and identically distributed, and usually assumed to be normally distributed with a known mean and variance.
3. Every histogram has finite tails - data sets are finite in size and extent and invariably display some level of chunkiness in the measurements.
4. No histogram can be said to follow a particular probability model -- a probability model is a limiting characteristic of an infinite sequence of data and it cannot be the property of any finite portion of that sequence. Tests of fit may allow you to say that a particular data set is inconsistent with a probability model, but it can never be used to make a positive statement. Moreover, since histograms have finite tails and probability models have infinite tails, it is inevitable that with enough data you will always reject any probability model you may choose.
5. Your data set is generated by a process or system that is subject to change -- like everything else in the real world.

Statistical Thinking: Eight Axioms of Data Analysis

Guides to interpretation

6. All outliers are prima facie evidence of nonhomogeneity -- Processes that live up to their full potential will be characterized by a homogeneous data stream.
7. Every data set contains noise. Some data sets also contain signals. Before you can detect the signals within the data, you must filter out the noise.
8. You must detect a difference before you can legitimately estimate that difference, and only then can you assess the practical importance of that difference. When the noise of routine variation obscures a difference it is a mistake to try to estimate that difference. A detectable difference is called "significant" and is a precondition for estimating the practical importance of the difference.

Statistical Thinking and Psychology



On what basis do we apply reward and punishment?

Scientific Thinking

“If I haven’t seen further, it’s because giants have stood on my shoulders.”

1 November 2005

Scientific Thinking

A disciplined way of thinking and talking about the world with the goal of building practical knowledge to guide wise actions.

Today's Menu

- Some Principles of Epistemology
 - Building Knowledge
 - Some Implications for Problem Solving
 - Some Implications for Project Management
-
- Next time: Measurements for Project Management

The Backstory on Deming's Epistemology



Shewhart and Deming were influenced by an American philosopher named C.I. Lewis, a “Conceptual Pragmatist.” Shewhart attended his classes at Berkeley in 1911 and encouraged Deming to read the 1929 work, “Mind and the World Order.” Dr. Deming recounted that he tried 13 times before completing the assignment.

Pragmatism asks it's question, "Grant an idea or belief to be true what concrete difference will its being true make in anyone's actual life? How will the truth be realized? What experiences will be different from those which would obtain if the belief were false? What, in short, is the truth's cash-value in experiential terms?" - William James, Pragmatism (1907)

Principles of Deming's Epistemology

- **On the Nature of Knowledge**
 - Knowledge is prediction
 - Some important things to manage are unknown and unknowable
 - Experience by itself teaches nothing; there is no learning without theory
 - Knowledge is always temporary and incomplete
- **Operational definitions are essential to communication**
- **PDSA is a strategy that builds knowledge**
- **The purpose of knowledge is to be true to something beyond it.**

Operational Definitions

An Operational Definition describes WHAT something is and HOW it is measured. It puts communicable meaning into a concept.

"Bath Temperature" : the average of three temperature readings from Vat #7B104, one taken three inches above the bottom near the left side, one taken three inches below the top six inches in from the side, and one taken one foot below the surface in the middle.

"Report Handed in on Time" : Complete report in standard format placed in manager's in-basket within ten minutes of the stated deadline.

- **There is no true value for anything.**
- **The goal of operational definitions is to get a definition that all affected parties can agree to, and that gives consistent results no matter who does the measuring.**
- **To collect meaningful data, you must know precisely what to observe and how to measure it.**

More Operational Definitions

Following the incident of oil spillage from the Exxon Valdez, operational definitions took center stage. To wit: *What is the definition of a "clean" beach?*

- **Exxon officials say: "It means that the natural inhabitants can live there without harm... This doesn't mean every oil stain is off every rock."**
- **Coast Guard officials say: "When it's extremely hard to rub it off the rocks, that's what we consider clean."**
- **Alaska officials say: "None of the Alaska beaches hit by oil have been cleaned. The rocks on Green Island are still covered with oil. They glisten in the sun, slick with crude. Wipe any stone, and come away with a handful of oil."**

Developing Operational Definitions

- 1. State the aim of the system**
- 2. Detail the method to be used to achieve it**
- 3. Specify any standards that need to be agreed upon**
- 4. Specify the degree of accuracy and precision expected**
- 5. Identify the method to be used to control variation**
- 6. Agree that “we don’t move forward until you can explain my thinking in your words – and I can do the same.”**

OPERATIONAL DEFINITIONS

Excerpts from a privately circulated draft by
W. EDWARDS DEMING

An operational definition is one that people can do business with.

It is a definition that means the same thing to the vendor as to the purchaser. It means the same thing today as it did yesterday, and it will mean the same thing tomorrow.

An operational definition consists of (1) a criterion to be applied to an object or to a group of objects, (2) a test of compliance for the object or group, and (3) a decision rule for interpreting the test results as to whether the object or group is, or is not, in compliance.

A specification may be applied to any number of things, dimensions, weights, hardness, concentration, color, pressure, shape, or performance, but a specification is not enough for an operational definition. The way of determining compliance is part of the operational definition.

There is probably nothing more important to the man in business than a healthy appreciation for operational definitions. A lot of the bickering between companies and between departments within a company about allegedly nonconforming materials or malfunctioning apparatus arises from a failure on both sides to state in advance, in meaningful terms, an operational definition of conformance or proper functioning.

In this regard the manufacturing world is more exacting than the world of pure science or teaching. As Shewhart said, the standards of knowledge and workmanship required in industry are more severe than the requirements in pure science. In no place is this more obvious than in the mass production of interchangeable parts.

While it is easy to discuss the concepts of shape, length, time, it is impossible to make something that is exactly round, or exactly one foot long. Our measurements are always the result of some procedure. If you change the procedure you may change the measurement. Likewise for the count of the number of people in a given area. No two procedures will give the same count. Neither of the two figures is right and the other wrong. One procedure may be preferred, simply because it supposedly gives results that are nearest to what are needed for a particular end, but that does not invalidate the other procedure.

It comes as a surprise to most people that there is no true value for the speed of light. The value obtained depends upon the method used by the experimenter. Moreover, a method of measurement does not exist unless the results show statistical control (especially with a change in observers). The only test of statistical control on record for results on the speed of light turned out to be negative. Thus we have not yet found a consistent way of estimating the speed of light.

This fundamental principle of science seems to have escaped even officials of the Census. I heard one official say that the Census of 1980 was the most accurate ever taken, leading himself and other people, I fear, to suppose that an accurate figure exists and could be obtained if only everybody in the Census would work hard enough. What he should have said is that the Census of 1980 found more people, especially black males in the 18 to 24 age group, than was ever before obtained for the same money and effort expended.

Claims put forth in 1980 by the mayors of various cities that the 1980 Census failed to count all their people showed a dismal failure on the part of the mayors to understand what a count is. Threats by the courts to award to cities adjustments of recorded counts display equal ignorance. Why not give every area an additional 2.5 percent?

There is no true value for the number of people in Detroit, but there is (was) a figure delivered by the procedures that the Census followed. If the procedure had been different in any way, a different figure would have been obtained.

I submit the thought that a sensible way for a mayor to obtain a count of the number of people in his city is to work in advance with the Census. It would be a requirement that he:

1. Learn in advance the procedures that the Census intends to follow.
2. Study and become familiar with the methods that our Census and other Censuses have used to find people in an area, including the definitions of whom to count and whom to omit, plus the rules for allocating people to each category.

3. Learn the various techniques by which our Census and other Censuses have estimated (a) the number of dwelling units and the number of people missed, (b) the number counted twice, and (c) the number counted in error. Incidentally, a roster of people that claim that they were not enumerated in the Census is not worth the paper that it is written on. You do not have to be home to be counted. Only a search of the Census records can answer the question whether some particular person was enumerated and allocated to the proper home address.
4. Make suggestions on the procedures until satisfied with them.
5. Monitor the Census in action, and provide statistical evidence of exactly what happened, in a small sample of area, appropriately selected.
6. Accept the results of the Census unless the monitoring shows failure in execution. Of course failure in execution must be defined in advance.

Without this participation, the mayor must accept what the Census gives him. To complain afterward is to play heads I win, tails new deal. It is hard for me to find partners for a game governed by such a rule, yet this is precisely how the mayors are asking other people to play.

Anyone familiar with the Census methods knows about the well organized attempt on the night of the 8th of April of the Census year to find and count the people in hotels, flophouses, and other shelters who have no usual place of residence. Many of these people have no information about themselves: some are not sure of their names, still fewer know their ages. An army of enumerators and other Census personnel take part in this dragnet, under close supervision and after many dress rehearsals.

