Statistical Thinking and Practical Applications for Business

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Overview:

Part 1: Statistical Thinking

Part 2: Process Breakthrough & Continual Improvement

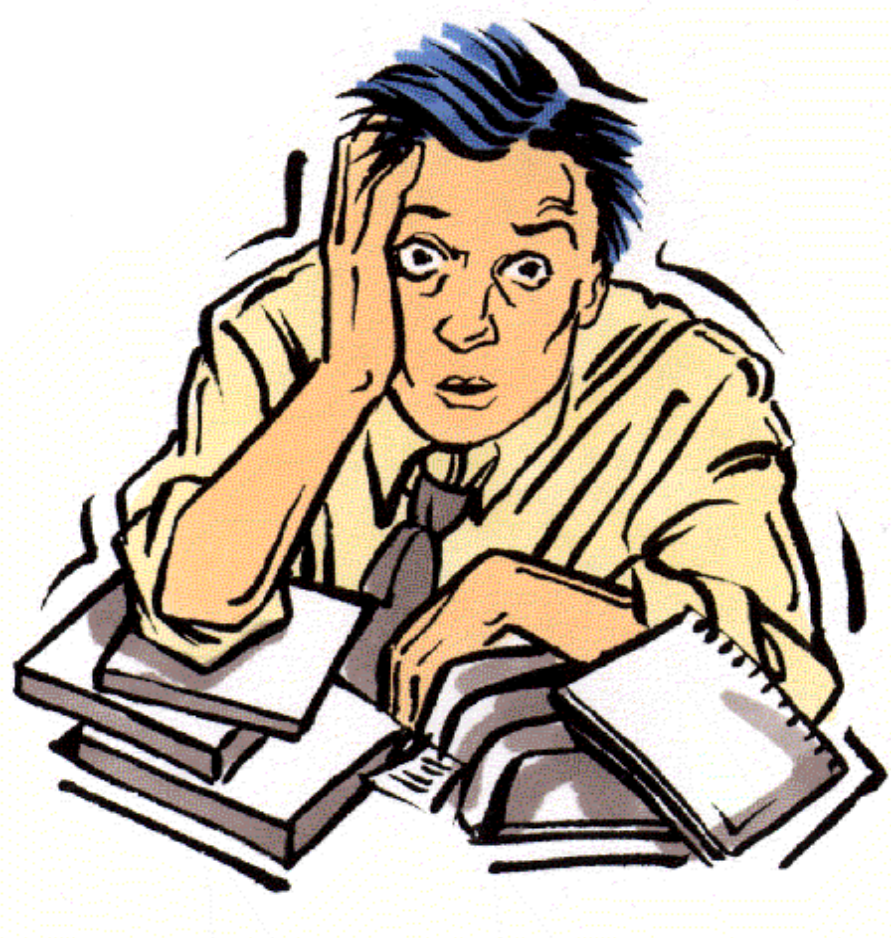
Part 3: Best Road to Process Improvement

Part 4: Key Secret Behind Success

APPENDIX

Part 1

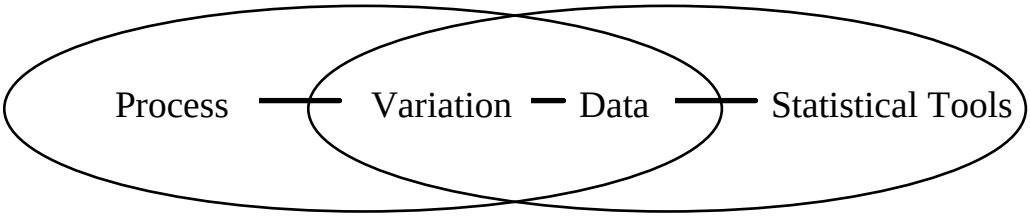
Statistical Thinking



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**
- **Understanding and reducing variation are keys to success**
- **Employees remain key players, but focus is on the *systems* rather than on the employees**

