

How to Apply Statistical Thinking Effectively

1997 FTC Short Course

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I. Introduction and Motivation

Overall Goal

- To better prepare attendees to apply Statistical Thinking effectively within their own organizations, to deliver improved results.

Objectives

- Obtain a common understanding of Statistical Thinking, its definition, and its application.
- Clarify the distinction between Statistical Thinking and statistical methods.
- Provide “practice” in applying Statistical Thinking to real situations.
- Provide attendees the opportunity to address implementation issues specific to their situations.

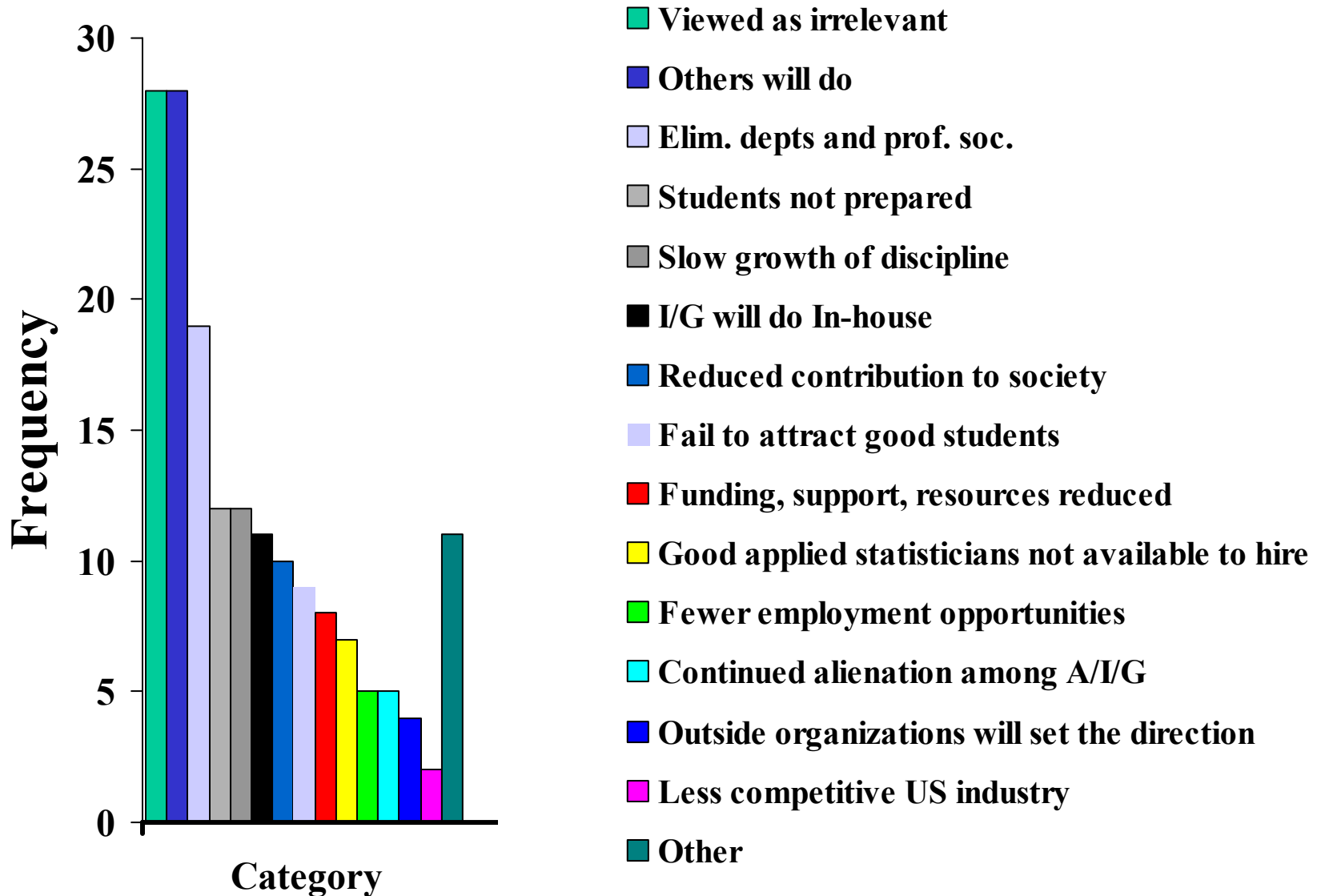
Outline

- Introduction and motivation - 45 minutes
- What is Statistical Thinking? - 3 hours
- Lunch
- How can I apply Statistical Thinking effectively in my organization? - 3 hours
- Summary - 15 minutes
- Note: All sessions (except the summary) will involve interactive team breakouts. We are not smart enough to tell you the answers!

The Cost of the Status Quo

**What will happen to us and to our
profession if we do not promote
statistical thinking?**

Cost of the Status Quo



Statistical Thinking and Reducing the Cost of the Status Quo

Statistical Thinking and Reducing the Cost of the Status Quo

Cost of the Status Quo

- A. Statistics as a discipline is irrelevant and loses influence
- C. Decline of statistics departments and professional societies
- I. Reduced money, resources, support

Using Statistical Thinking

- Makes statistics more relevant because of its focus on process and variation

Statistical Thinking and Reducing the Cost of the Status Quo

Cost of the Status Quo

D. Students not prepared for the future

H. Failure to attract good students

J. Good applied statisticians not available

Using Statistical Thinking

- Making statistics relevant attracts good students and prepares them for the needs of the marketplace

Statistical Thinking and Reducing the Cost of the Status Quo

Cost of the Status Quo

B. Non-statisticians will do statistics

F. Industry and government will do in-house training

K. Few job opportunities

Using Statistical Thinking

- B. and F. are good trends. Statisticians will influence these activities.
- There will always be a job for someone who has something relevant and useful to contribute.

Statistical Thinking and Reducing the Cost of the Status Quo

Cost of the Status Quo

H. Slow growth in technical advances in statistics

G. Reduced contribution of statistics to society

N. US industry will be less competitive

Using Statistical Thinking

- Opportunities for technical advances will be identified.
- Broader use will increase contributions and help US industry be more competitive

Statistical Thinking and Reducing the Cost of the Status Quo

Cost of the Status Quo

M. Outside forces will determine the direction of the profession

L. Continued alienation among academic, industry, and government statisticians

Using Statistical Thinking

- Outside forces have and will always determine the direction of our profession. A unified focus on Statistical Thinking will give statisticians greater control over their future.

Value of Using Statistical Thinking

- Process focus provides the context and relevancy for using statistical methods
 - How we do our work for our customers
- Results in broader and more effective use of statistical methods
 - All parts of the organization
 - Manage and improve processes
 - Guide strategic and managerial action
 - Provides “suction” for statistical methods

II. What is Statistical Thinking?

Breakout Assignment

- Come up with an operational definition of “Statistical Thinking.”
- Be prepared to report formally.
- Take 15 minutes to develop the definition.
- Do not worry about “wordsmithing.”
- Each team will only have 1 minute to report.

Definition

Statistical Thinking is a philosophy of learning and action based on the following fundamental principles:

- All work occurs in a system of interconnected processes,
- Variation exists in all processes, and
- Understanding and reducing variation are keys to success