It is notable that further efforts and expense beyond a reasonable level to find more people are singularly unsuccessful, especially for black males 18 to 24 years of age. Intensity of search may easily cost \$100 for every addition to the count. Further effort raises the cost to \$200 for each addition.

How much is one name worth?

Now what do you mean by the number of people in an area. What is your operational definition? There would have to be agreement in advance on just what effort is to be expended and who will pay the cost beyond regular authorized Census methods.

A judge and his staff, to qualify to hear with intelligence a claim for a shortage, would require a short course in Census methods, and a briefing on the difference between a concept and an operational definition.

An operational definition puts communicable meaning into an adjective. Adjectives like good, reliable, uniform, round, tried, safe, unsafe, and unemployed have no communicable meaning until they are expressed in operational terms of criterion, test and decision rule. Whatever they mean in concept to one person cannot be known to another until both agree on a communicable definition. A communicable definition is operational, because it involves doing something, carrying out a test, recording the result, and interpreting the result according to the agreed upon decision rule.

Everyone supposes that he knows what pollution means until he tries to explain it to somebody. Clearly, there has to be an operational definition of pollution for each situation. Even the adjective red has no meaning for business purposes unless it is defined operationally in terms of test and criterion. Clean is one thing for dishes and something else entirely in the manufacture of hard discs for a computer.

The label on a blanket reads "50% wool." What does this mean?

Half wool, on the average, over this blanket, or half wool over a month's production? What is half wool? Half by weight? If so, at what humidity? By what chemical analysis? How many analyses? If the top half of the blanket is wool and the bottom half is something else, then is it 50% wool? Does 50% wool mean that there must be some wool in any cross section the size of a half-dollar? If so, how many cuts shall be tested? How to select them? How much variation between the cuts is permissible? Obviously, the meaning of 50% wool can only be stated in statistical terms. Mere words will not suffice.

Note: This article was part of the handout to Dr. Donald Wheeler's course, *Advanced Concepts in Statistical Process Control*, and is duplicated here with permission for your enjoyment.



The purpose of a team is ALWAYS to PDCA

No team that PDCA's and achieves no other goals can be called dysfunctional;

No team that fails to PDCA despite achieving all other goals can be called functional.



Plan – Do – Study – Act

- **Nothing happens on a reliable, sustained basis unless we build a system to cause it to happen on a reliable, sustained basis.**
- **It appears so simple that most people don't do it**
- **Most management work reduces to PDSA**
- **The most difficult and important step is STUDY. Without it, we cannot keep our processes alive.**
- **The first lessons from STUDY are almost always the same:**
 - **We weren't clear on the objectives**
 - **We had conflicting objectives**
 - **We had unrealistic expectations**
 - **We weren't clear about our methods**
- **It's hard to do good STUDY from inside the system. It's a benefit to have someone outside the system help the cycle turn.**
- **The organization that does good, non-blaming STUDY is on the road to rapid improvement.**
- **This is very difficult to do.**

On the Limitations of Problem Solving

- Problem solving makes bad things go away – it doesn't necessarily create good new things.
- One smart thing about Six Sigma is that two distinct methodologies have been designated: DMAIC and DMADV
(define-measure-analyze-improve-control
and define-measure-analyze-design-verify)
- It is useful to identify four levels of issues:
 - **Puzzles** – data is available, but need to be ordered to be understood
 - **Problems** – the system has broken down and patterns of behavior and causal relations need to be understood
 - **Polarities**
 - **Mysteries** – A new paradigm is required to look outside the system.

Some Cautions When Problem Solving



When faced with a problem...

- 1. You could have prevented it
(of course now it's too late)**
- 2. You could correct it
(if time, money, schedule, and skill allow)**
- 3. You could take an interim action
(learn to live with it)**
- 4. You could take an adaptive action
(build it into your system*)**

***This of course means that others must also
build it into their systems!**

Everyone Has a Favorite...Here's Mine

1. **Identify the goals of the effort and separate goals from necessary conditions (*hint: you get to pick the goals*)**
2. **Identify the controllable variables**
3. **Identify the uncontrollable variables (*and challenge the choices*)**
4. **Map the relationships**
5. **Communicate, communicate, communicate**

Strategies for Communication and Exploration

Translate:

words to pictures
pictures to words
numbers to metaphors
metaphors to pictures
graphs to stories
stories to numbers
words to 3D physical models
words to formulas
concepts to examples
examples to concepts
formulas to pictures
formulas to numbers
numbers to pictures
numbers to words
words to actions
actions to pictures
actions to formulas
...and many others

Hume's Guidelines for Skeptical Causation

1. There must be a logical chain $Y = (f)x$
2. There must be temporal precedence
3. There must be co-variation, i.e., the strength of the cause must be proportional to the strength of the effect
4. There must be no related major effects (no “red x”) – especially in a co-linear relationship.

Lessons from Lewis on Project Management (The Five Major Imperatives of Rationality)

The Goal: “To attain a life that is good in the living of it.”

1. **The Fundamental Imperative: To be consistent.**
2. **The Imperative of Cogency: One must build empirical knowledge.**
3. **The Technical Imperative: Efficiency will only be achieved by overcoming the unique technical challenges of the particular end sought.**
4. **The Prudential Imperative: to act so as to maximize one's own good in the long run.**
5. **The Moral Imperative: To act so that one could wish the maxim of one's act to be a universal law.**

1. The Fundamental Imperative

The Fundamental Imperative: To be consistent. To act successfully in a dangerous and partially indeterminate world, people must be able to formulate a plan and carry it through, despite distractions and interruptions.

- **Most work is project management**
- **A project is an experiment in which time is held constant**
(Fisher: “That’s not an experiment you have there, it’s an experience!”)
- **Work breakdown, Scheduling, Estimating, and Balancing are tools to keep focused in the face of reality**

2. The Imperative of Cogency

The Imperative of Cogency: One must build empirical knowledge. One must act in terms of the world as it really is if one is to regularly achieve goals.

- **Operational definitions and PDSA build knowledge**
- **Multiple views are required to capture “reality” – facilitation tools are very useful**
- **In God we trust...all others bring data**
- **You must go to the “gemba” (where the action is).**

3. The Technical Imperative

The Technical Imperative: Efficiency will only be achieved by overcoming the unique technical challenges of the particular end sought.

- **There's no substitute for bringing forward your expertise and drawing out the expertise of others – *learn what you know.***
- **To work with others:**
 - ***Center*** (yourself)
 - ***Enter*** (the space of others)
 - ***Turn*** (the problem to a solution with a collaborative method)

4. The Prudential Imperative

The Prudential Imperative: to act so as to maximize one's own good in the long run.

- **How do projects fall behind?**
(say it with me ... **one day at a time**)
- **Lots of little PDSAs are better than a few large ones**
- **No work package should be larger than two reporting periods (the 0 – 50 – 100% rule)**
- **There's nothing magical about the seven-day week or the time it takes the earth to circumnavigate the sun**
- **Beware of managing by the critical path (management by exception). Small sins have a way of catching up.**

5. The Moral Imperative

The Moral Imperative: To act so that one could wish the maxim of one's act to be a universal law.

"The significance of concepts is that they lead to knowledge;

the significance of knowledge is that it leads to action,

community of knowledge leads to community of action.

Our common world is social achievement fostered by our need to cooperate. The eventual aim of communication is coordination of behavior - it is essential that we have purpose and aim in common."

- C.I. Lewis

“The era of force must give way to that of knowledge, and the policy of the future will be to teach and to lead.”