Statistical Thinking and Methods



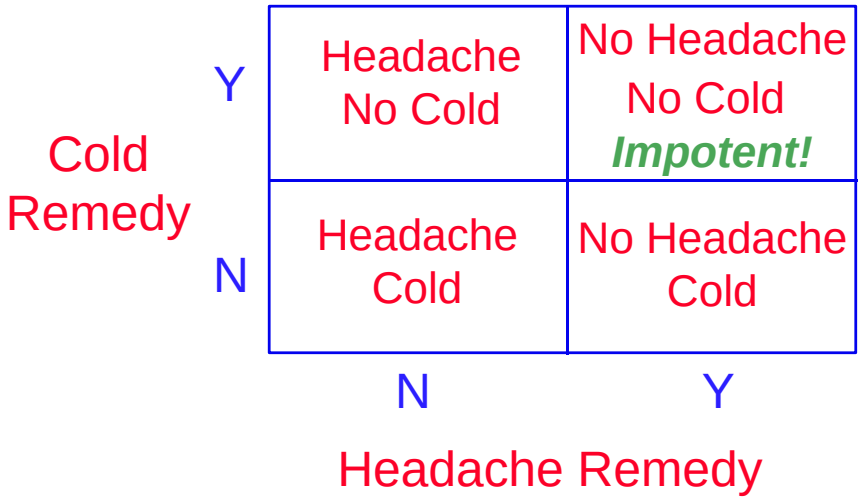
Statistical Thinking **Statistical Methods**

STATISTICAL Methods:

- **In Process Results** - Tells how well we are doing what we do (**S**tatistical **P**rocess **C**ontrol) that utilizes the **process behavior chart** tool. These special line graph charts provide guides as to how to go about making improvements.

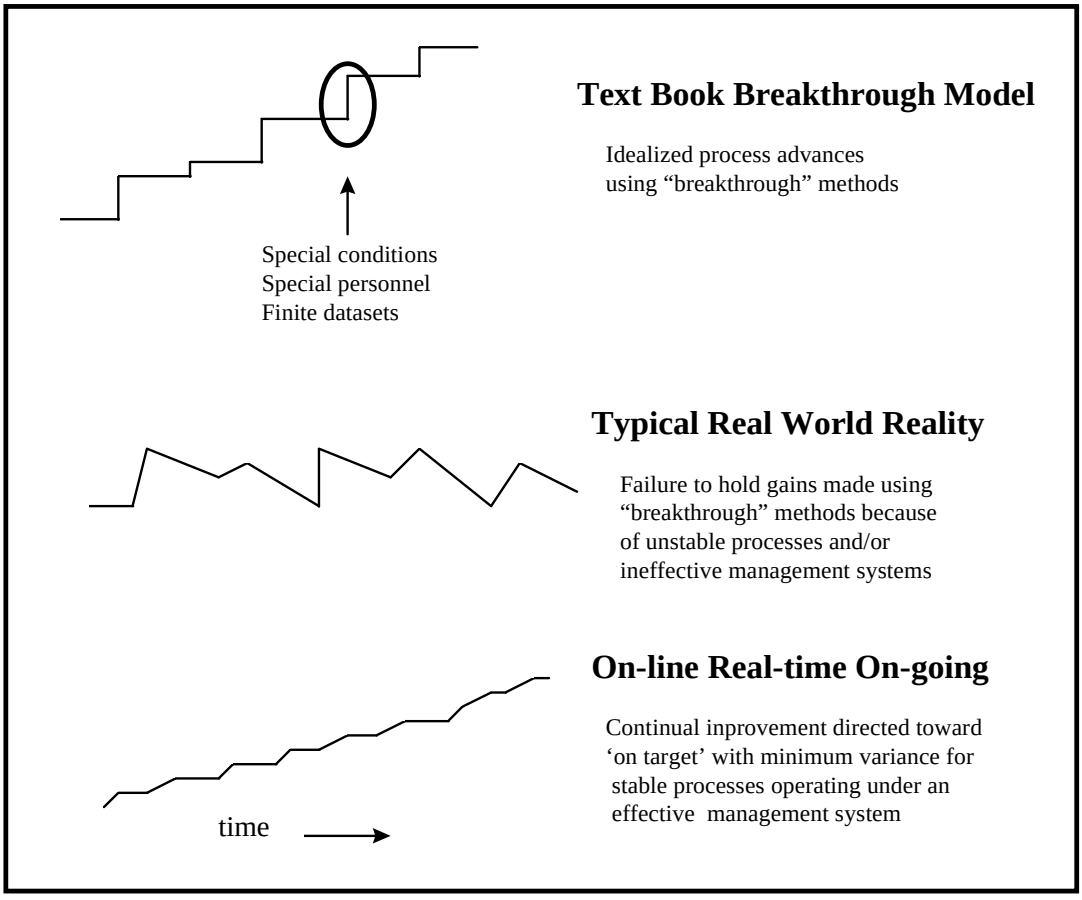
- **Design of Experiments (DOE)** - Determines how we can change what we do and improve the way we do it by identifying significant factors with provisions to optimize them. Why not test first before implementation? Wasted time and resources may result before major failures are discovered.