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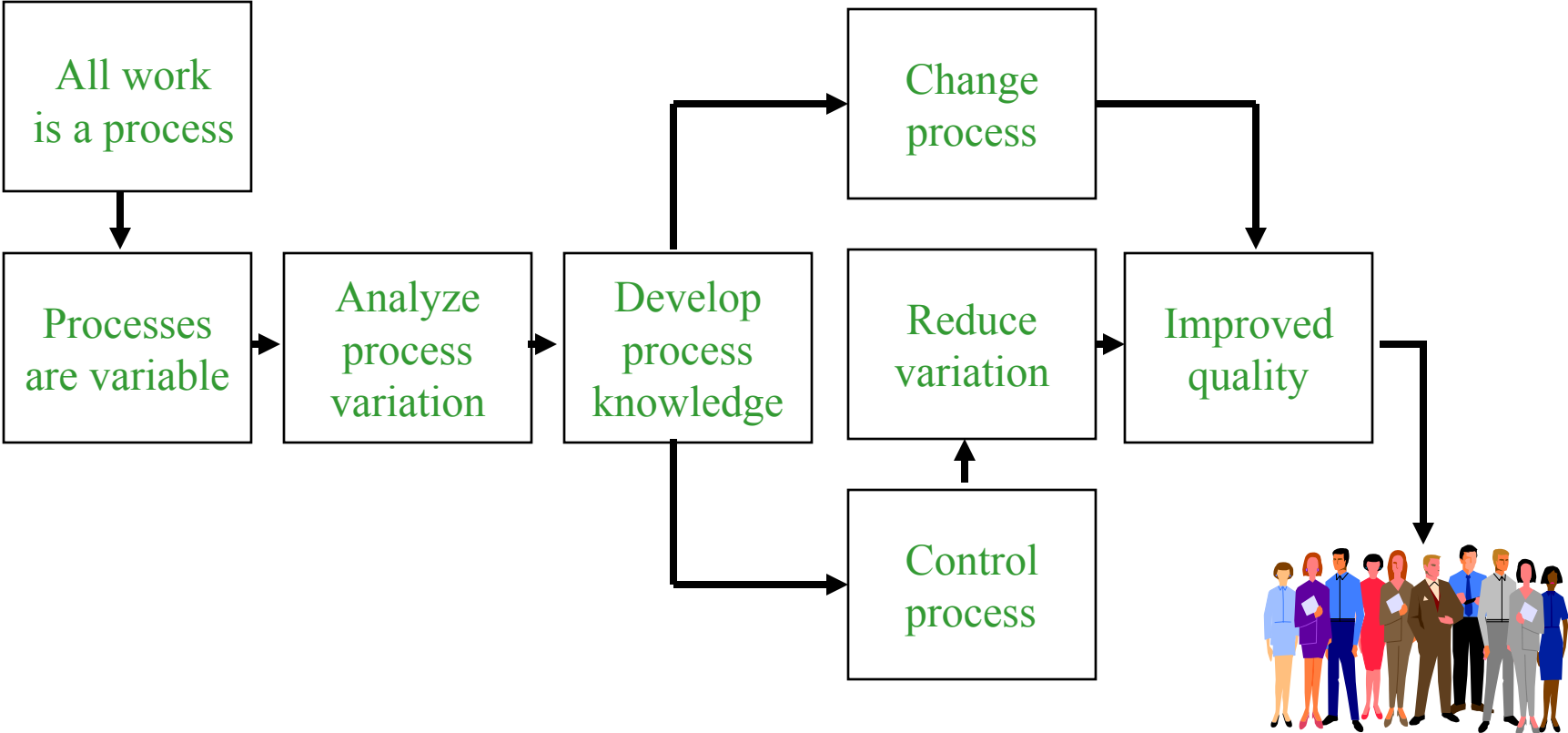
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Relation between Statistical Thinking and Statistical Methods

Steps in Implementing Statistical Thinking



Satisfied:

- Employees
- Customers
- Shareholders
- Community

Statistical Thinking

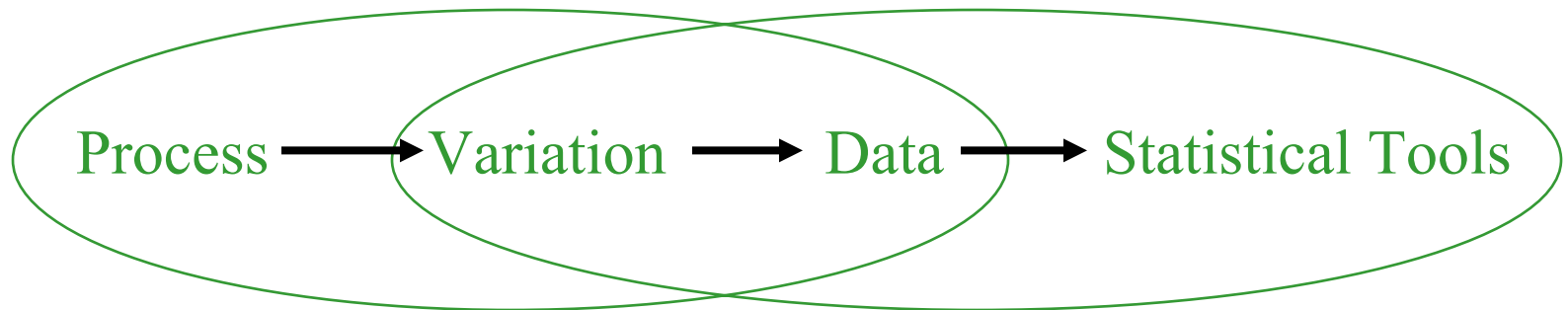
Key Concepts

- Process and systems thinking
- Variation
- Analysis increases knowledge
- Taking action
- Improvement

Role of Data

- Quantify variation
- Measure effects

Statistical Thinking and Methods



Statistical Thinking

Statistical Methods

Comparison of Statistical Thinking and Statistical Methods

	<u>Statistical Thinking</u>	<u>Statistical Methods</u>
Overall approach	Conceptual	Technical
Desired application	Universal	Targeted
Primary requirement	Knowledge	Data
Logical sequence	Leads	Reinforces

Without a Process View

- People have problems understanding the problem and their role in its solution (turf).
- It is difficult to define the scope of the problem.
- It is difficult to get to root causes.
- People get blamed when the process is the problem (85/15 Rule).
- Process management is ineffective
- Improvement is slowed

*“You can’t improve a process
that you don’t understand”*

Without Understanding Variation

- Management by the last datapoint
- There's lots of firefighting
 - Using special cause methods to solve common cause problems
- Tampering and micromanaging abound
- Goals and methods to attain them fail
- Understanding the process is handicapped
 - Learning is slowed
- Process management is ineffective
- Improvement is slowed

Without Data

- Everyone is an expert: discussions produce more heat than light
- Historical memory is poor
- Difficult to get agreement on:
 - What the problem is
 - What success looks like
 - Progress made
- Process management is ineffective
- Improvement is slowed

Without Statistical Thinking

- Your management and improvement processes are handicapped
- It's like
 - Football without a passing attack
 - Growing a lawn without fertilizer
 - Doing research without measurements
 - Playing golf without your irons

“Early on, we failed to focus adequately on core work processes and statistics.”