- Henry Gantt, 1917

Knowledge of Psychology

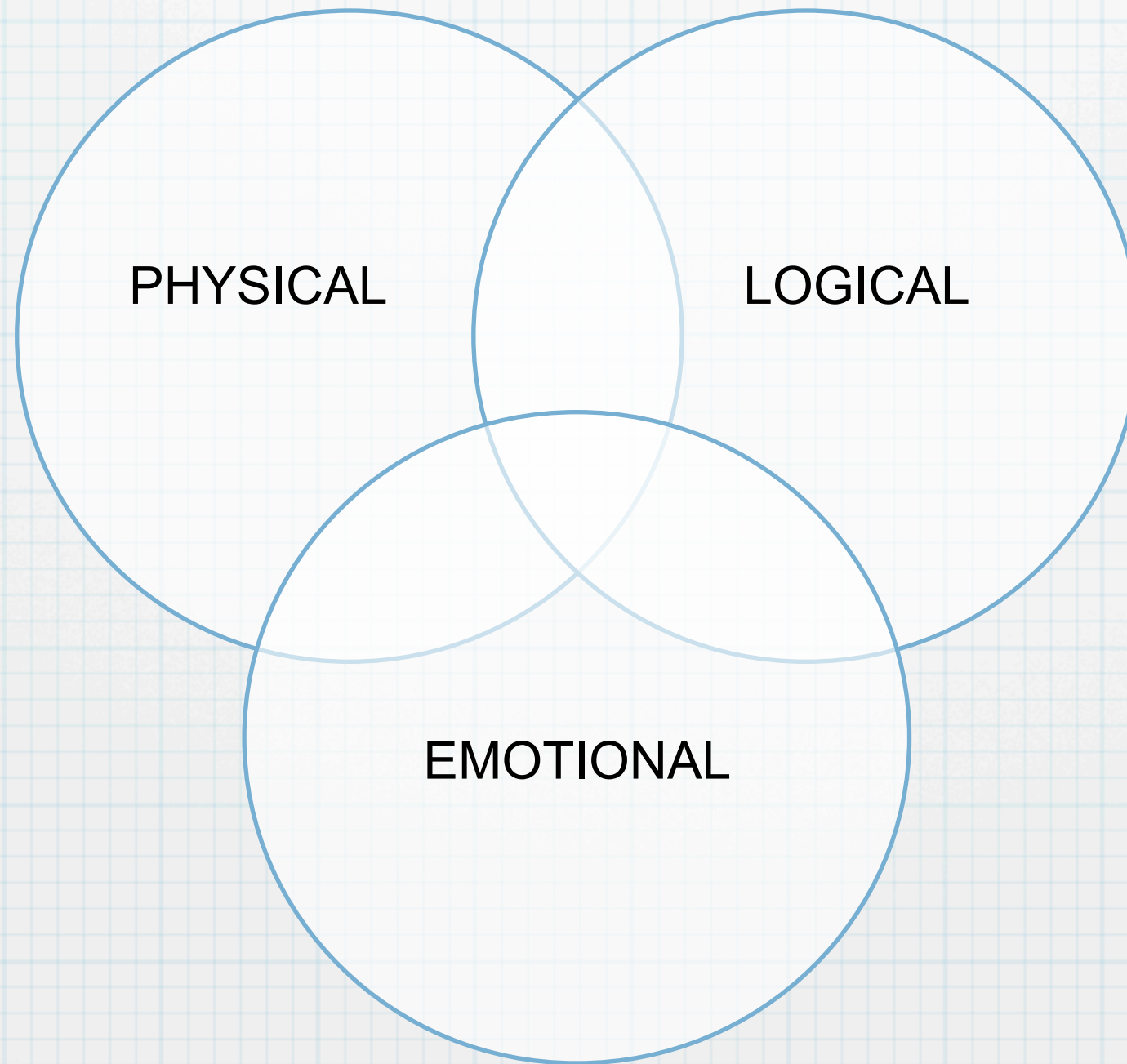
The Fourth Part of Dr. Deming's System of Profound Knowledge

14 December 2005

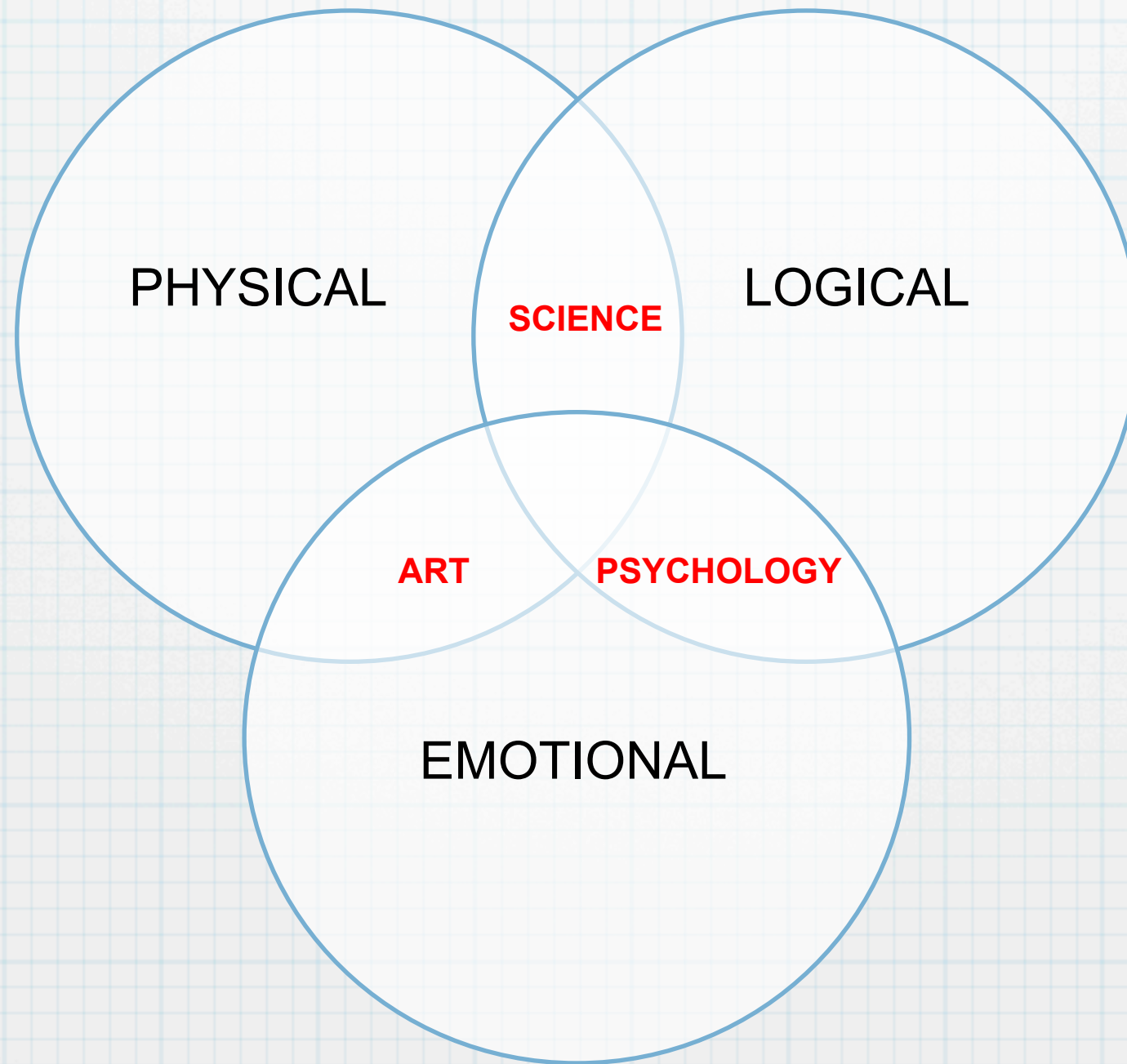
Some Knowledge of Psychology

Psychology is the study of the relationship between our emotional states and our actions