- **Multivariable Methods** - Determines how we can change what we do and improve the way we do it by assessing the combined effects of more than one variable in a system. Interactions occur when two or more factors act differently when implemented at the same time than when done individually.



Part 2

Process Breakthrough & Continual Improvement



Having the ability to manage your process in a way that it **operates predictability** means that the:

- **future, based on what your process typically produces, can be predicted.**
- **ability to capture and incorporate process improvements, permanently, is made possible.**

Part 3

Best Road to Process Improvement [1]

- On Target with Minimum Variance
- Operate Your Process Predictably

Agree on operational definitions

1) **Apply a criterion.**
2) **Apply a test of compliance.**
3) **Use a decision rule for interpreting the test results.**

Ask the following questions:

1) **What do you want?**
2) **By what method?**
3) **How will you know?**

Traditional "Goal Post" management philosophy:

'Just make the bottom line number'

A better way:

'Concentrate on reducing process variation while moving toward the target'

[1] Donald J. Wheeler. *Building Continual Improvement: 'A Guide for Business'*. Knoxville, Tennessee, SPC Press, Inc., 1998.

Part 4

KEY SECRET BEHIND SUCCESS

Statistical thinking

It is a <u>way</u> <u>of</u> <u>thinking</u>, involving all levels of the company top to bottom, that <u>*stimulates*</u> action on the right things at the right time.

Because it is the process that is the vehicle that generates the results, <u>fix</u> the process and the results will be there!

APPENDIX

A) 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

Managerial Level

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

Operational Level

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

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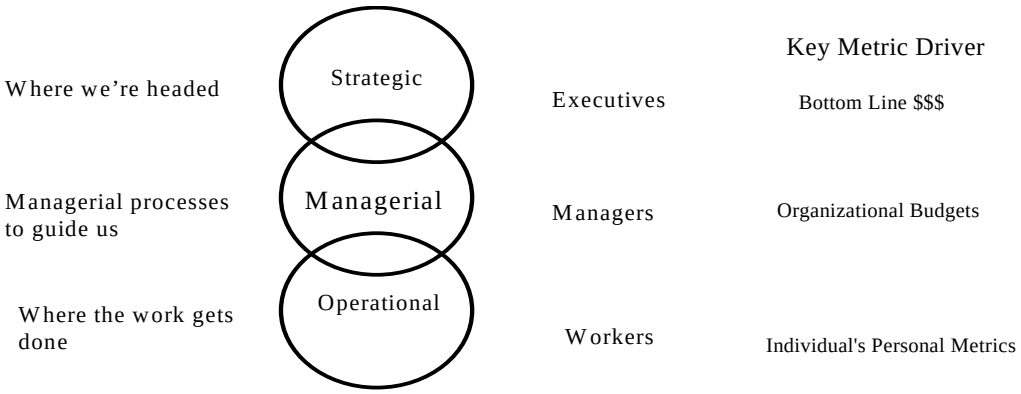
Statistical Thinking Applies to Various Organizational Levels



B) Success Stories

<u>U.S. WEST PROCESS IMPROVEMENT SUCCESS</u>

Problem: Failures in Telecommunication Links to In-house PC Users

Source: Video Tape: "Find the Hidden Gold Mine in Your Business Without Spending a Forture", by Jay Arthur at lifestar@rmii.com & Web Site http://rmi.net/~lifestar

Situation: By January, 1995, over 100,000 minutes of outage per week involved 9,000 people or approximately 11 minutes per week per user. U.S. West was made up of 14 states, 26 business offices, 650 computer servers, and utilized 3 applications on these servers.

Commitment: Dick O'Keefe, head manager over the computer operation group, set a goal to reduce outages by 50%.

End Results: In six months, outage was reduced to 74,000 minutes per week. One Year after that (1½ years), it was reduced to 10,000 – 11,000 (near the 5 sigma level or 233 defects per million opportunities).

Method Used: Root cause investigation attacked the 5% that caused 50% of the pain.

- Data gathering and data collection improvements were developed.
- Analysis was conducted and process flow diagrams were used. Pareto Charts focused on key problem areas.
- Specialized teams made up of SMEs in those problem areas were sent to investigate and develop implementation plans.
- Project managers carried out the execution of those plans.