David Kearns and David Nelder, Xerox Corporation

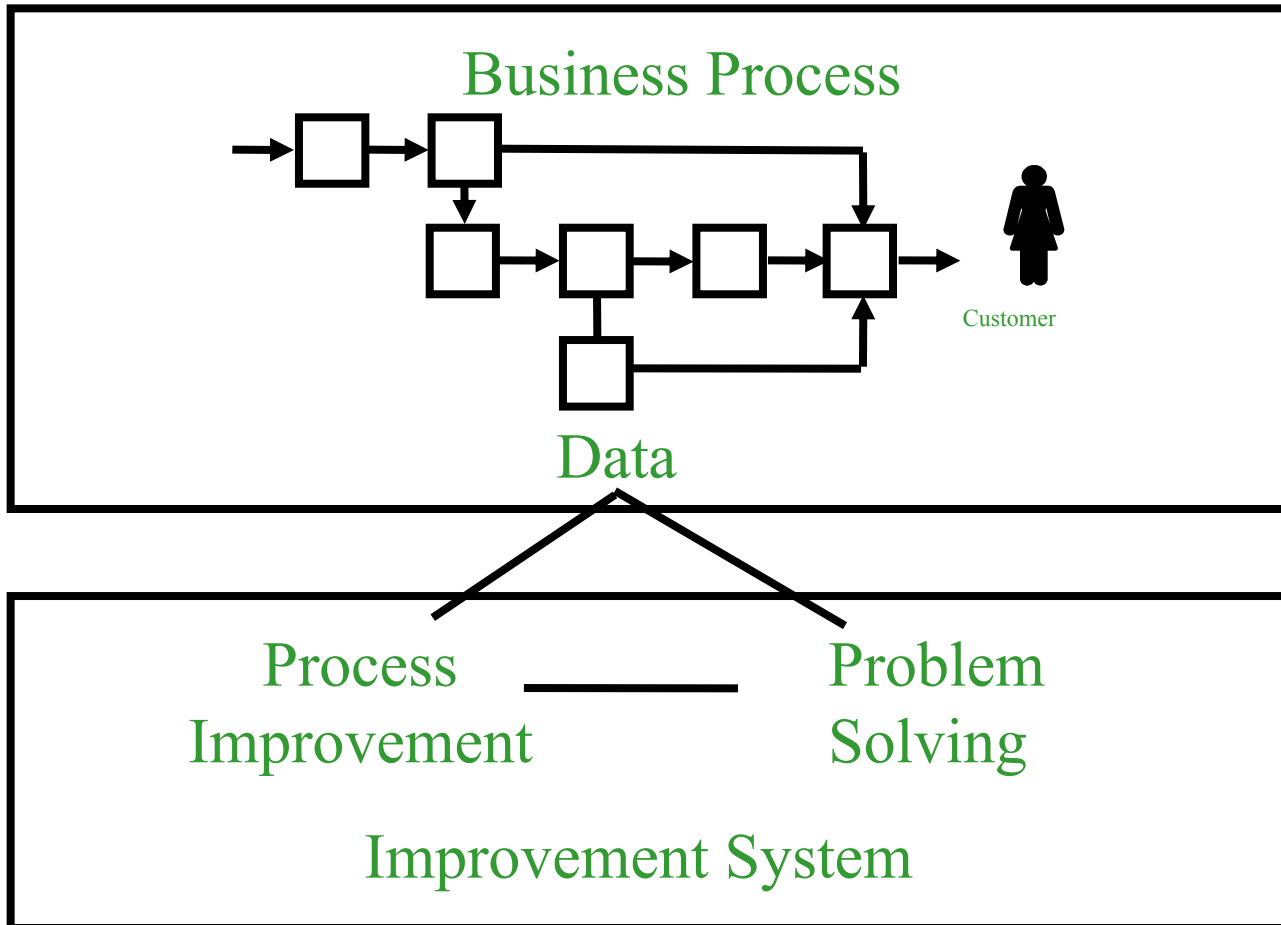
Use of Statistical Thinking

Statistical Thinking Element

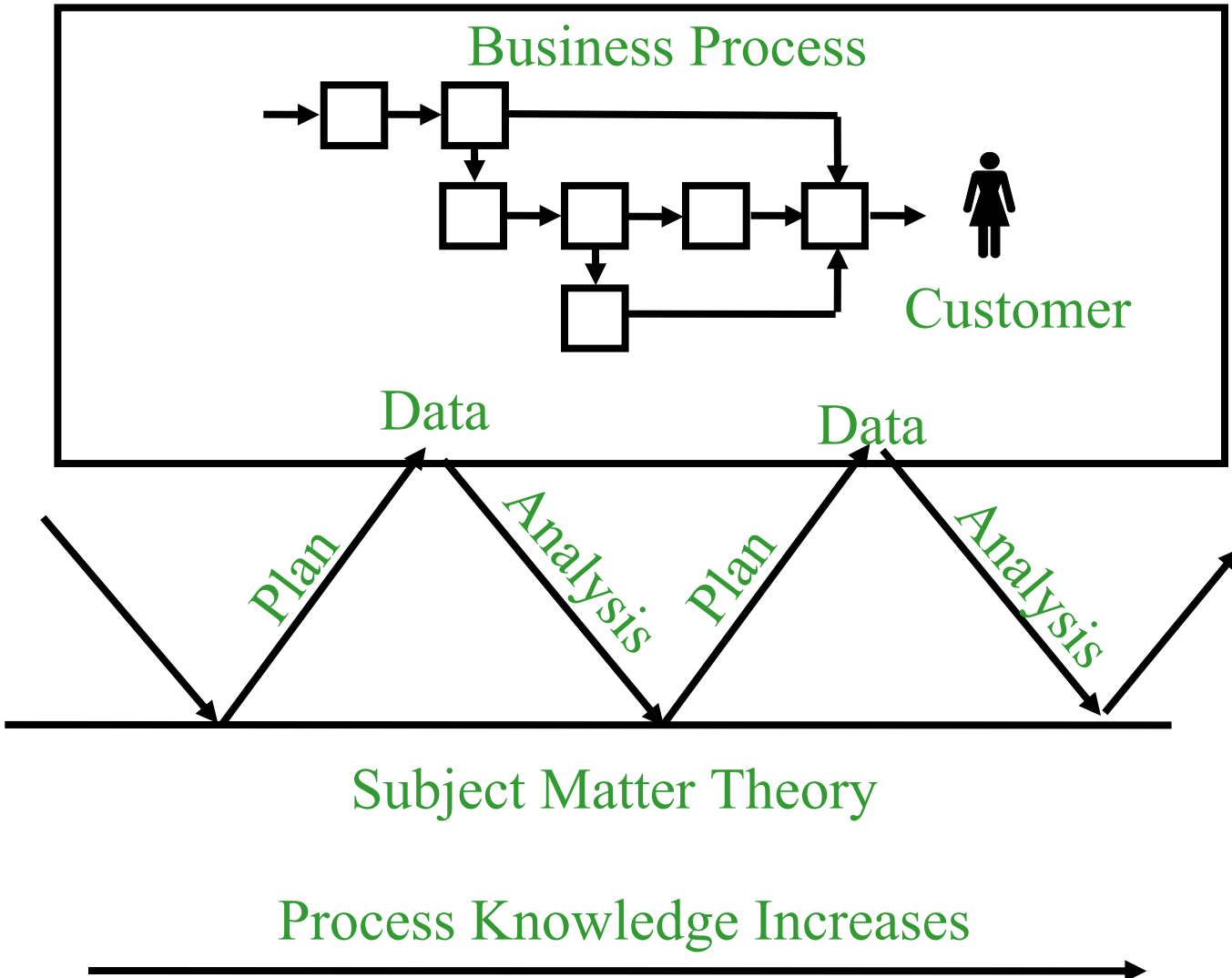
Process Variation Data

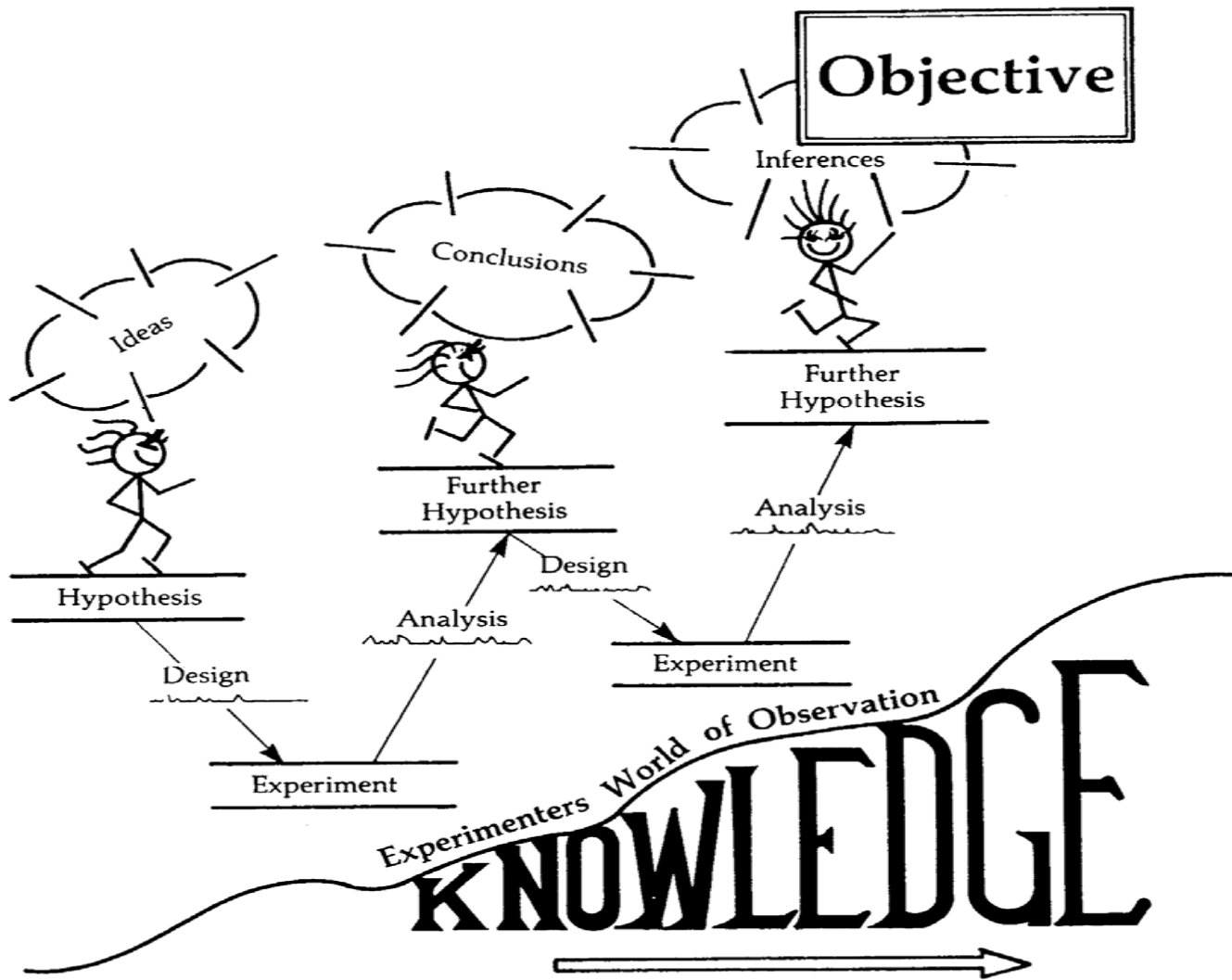
Process reengineers	✓		
Process/ Measurement Reengineers	✓		✓
Data analysts			✓
Special cause Hunters		✓	✓
Improvers	✓	✓	✓