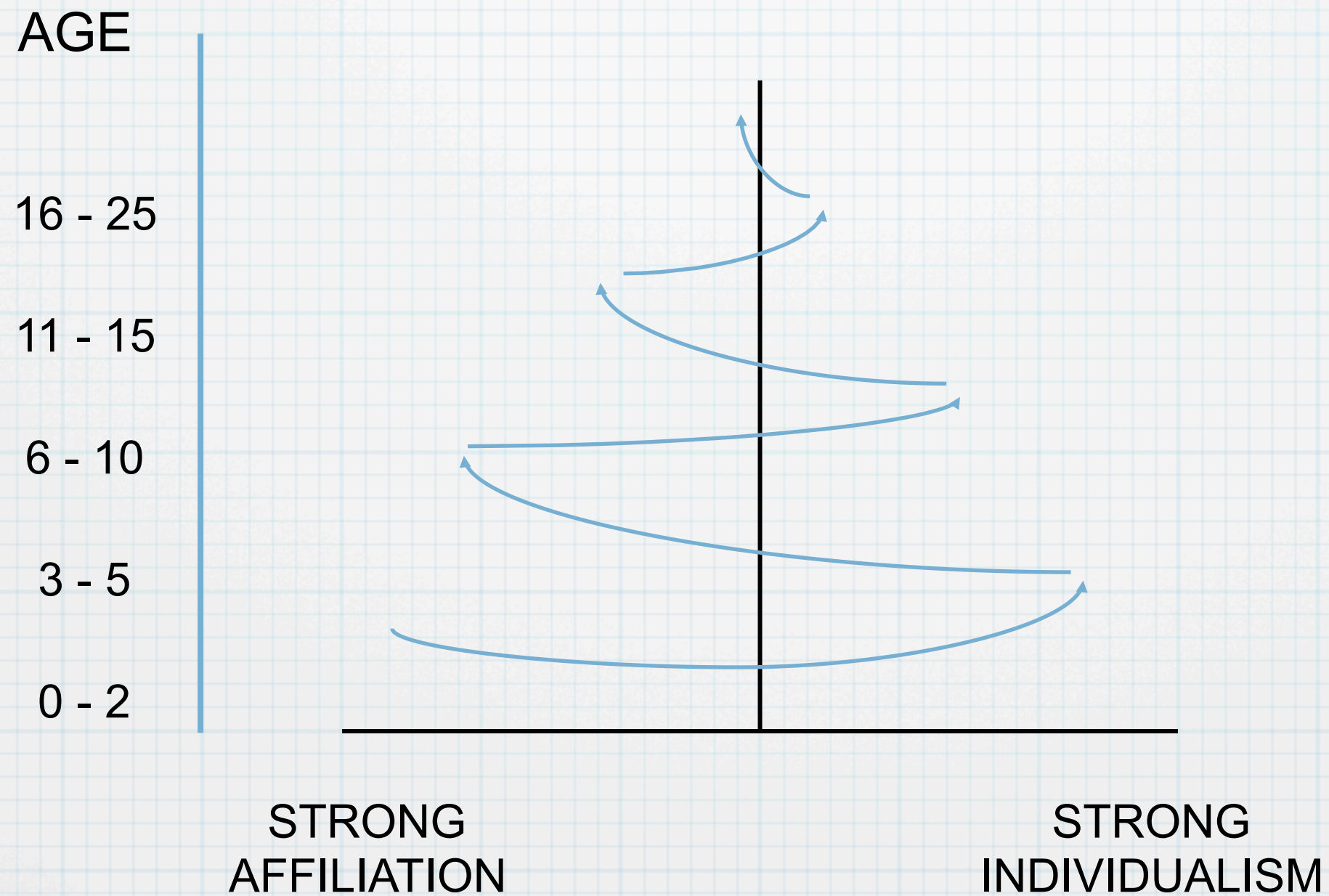
A SIMPLE MODEL OF THE HUMAN LANDSCAPE



A SIMPLE MODEL OF THE HUMAN LANDSCAPE - DOMAINS



THE NEEDS FOR AFFILIATION AND INDIVIDUALISM



CHOICE

“ In the early days of ‘humanizing the workplace,’ quite a few managers were willing to listen to information and ideas that might give them some new gimmicks. The question they frequently asked revealed the nature of their interest: ‘How can we make the workers feel that they are participating?’ We sought to explain that, in the long run, workers would not feel that they were participating unless they had some real impact upon decisions important to management as well as to workers. This generally ended the conversations.”

– William Foote Whyte

- We are most likely to become enthusiastic about what we are doing and to do it well, when we are free to make decisions about the way we carry out a task
- People sense very quickly when empowerment is shallow
- Empowerment itself contains an internal contradiction
- Why does a culture that values democracy so highly always create an autocracy when something must be done?
- You are duplicated nowhere else on Earth. You bring unique magic to your workplace.

CHALLENGE

“ Idleness, indifference, and irresponsibility are healthy responses to absurd work. If you want people to do a good job, give them a good job to do.”

– Fredrick Herzberg

- A good job is meaningful. The point is not just that work should be fun, but it should make a difference.
- People should be matched to their jobs with guidance from statistical and psychological insight.
- Jobs should be structured to increase levels of responsibility, meaningfulness, and feedback.
- Performance measures are very important. People will perform extraordinarily well under even harsh circumstances if they can see the results of their efforts.

COLLABORATION

“ Most so-called managerial teams are not teams at all, but collections of individual relationships with the boss in which each individual is vying with every other for power, prestige, recognition, and personal autonomy. Under such conditions, unity of purpose is a myth ... However, the limits on human collaboration in the organizational setting are not limits of human nature, but of management's ingenuity in discovering how to realize the potential represented by its human resources.”

– Douglas McGregor

- Almost nothing is produced in isolation
- Collaboration is synergistic – multiple viewpoints are better informed, more creative, and draw upon much richer case examples
- Human beings struggle with two divergent needs: individualism and affiliation
- The greatest aid to affiliation and collaboration is a deeply shared understanding of mission, vision, and values.

THE COLLABORATION LESSON

THE SITUATION

It is approximately 10 a.m. in mid-August and you have just crash-landed in the Sonora Desert in the southwestern United States. The light twin-engine plane, containing the bodies of the pilot and co-pilot, has completely burned. Only the air frame remains. None of the rest of you has been injured.

The pilot was unable to notify anyone of your position before the crash. However, he had indicated before impact that you were 70 miles south-southwest from a mining camp which is the nearest known habitation, and that you were approximately 65 miles off the course that was filed in your VFR Flight Plan.

The immediate area is quite flat and, except for occasional barrel and saguaro cacti, quite barren. The last weather report indicated that the temperature would reach 100 degrees that day, which means that the temperature at ground level will be 130 degrees. You are dressed in light-weight clothing – short-sleeved shirt, pants, socks, and street shoes. Everyone has a handkerchief. No cell phones or GPS units survived the crash. Collectively, your pockets contain \$2.83 in change, \$85.00 in bills, a pack of cigarettes, and a ball-point pen. Everyone in your party has a 7.5 lb. laptop in working condition.

THE CHALLENGE

Before the plane caught fire, your group was able to salvage the 15 items listed on the next page. Your task is to rank these items according to their importance to your survival, starting with “1” as the most important, to “15” as the least important.

You may assume that:

- The number of survivors is the same as the number on your team
- The team has agreed to stick together
- All 15 items are in good condition.

STEP 1: Each member of the team is to individually rank each item in silence – without discussion.

STEP 2: After everyone has finished the individual ranking, rank order the 15 items as a team. Once discussion begins, do not change your individual ranking.

Your team has seven minutes to complete this exercise.

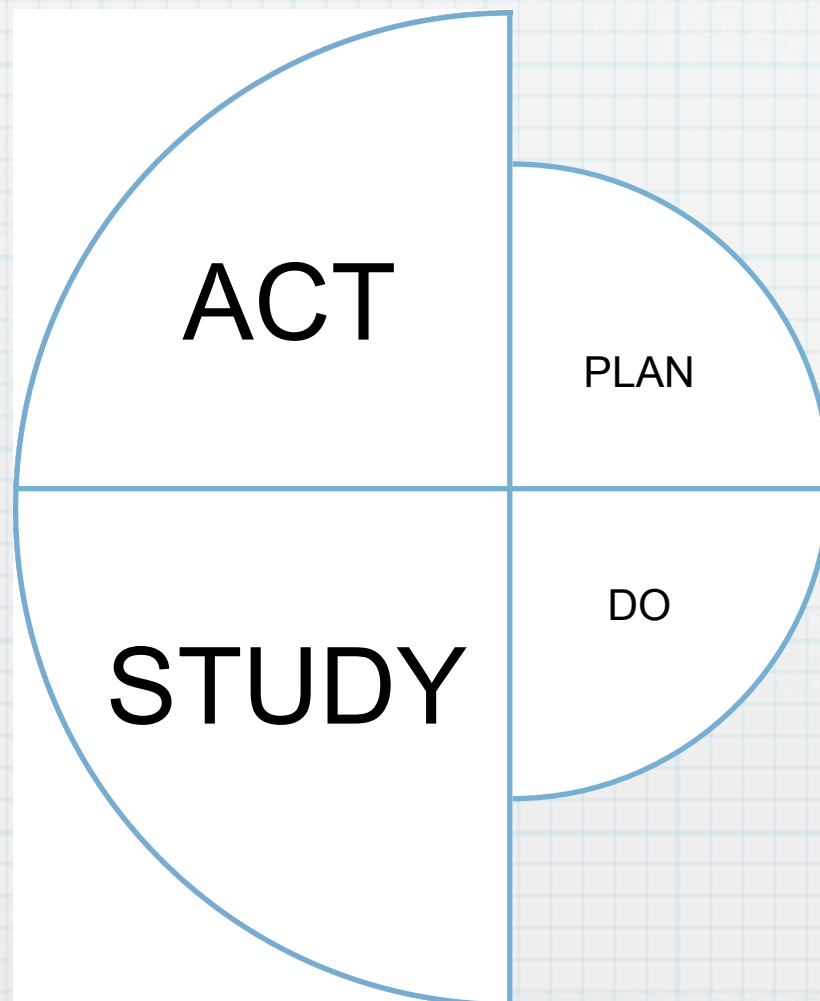
THE COLLABORATION LESSON - Part 2

ITEMS	STEP 1 Your individual ranking	STEP 2 The team' s ranking	STEP 3 Expert' s ranking	STEP 4 Difference between 1 & 3	STEP 5 Difference between 2 & 3
Cosmetic mirror					
1 heavy coat per person					
1 quart of water per person					
Flashlight with 4 D-cell batteries					
1 Parachute (red and white)					
Pocket knife					
1 plastic rain coat					
.45 caliber pistol (loaded)					
1 pair of sunglasses per person					
Compress kit with gauze					
Magnetic compass					
Sectional air map of area					
Book entitled <i>Edible Animals of the Desert</i>					
2 Quarts of 180-proof vodka					
Bottle of salt tablets (1000 tablets)					
TOTAL					

ORGANIZATIONAL LEARNING

“A learning organization is an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights.”