Root Causes: 94% of the problems occurred in three areas with 39% in the first alone:

(1) Server software
(2) Application software
(3) Server hardware

- One single application had 84% of the problems. Many failures with the 15,000 password files resulted from corrupted passwords (i.e. over night they go defective).
- An old version of the operating system was producing both process errors and application errors.
- Servers were physically stuffed into tiny closets without adequate ventilation, creating over heating that caused strange things to occur.

Summary: Root cause analysis focused on the very small that was causing the very large. Management commitment saw that a project management approach with the resources necessary to fix the problem was undertaken. Prevention measures were built into the system to maintain gains made.

NEW ORLEANS – THE FIRST GRISLY CHALLENGE:

Shortly after this city of the swamps was founded in 1718, the first man died. But how does one properly dispose of his remains? Remember, the city is below sea level (still a problem today during hurricanes and heavy rains). Cemetery is a Greek word meaning

"to lie down". In 1718 in the French Quarter when you dug a hole six feet deep, you instantly got 5 feet 11-3/4 inches of water. One could not lie down, but literally had to sink down. What do you do?

At first, the approach was to drill holes in the bottom of the coffins to make them sink faster. Then someone came up with the idea of building a small wooden house structure above the ground. Because of the high humidity and 60 inches of annual rain fall, the wooden structures didn't last, so bricks were used. Finally the bricks were plastered to protect them from the elements. For a final touch, they were pained white as a sign of purity.

These little structures sitting side by side look like miniature houses, hence the cemeteries of New Orleans became known as the "Cities of the Dead."

But what does this have to do with management approaches? This illustration shows how the people of New Orleans in 1718 utilized a multiple-approach problem solving method. They were willing to think "outside-of-the-box".

C) Statistical Thinking: A Statistician's Application

"Time" Is Measured With A Clock, Not A Checksheet
David Laney
Director of Statistical Methodology
April 10, 1998

There is a common tendency among many businesses to make repeated measurements of work time but to express the outcome of such measures in terms of a single number: "Per Cent Late." I have often wondered why they do that. The only reason I can figure is expressed by the old story of the drunk crawling on his hands and knees in the middle of the night, continually bumping his head into a lamppost. When a cop comes along and asks him what he's doing, he stammers,

> "Ish OK, Oshifer, I'm jush looking for my keys."
> "Where did you lose, 'em?" the cop asks.
> "About a halfa block thataway."
> "Well, why in the world are you looking for them here by this lamppost?"
> "Shimple…the *light* ish better here!"

It must be that work time, which had to have been measured by a clock (or calendar) at some point, is transformed to a percentage because it's easier to deal with this single number. So what's wrong with that? Two things:

1. Expressing time as a "percent out of spec" does not give us enough information to manage a process. As Dr. Donald Wheeler says, "*Data* are random and miscellaneous, but *knowledge* is orderly and cumulative."

Unless expressed in the proper context, data are meaningless. "The latest measure is 20%…what should we do?" I don't know, is that good or bad?

When expressed properly, data can help us reach understanding and can suggest action. "The latest measure is 20%; the 25 immediately preceding measures were between 2% and 8%." So now what? So find out what just happened and why!

Example: A work process is performed in two centers, A and B. Work time is regularly measured in both. For each operation, 2 hours is considered "late." Both centers have been averaging 10% late recently. Last month, a new step was introduced in the process which would add about 5 minutes to every job (but the two-hour specification was not changed). As might be expected, both centers report this month that their %-late measure has increased. In center A, the latest value is 15%; in center B it is 50%. What happened?!

The answer is simple: the two centers may have had the same relative proportion of jobs hanging over the spec limit, but their actual *distributions* of work time were very different. Center A had a mean of only one hour, but their variance was so large that 10% of their data was out of spec. Center B had an average of an hour and 55 minutes, very close to the spec; but their variance was so small that only 10% of their readings were late. Adding 5 minutes to the process moved both distributions to the right by 5 minutes. This put A's average at 1:05 and pushed slightly more readings into the danger zone. Unfortunately, it put B's average right on *top* of the spec limit, so naturally half of its data are now out of spec.

2. This type of measurement stimulates customer-unfriendly behavior. We've all heard that what gets measured gets done. Therefore, if we measure the wrong things, people will do the wrong things. What is wrong with "% late?"