Improvement Model



Statistical Thinking for Business Improvement





The Iterative Nature
of
Experimentation

Using Statistical Thinking Without Data

- Reduce the number of suppliers
- Use a variety of communication media
- Reduce tampering, micromanagement, and overcontrol
- Provide flexible benefits and work hours
- Use meeting management techniques
- Create project management systems
- Create, monitor, and update plans

Two Case Studies

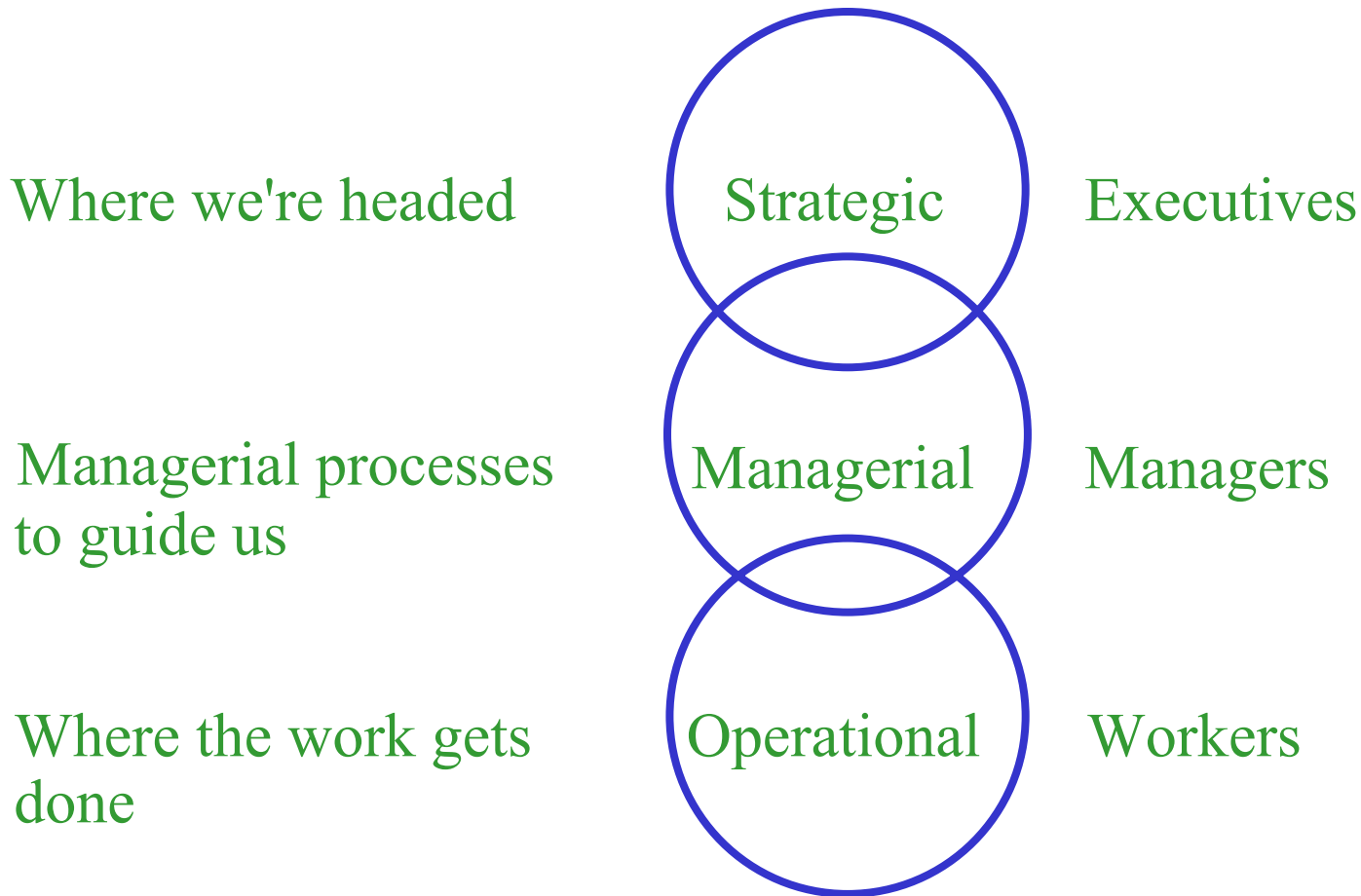
- Where's the Beef?
- Golden Acres

Group Discussions: (15 Min.)

Reports: (7 Min. each)

Use of Statistical Thinking

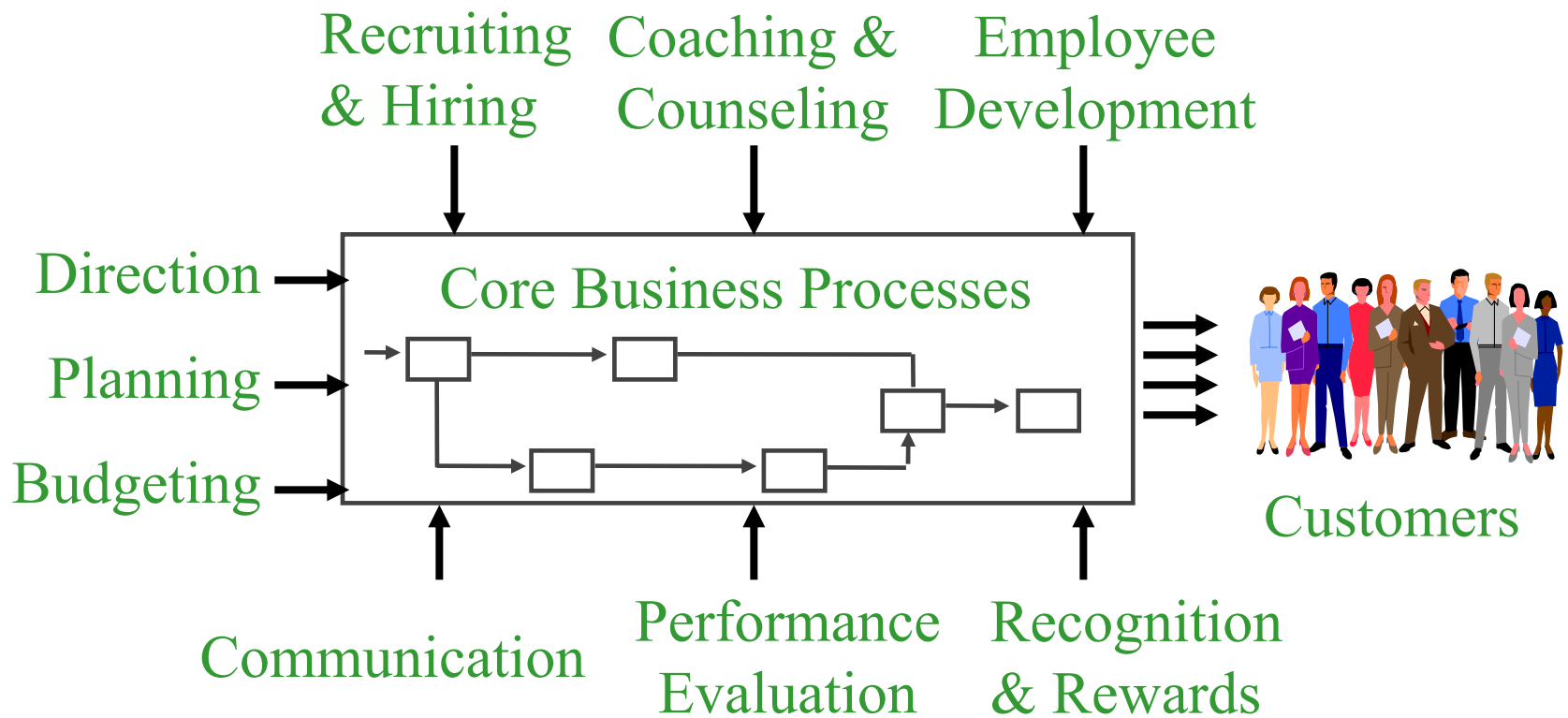
Depends on levels of activity and job responsibility.



Examples of Statistical Thinking at the Strategic Level

- Executives use systems approach.
- Core processes have been flow charted
- Strategic direction defined and deployed.
- Measurement systems in place.
- Employee, customer, and benchmarking studies are used to drive improvement.
- Experimentation is encouraged.