– David A. Garvin, Harvard Business Review



Organizational learning means
Doing STUDY-ACT very well

ACTIONS OF ORGANIZATIONAL LEARNING

The freely chosen and willful ability to:

- Question evidence – “How do we know what we know?”
- Question point of view – “Whose perspective does this represent?”
- Question connections – “How is this related to that?”
- Question supposition – “How else might things be?”
- Question relevance – “Why is this important?”

(It takes the whole organization to educate the leader)

QUESTIONS TO PROMOTE LEARNING

To Broaden Learning

“What are other’s views?”

“Does anyone have other reactions or thoughts?”

“Does anyone have a different view or additional data?”

“What might we miss by looking at it this way or by going in this direction?”

To Deepen Learning

“What leads you to think so?”

“What is an example of the kind of thing you are saying or recommending?”

“What do you think might happen if we do X?”

“What prevents you from doing X or from looking at it this way?”

To Help Resolve an Impasse

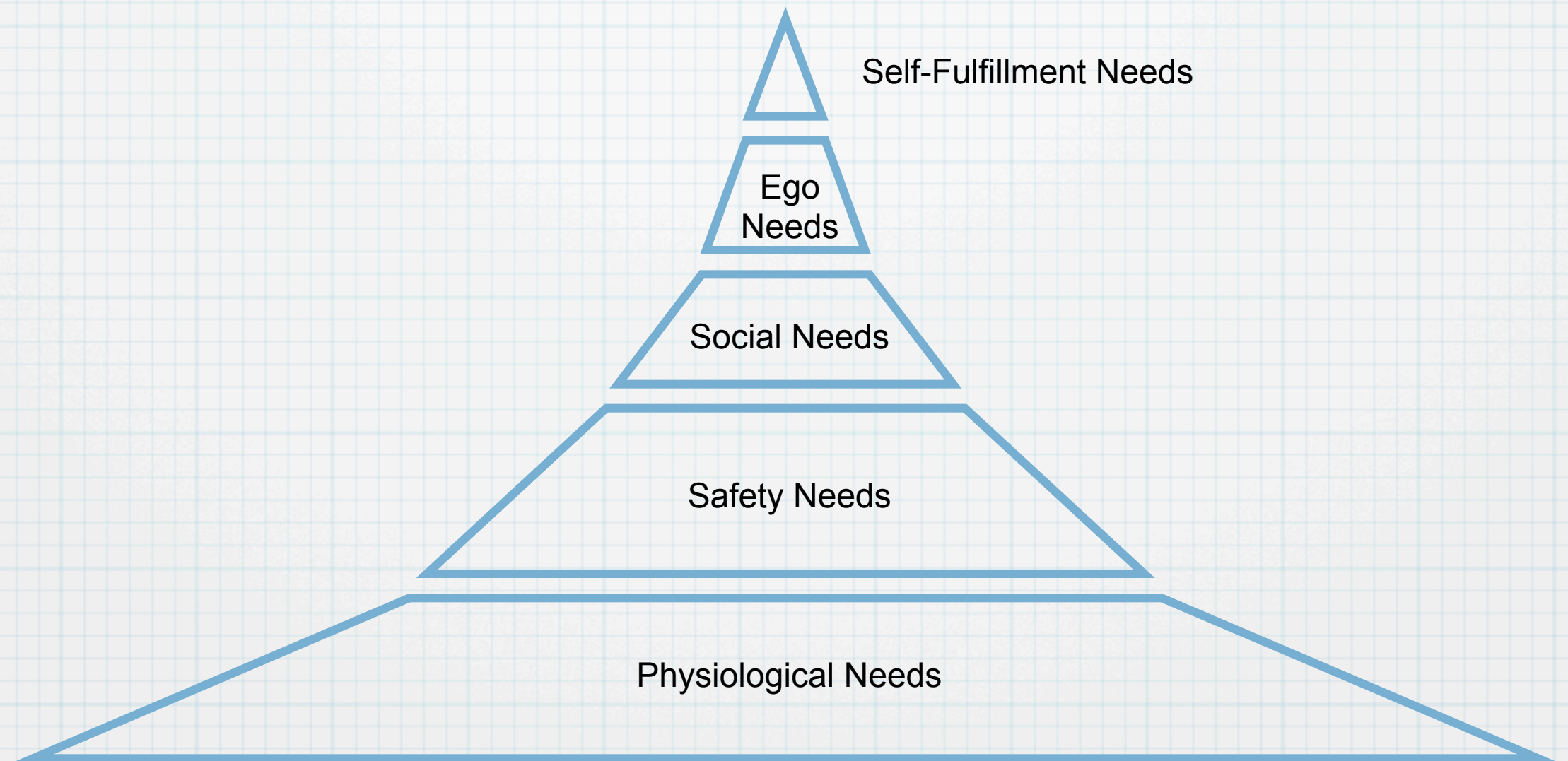
“What is the concern behind your views?”

“What if we did Y? Would that settle your concern or would you still have doubts?”

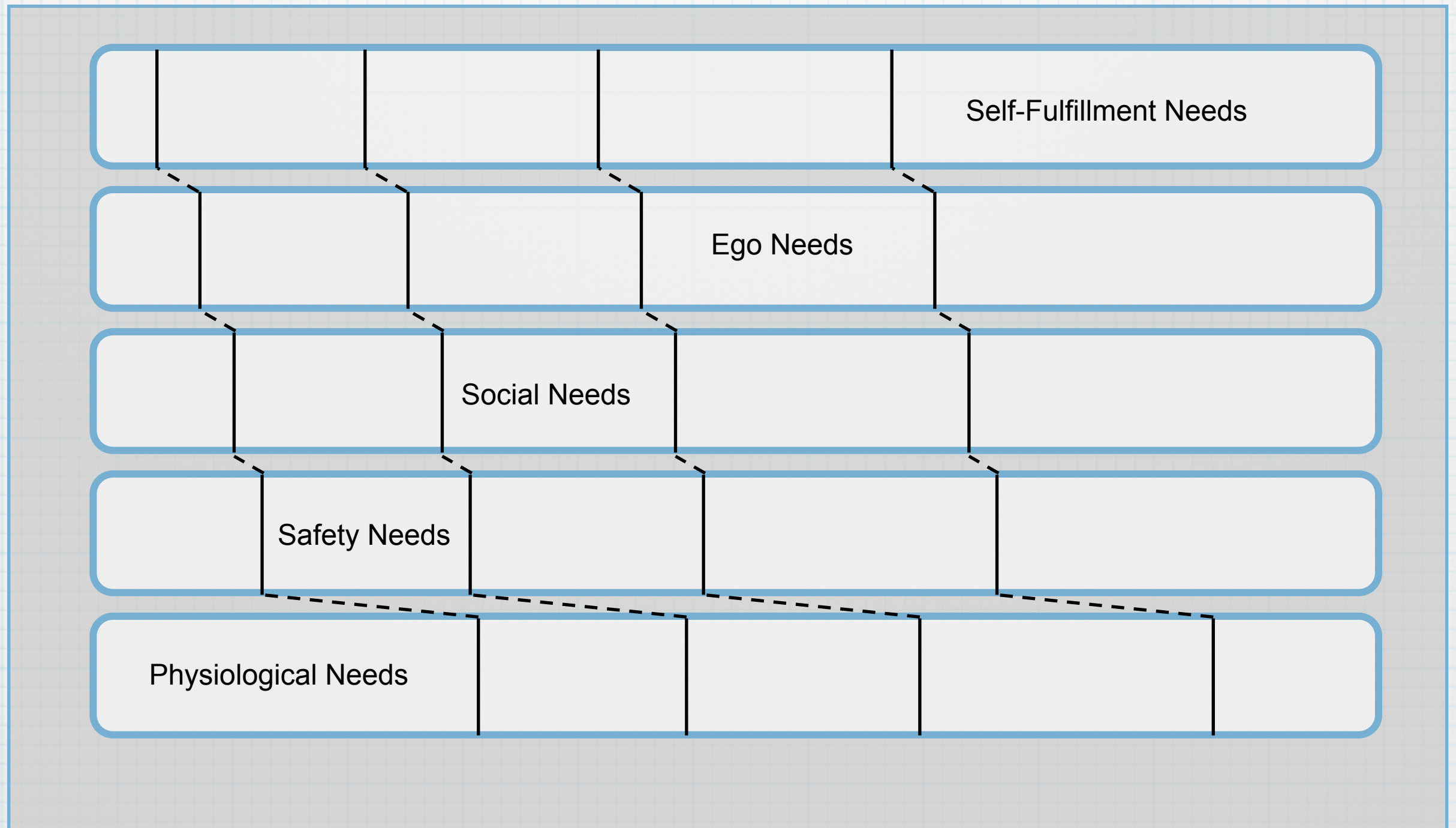
“Is there anything I am doing that is contributing to the problem from your point of view?”