Suppose a large portion of your pay is tied to a "% greater than 2 hours" measure. Suppose you are working on a job that needs another 15 minutes to finish but is already 1:59 old. Right behind that, you have another job that also needs 15 more minutes of your time, but it is only 1:40 old. Do you (a) finish the first job, knowing it will be counted late, thus guaranteeing that the second job will be in jeopardy as well; or (b) drop the first one as a lost cause, finish the second one on time, and maybe get back to the first one later, once you get "caught up"? [Be honest!]

The latter practice is called FILO, for "First In, Last Out." Try to imagine: "Your call will be answered in the *inverse* of the order it was received. The longer you hold, the less likely we are to ever answer you." As so often happens when measurement methods are misapplied, we find ourselves having to choose between what is good for *us* (our bonuses, maybe our very jobs) and what is good for our *customers* (and the company's survival). The outcome is easily predicted. I have no doubt that Studebaker's executives kept getting large bonuses until the very end. Everyone was meeting their targets, so why did the company go broke? Simple… they were making a fine product that nobody wanted to buy.

There is a better way. It is called "capability analysis." Like any proper analysis of data, it recognizes both the central tendency (mean) of the data and its spread (standard deviation). The "capability index" for a process like work time, which has only an *upper* spec limit, is given by:

$$c = (SL - M) / (3 s)$$

where SL = the spec limit

M = the process mean
and s = the process standard deviation

The numerator, SL - M, is how far the spec limit lies above the mean. The denominator , 3s, is how far the *upper control limit* is above the mean (the point below which we expect our data to fall). We *hope* that all of our data will fall below the *spec* limit as well. Therefore we hope c > 1. If c < 1, it means that the natural variation in our process is causing some products to be out of spec. To correct this, we can easily see that we have to reduce either the mean or the variation (or both). For what it's worth, in manufacturing (where they use this religiously), c = 1.3 is considered pretty good; c = 0.7 is pretty bad.

How does this help? Knowledge of the capability of a process, recognizing both its central tendency and its dispersion, is essential to predicting the effects of proposed process changes. Further, the incentive for FILO behavior is eliminated. Deserting a "lost cause" and moving to other tasks will inflate the standard deviation of the process, causing the capability index to get smaller (and with it our "at risk" pay).

Culture change is not easy, but if market conditions are changing, a company must change or die. I have heard rumors that the telephone business might be getting somewhat competitive. If that's true, then it would seem we have two choices: change the way we do things in order to be more customer-focused, or cling to our traditional methods and join Studebaker in the "Where Are They Now" Hall of Fame.

"Using Multivariate Statistics to Make a Best New Car Selection"

Ralph F. Felder, MBA, CQE

Objective: Utilize a Multidimensional Scaling (MDS) Proximity Map tool to select the best 2002 mid-Size Car using only the characteristics that I'm personally interested.

MDS Method: Build an initial matrix for 11 characteristics and ten selected 2002 Mid-size cars. Standardize this matrix and mathematically convert it into a "proximity" distance matrix (much like a road map table showing mileage between cities). Use a MDS algorithm on this matrix to convert the 11 variables into 2 transformed dimensions that account for the greatest possible *variation*. They will reproduce, as close as possible, the overall automobile characteristics. Plot them as x-y coordinates. Individual entities reflecting similar variable structures will group into clusters. Use the map, standardized variables, and Consumer Guide ratings to analyze.

Conclusion: Buy either Camry as first choice. Avoid the 2002 American made Mid-Size cars.

{Consumer Guide: 2002 Mid-Size Car Comparisons}

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{Statistical Process Control: ' A Practical Applications Approach'}

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{Supporting Stories (for class discussion)}

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{Multivariate Statistics Application – Who is the real author?}

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{Statistical Methods}

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{The P36 Platform Disaster}

ASQ New Orleans Section 1518 - May 15, 2001 Meeting Newsletter, page 3
This page with photos shows the sinking of the Petrobras P36 Platform that collapsed into the ocean. Prior to this, their top executive said, "The project successfully rejected the established constricting and negative influences of prescriptive engineering, onerous quality requirements, and outdated concepts of inspections and client control. Elimination of these unnecessary straitjackets has empowered the project's supplies and contractors to propose highly economical solutions, with the win - win bonus of enhanced profitability margins for themselves. The P36 platform shows the shape of things to come in unregulated global market economy of the 21st Century."

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