Examples of Managerial Processes



Examples of Statistical Thinking at the Managerial Level

- Managers use meeting management techniques
- Standardized project management systems are in place.
- Both project process and results are reviewed.
- Process variation is considered when setting goals.
- Measurement is viewed as a process.
- The number of suppliers is reduced
- A variety of communication media are used.

Examples of Statistical Thinking at the Operational Level

- Work processes are flowcharted and documented
- Key measurements are identified.
 - Time plots displayed
- Process management and improvement utilize:
 - Knowledge of variation, and
 - Data
- Improvement activities focus on the process, not blaming employees.

Statistical Thinking Applications at Strategic and Managerial Levels

- Strategic
- Managerial

Group Discussions: (15 Min.)

Reports: (7 Min. each)

Robustness - An Underused Concept

- Key aspect of Statistical Thinking
- Reduce the effects of uncontrollable variation in:
 - Product design
 - Process design
 - Management practices
- Anticipate variation and reduce its effects

Robustness of Product and Process Design

- A third way to reduce variation
- Anticipate variation
 - Design the process or product to be insensitive to variation
- A robust process or product is more likely to perform as expected
- 100% inspection cannot provide robustness

Robust Products are Designed in Anticipation of Customer Use

- Washing machine tops
- User-friendly computers and software
- Low-maintenance automobiles
- 5 mph bumpers
- Medical instruments for home use

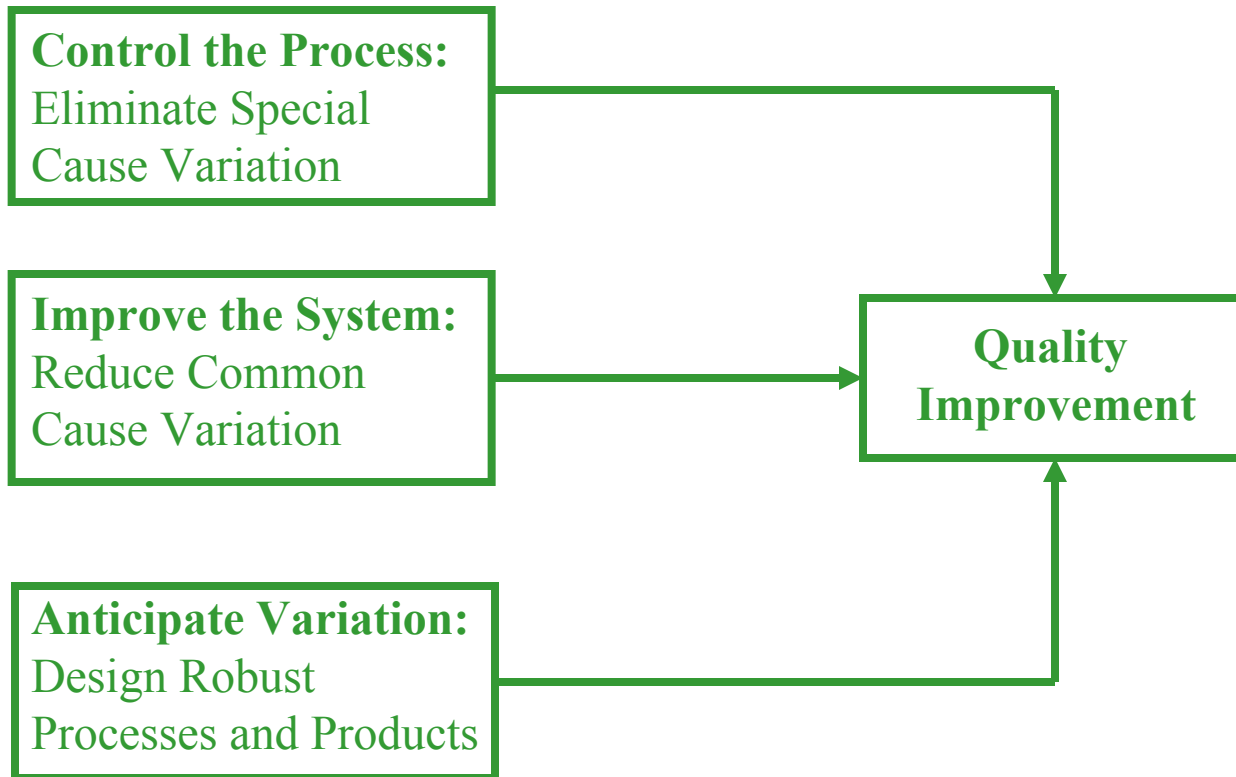
Product and Process Robustness

- Product Performance is insensitive to variations in conditions of manufacture, distribution, use and disposal.
- Process Performance is insensitive to uncontrollable variations in process
 - Inputs
 - Transformations - activities - steps
 - External factors

Robustness in Management

- Develop strategies that are insensitive to economic trends and cycles
- Design a project system that is insensitive to
 - Personnel changes
 - Changes in project scope
 - Variations in business conditions
- Respond to differing employee needs
 - Adopt flexible work hours
 - Provide “cafeteria” benefits package
- Enable personnel to adapt to changing business needs
- Ensure meeting effectiveness is not dependent on facilities, equipment, or participants

Three Ways to Reduce Variation and Improve Quality



Process Robustness Analysis

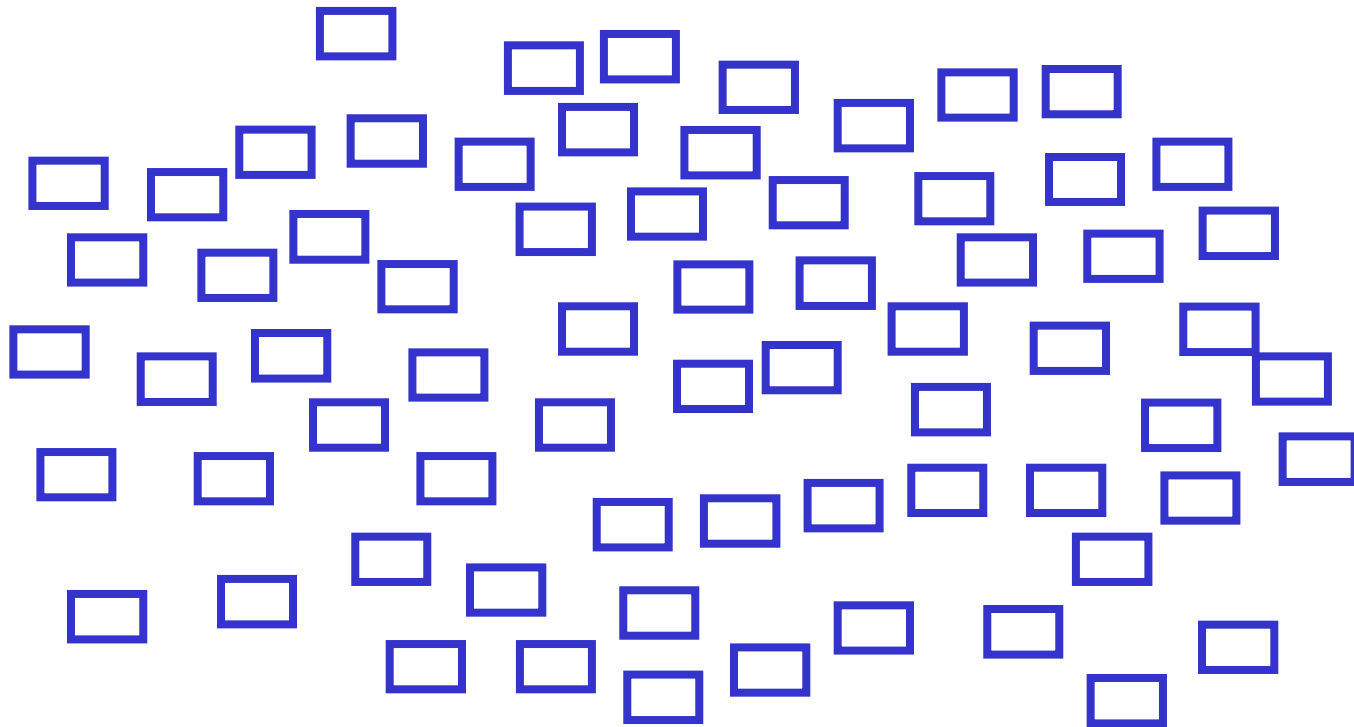
- Identify Those Uncontrollable Factors that Affect Process Performance
 - Weather
 - Customer Use of Products
 - Employee Knowledge, Skills, Experience, Work Habit
 - Age of Equipment
- Design the Process to be Insensitive to the Uncontrollable Variations in the Factors

III. How can I apply Statistical Thinking effectively in my organization?

The barriers that stand between my organization and the implementation of Statistical Thinking are:

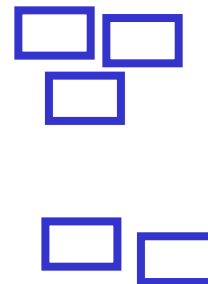
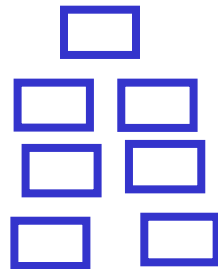
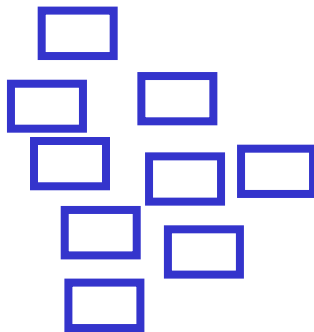
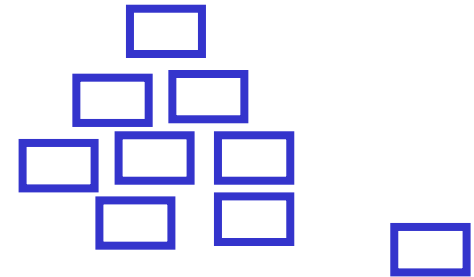
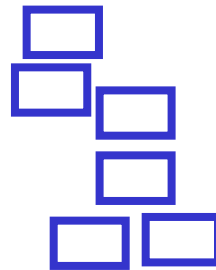
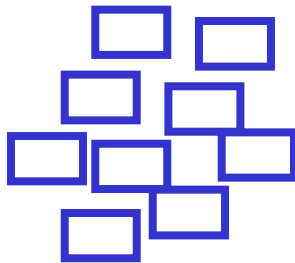
Affinity Mapping