“What data, if we discovered it, would lead you to reconsider your conclusion?”

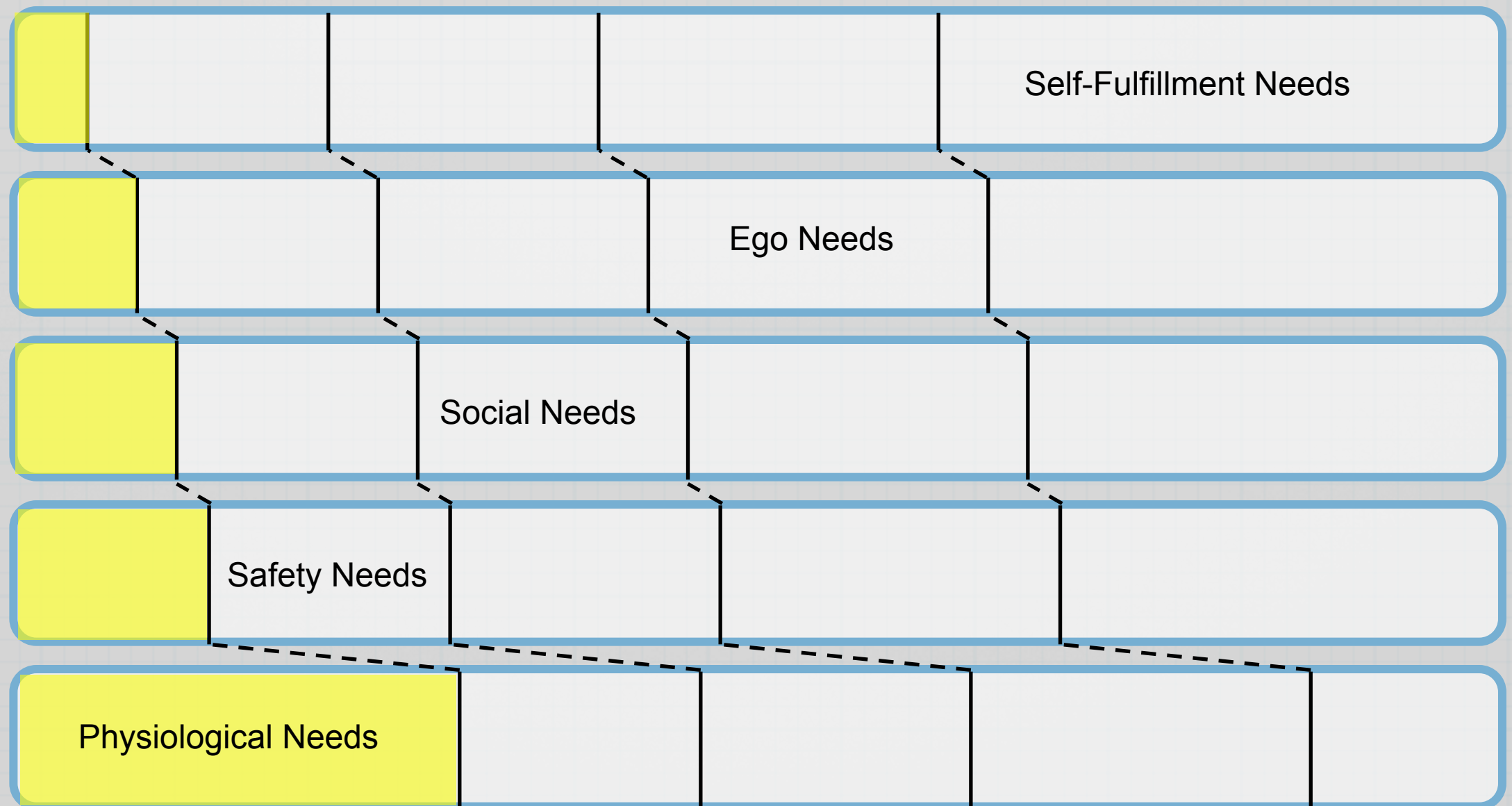
MASLOW'S HIERARCHY OF HUMAN NEEDS: A COMMON READING



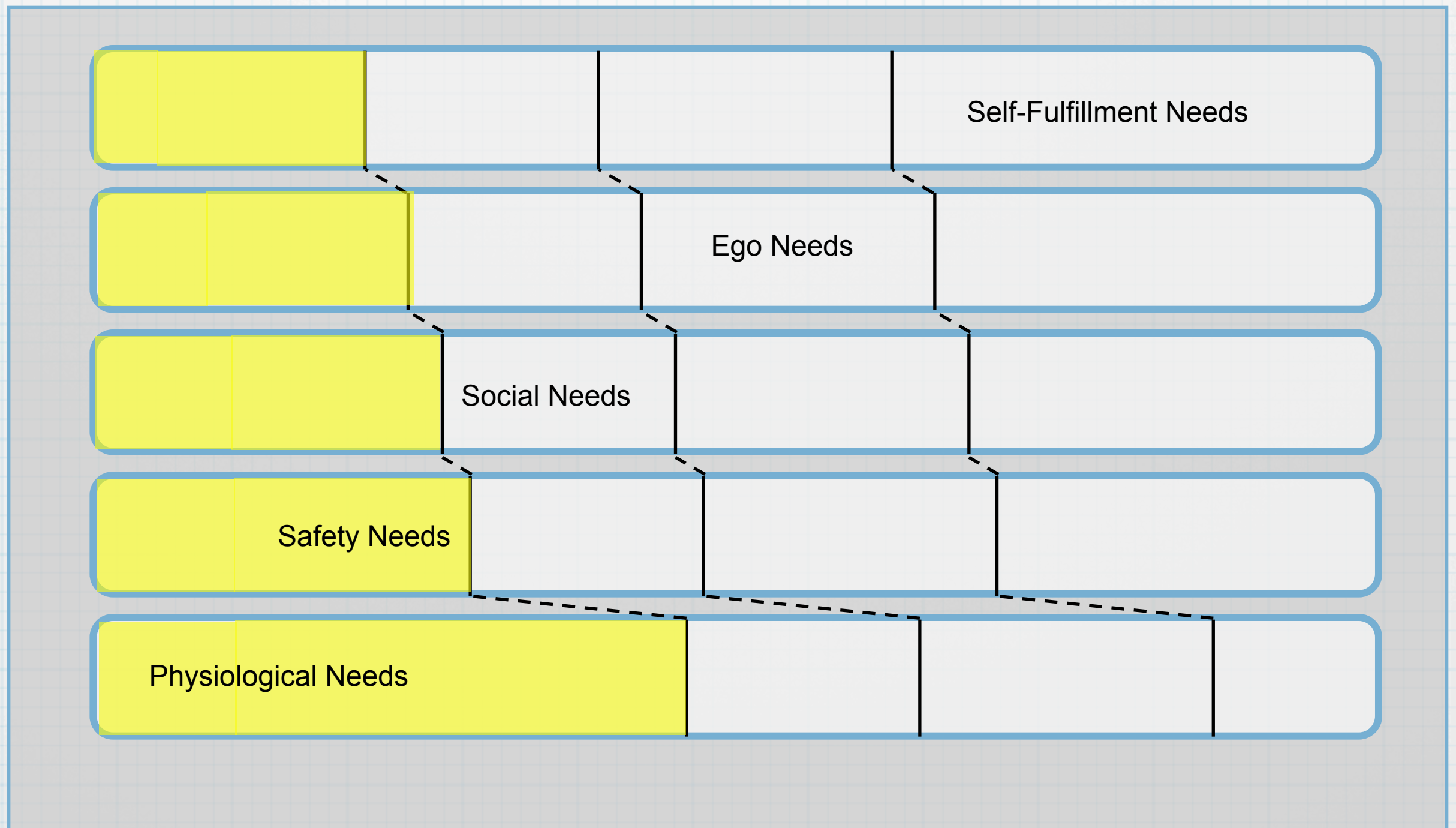
MASLOW'S HIERARCHY OF HUMAN NEEDS: A BETTER READING



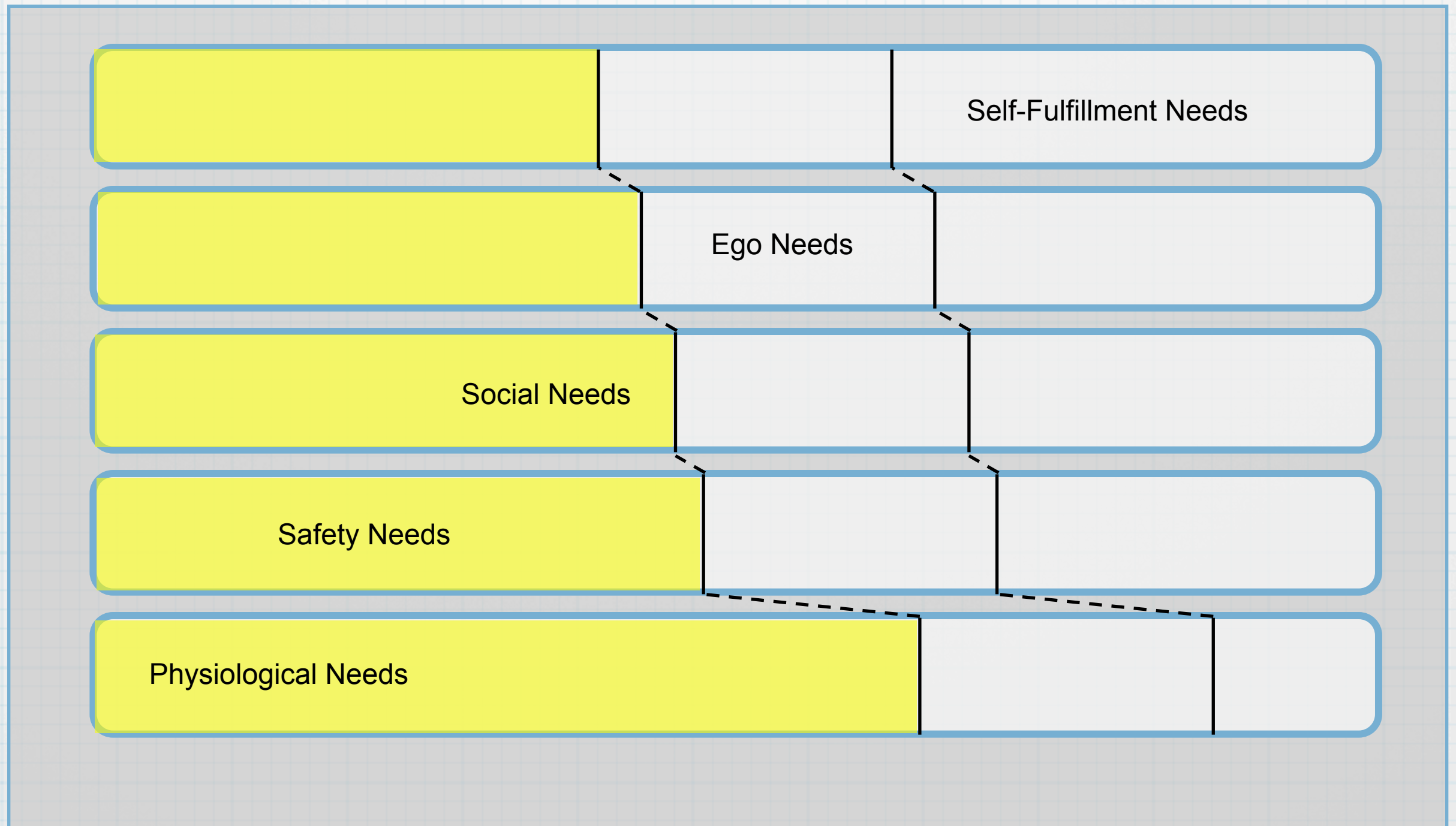
MASLOW'S HIERARCHY OF HUMAN NEEDS: A BETTER READING



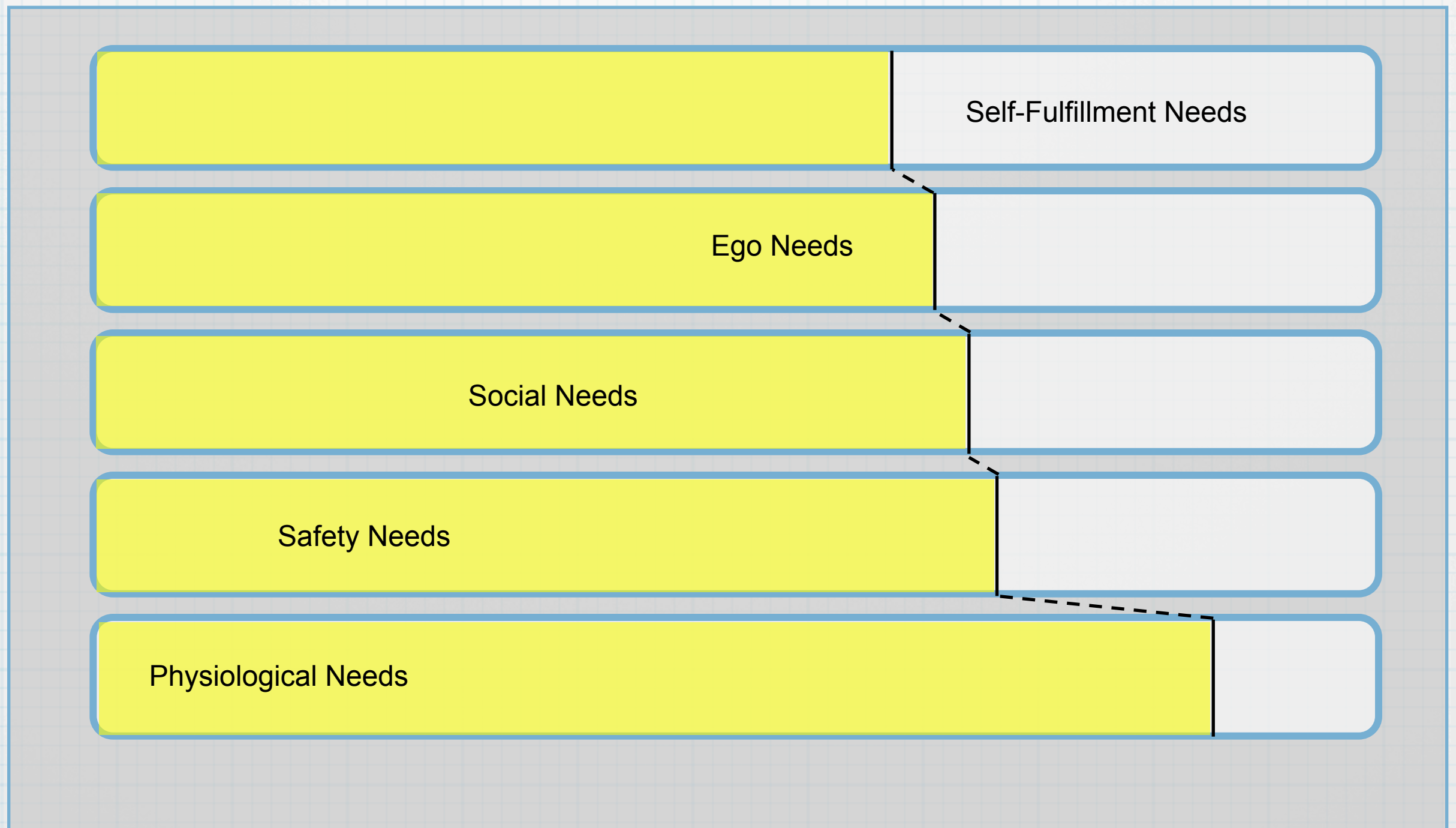
MASLOW'S HIERARCHY OF HUMAN NEEDS: A BETTER READING



MASLOW'S HIERARCHY OF HUMAN NEEDS: A BETTER READING



MASLOW'S HIERARCHY OF HUMAN NEEDS: A BETTER READING



THE CASE AGAINST COMPETITION



Competition among people, business units, or sites is an enemy of quality, innovation, and performance because it:

- Creates anxiety about who will win. When others will benefit from your mistakes, you tend to play it safe and avoid errors.
- Encourages dichotomous thinking (us/them, win/lose) with one of the choices seen as good, the other bad.
- People quickly learn and can predict who are going to win most of the time. Instead of “bringing their best,” this knowledge demotivates the losers from the beginning.
- Competition undermines collaborative relationships. It’s irrational to cooperate with someone whose success jeopardizes your own.