- Phrase or Complete Sentence
- One Idea to a Card
- Place Randomly



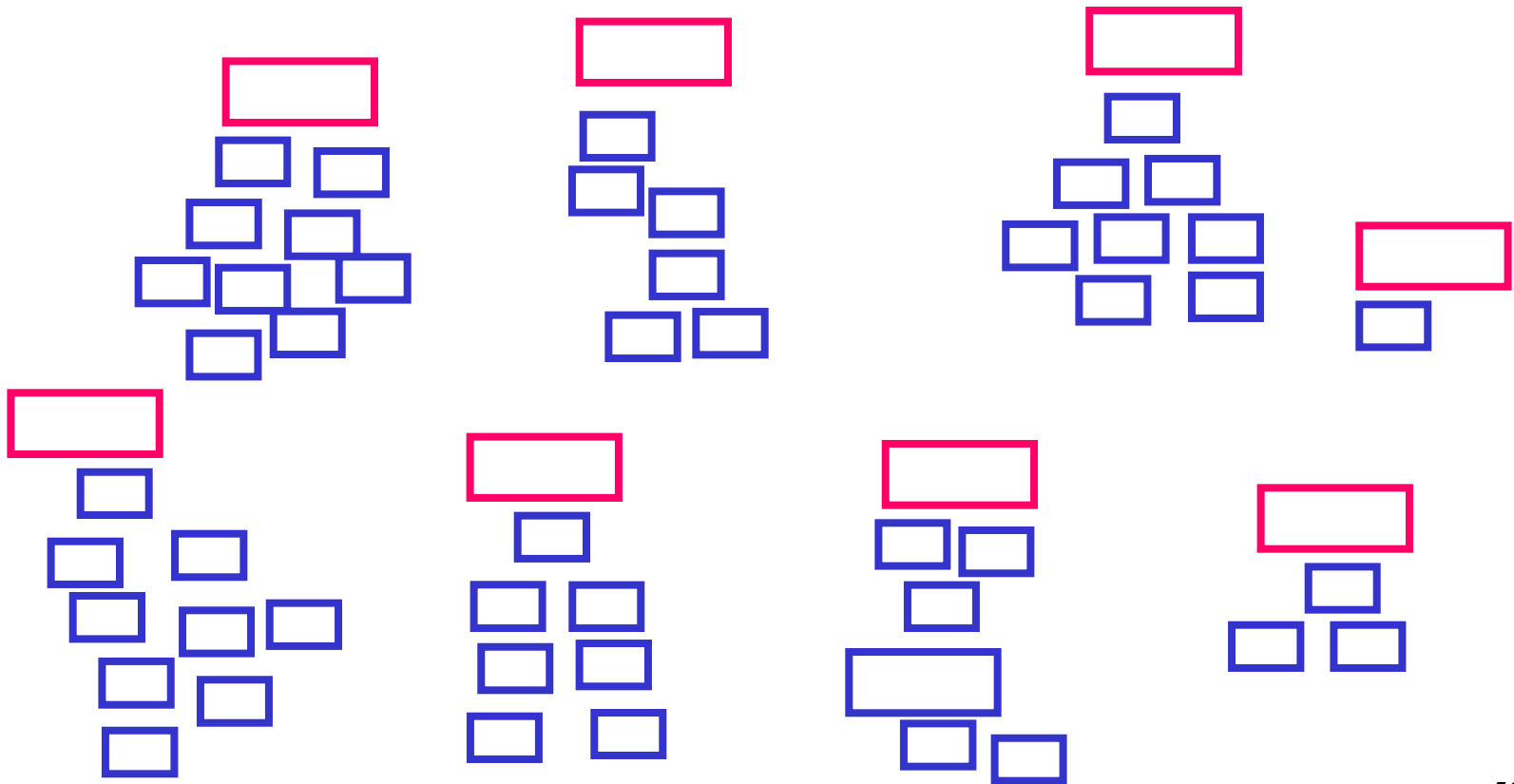
Affinity Mapping

- Don't Talk
- Use "Other" Hand
- Group Like Ideas



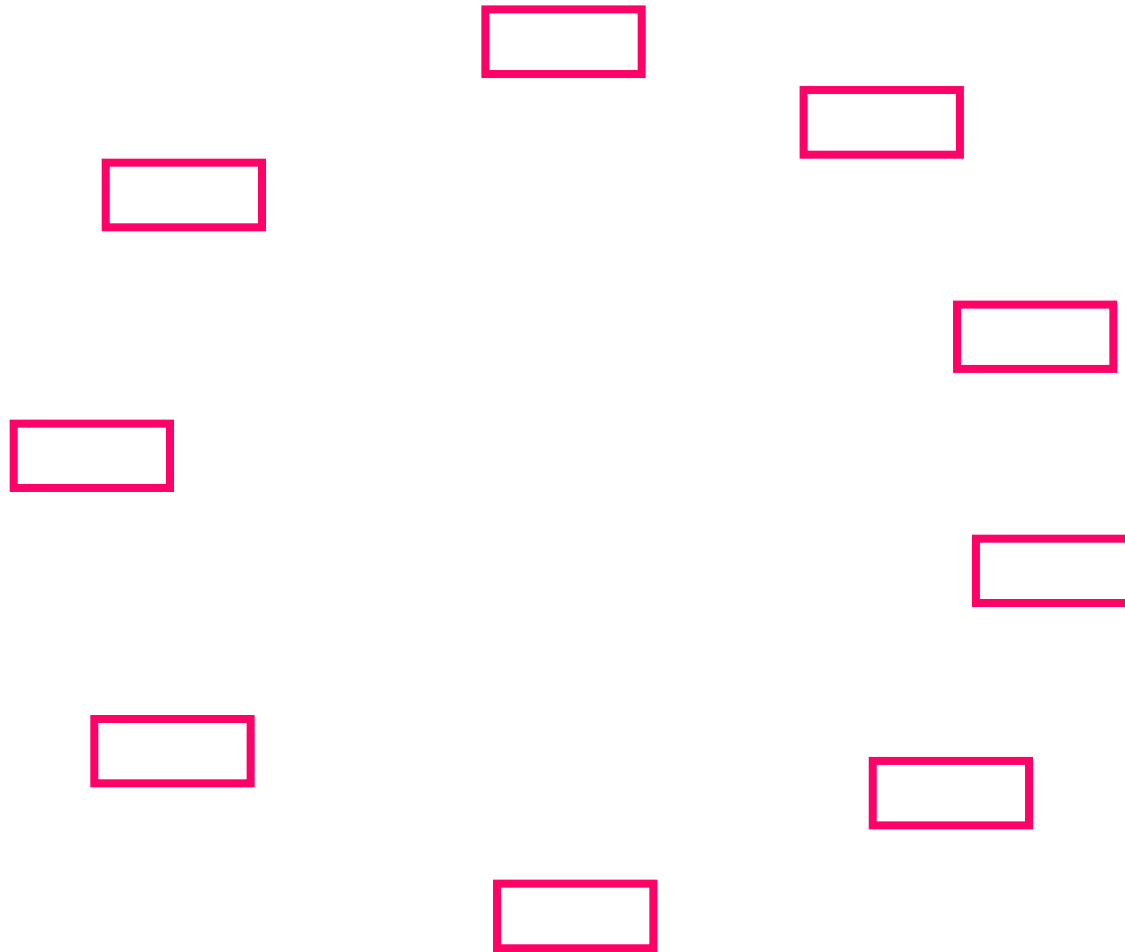
Affinity Mapping

- Name the Clusters using Headers
- Name Captures Uniqueness of Elements



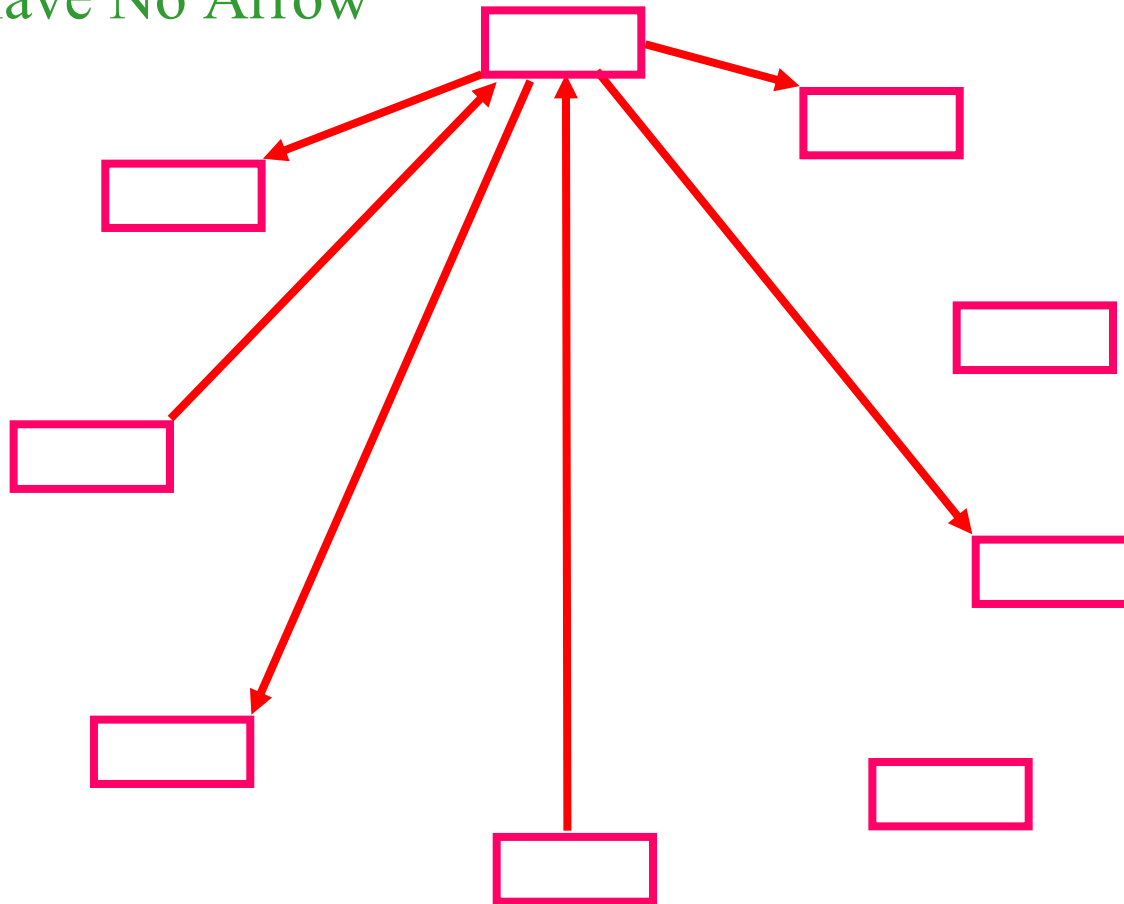
Interrelationship Digraph

- Place Headers in Circle



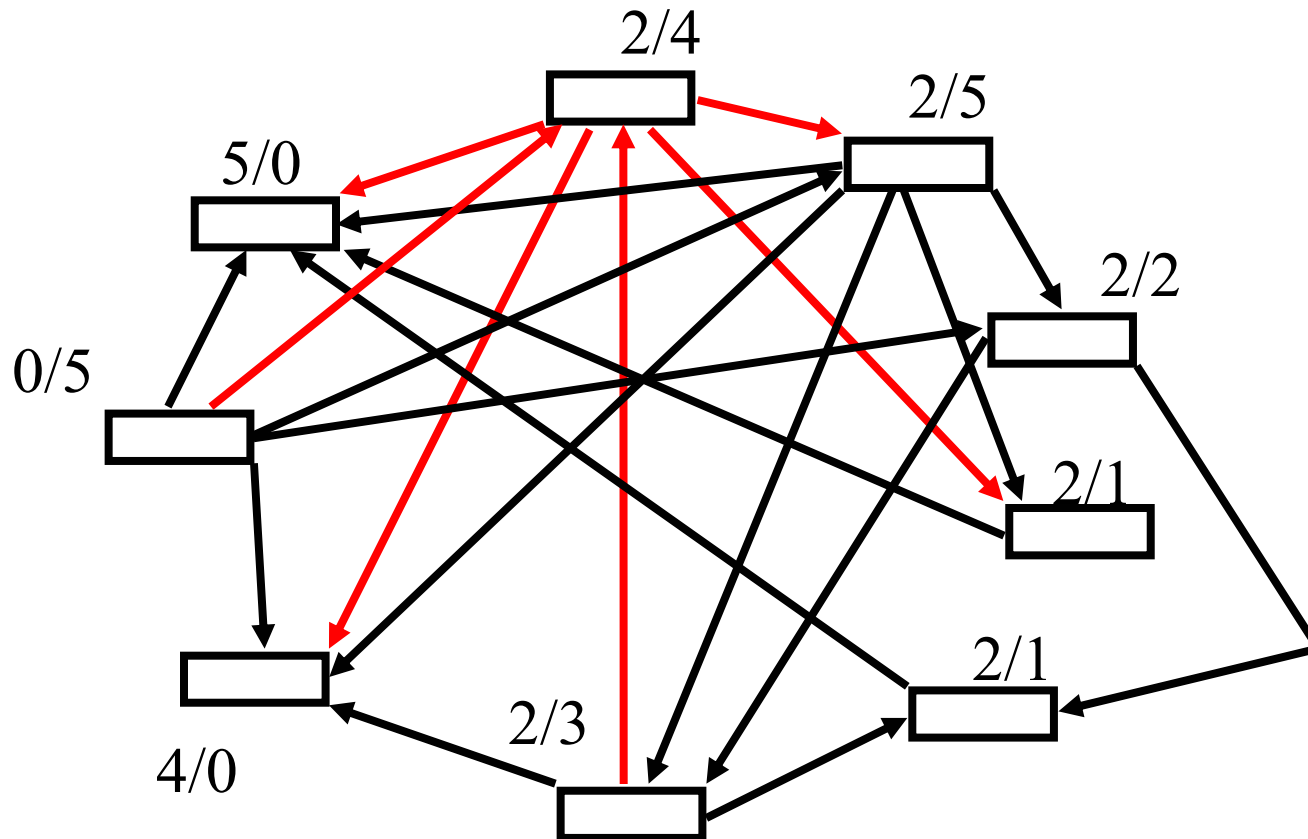
Interrelationship Digraph

- One Header at a Time
- Arrows Indicate Primary Cause
- Arrows One Way Only
- May Have No Arrow



Interrelationship Digraph

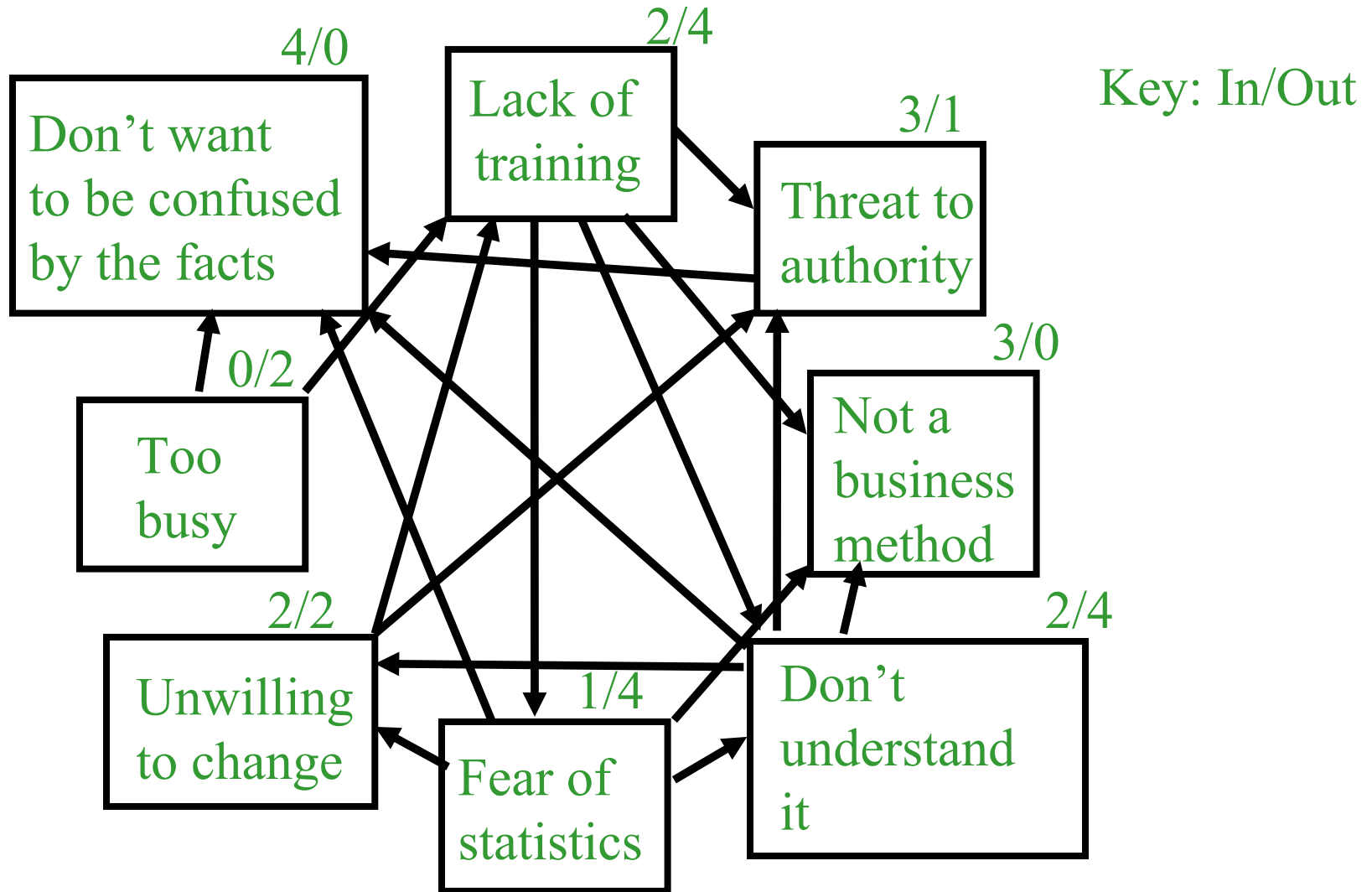
- Complete the Circle
- Label "In / Out"
- High Number of "Ins" are Effects
- High Number of "Outs" are Drivers (Root Causes)



Barriers to Statistical Thinking

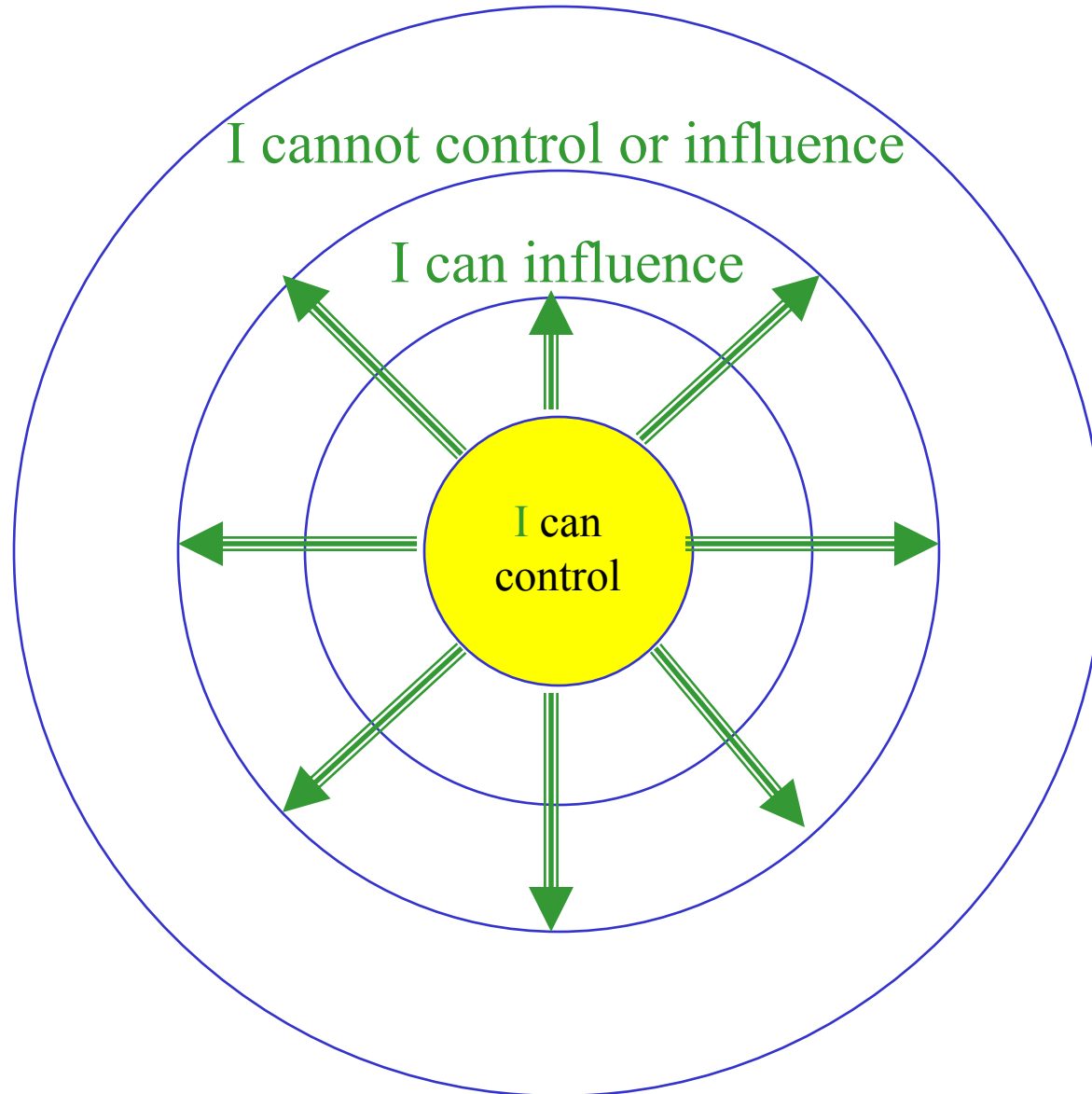
- Lack of training
- Threat to authority
- Not a business method
- Don't understand it
- Fear of statistics
- Unwilling to change
- Too busy
- Don't want to be confused by the facts

Barriers to Statistical Thinking



Circle of Influence

Circle of Influence



Expanding Your Circle of Influence

- Find a champion
- Get on important teams
- Develop statistically-based management systems
 - Product quality management
 - Strategy of experimentation
 - Process management
- Circulate information on other companies
 - Six sigma activity of GE, Kodak, and Allied Signal
- Spur executives to action
 - Do customer surveys that are actionable
 - Root cause analysis of customer complaint data

Breakout Assignment

Brainstorm ideas for addressing major barriers to implementing Statistical Thinking. Come to agreement on best ideas.

Discussion	30 Minutes
Reports	15 Minutes

Individual Breakout

- Develop a personal implementation plan to improve the quantity and quality of statistical thinking applications in your organization.
- Focus on the “circle of influence.”
- Consider both long and short term actions.
- Keep in mind the barriers and potential solutions discussed which are relevant to your situation.
- The plan should involve tangible actions, not just broad goals; i.e, “I will set up a meeting with...” versus “I will champion the cause of...”.

Breakout Format

- Take 45 minutes to work on your plan.
- Feel free to ask the session leaders, or other participants for advice.
- Be creative! Use text, diagrams, bullet points, etc.
- You may wish to begin with a brief description of your unique situation, including barriers.
- We will ask a few volunteers to report their plans, to provide a benchmark for others.
- The reports will be limited to 2 minutes.

Summary

Value of Using Statistical Thinking

- Process focus provides the context and relevancy for using statistical methods
 - How we do our work for our customers
- Results in broader and more effective use of statistical methods
 - All parts of the organization
 - Manage and improve processes
 - Guide strategic and managerial action
 - Provides “suction” for statistical methods