EXTRINSIC MOTIVATION

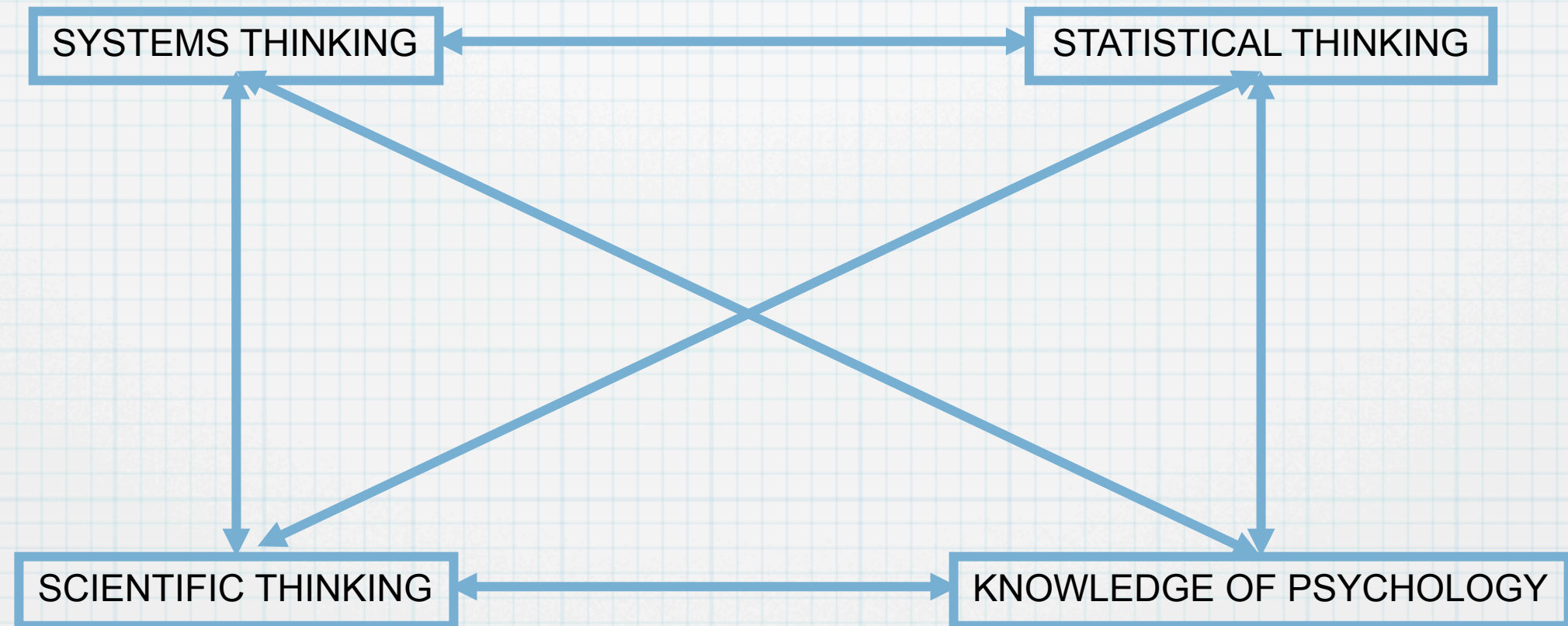
We destroy the love of learning in children, which is so strong when they are small, by encouraging and compelling them to work for petty and contemptible rewards – gold stars, or papers marked 100 percent and tacked to the wall, or A's on report cards, or honor rolls, or dean's lists, or Phi Beta Kappa keys – in short, for the ignoble satisfaction of feeling that they are superior to someone else.

– John Holt, *How Children Fail*

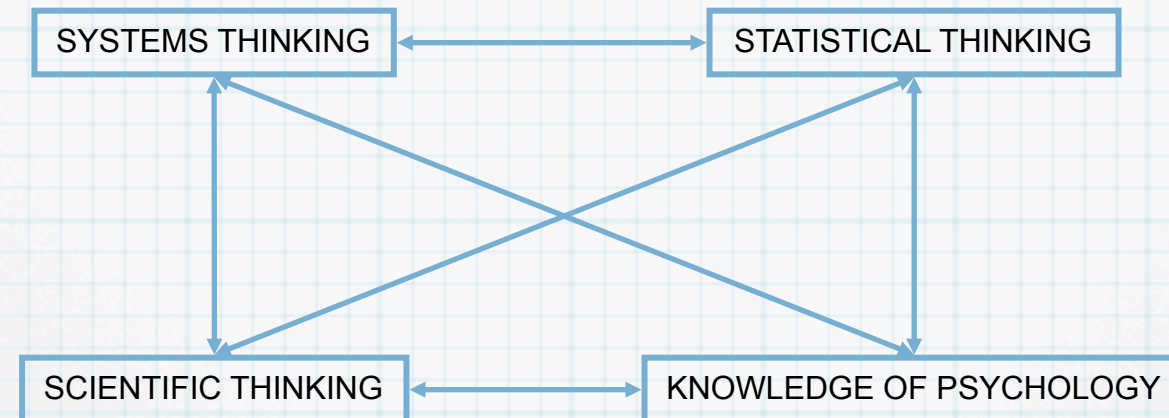
16 Reasons Why People Don't Do What They're Supposed To Do And What To Do About It

1. They don't know why they should do it
They don't seem to care because they don't know why they should – give them the big picture and make it personal.
2. They don't know how to do it
Telling is not the same as teaching and assuming they know costs money – make sure they know how to do it.
3. They don't know what they are supposed to do
Eliminate guessing – provide operational definitions.
4. They think your way will not work
Sell them, don't just tell them.
5. They think their way is better
Maybe they're right – ensure user perspectives drive design. But sometimes even very smart people think incorrectly – don't let innovation reinvent failure.
6. They think something else is more important
Working on the wrong things is expensive – make sure they know what's important and why the organization's priorities are the way they are.
7. There is no positive consequence for them doing it
In a culture dominated by extrinsic motivation, ignore it at your peril – what message is your reward system sending? Leverage every opportunity for the intrinsic motivators of Choice, Challenge, and Collaboration.
8. They think they are doing it
Don't focus on locking the gate after the horse has bolted. Use three kinds of feedback to allow self-control.
9. They are rewarded for not doing it
Stop watering the performance you don't want to grow.
10. They are punished for doing what they are supposed to do
Understand the user's perspective – stop killing good performance
11. They anticipate a negative consequence for doing it
Fearful people don't perform well – understand their expectations and free up performance
12. There is no negative consequence to them for poor performance
What to do before discipline – help poor performers improve.
13. There are obstacles beyond their control
Remove obstacles, show a way around them, or mitigate their impact.
14. Their personal limits prevent them from performing
Deal differently with temporary and permanent limitations.
15. They have personal problems
Everyone has them – keep them from affecting performance.
16. No one could do it
Understand the entire work system – model it and gather data.

USING THE SYSTEM OF PROFOUND KNOWLEDGE AS AN INQUIRY ENGINE



USING THE ELEMENTS AND INTERACTIONS



SYSTEMS THINKING

“Elements united by a common aim”

Contribution: each part of a system contributes something to performance

Interdependence: the performance of one part of a system is always dependent upon another

Expansionism: systems are nested subsystems ad infinitum

STATISTICAL THINKING

There must be a reason to group data in a set

Variation is ubiquitous and inevitable

Customers don't feel the “average;” they feel the “standard deviation”

Separating signals from noise will help us minimize economic loss

Signals must be detected before their effects can be assessed

SCIENTIFIC THINKING

Meaningful language is operationally definite

Knowledge is prediction

The purpose of knowledge is to be true to something beyond it

There is nothing more practical than good theory

Some important things to manage are unknown and unknowable

The successive application of random forces produces instability and loss

PDSA cycle is theory that builds knowledge

APPLICATIONS OF PSYCHOLOGY

People are diverse

We are born with intrinsic motivation: the three “Cs”

The capacity to learn is our most defining characteristic

We must balance the benefits of individualism and the benefits of affiliation