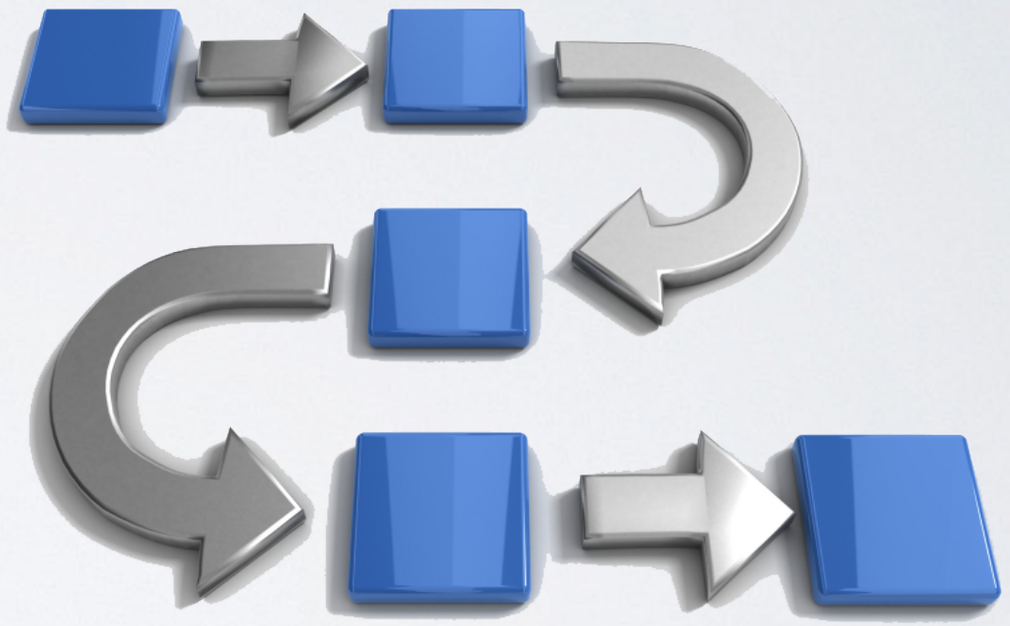
FUNDAMENTALS OF QUALITY IMPROVEMENT

William Baum

WHY QUALITY IMPROVEMENT?

- To provide a simple framework to apply the Data Science skillset…
- to real-world problems,
- incorporating soft skills,
- with real people.



A SYNERGISTIC BLEND OF THREE KEY DISCIPLINES

- 1. Organizational Behavior (Cultural Change)
- 2. Systems Thinking
- 3. Analytic Problem Solving

W. Edwards Deming

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"Defects are not free. Somebody makes them and gets paid for making them"

–W. Edwards Deming

ORGANIZATIONAL BEHAVIOR

- I. Organizational Behavior (Cultural Change)
    - Presents the most challenging aspect of QI
    - Where there are people, there are politics.
    - Goal: Implement a culture of *continuous* and *harmonious* quality improvement

HOW TO TACKLE ORGANIZATIONAL BEHAVIOR

- Find a Champion (Organization-wide, Project-specific)
    - Data scientists typically support Line/Product Managers, Directors
    - Line Managers usually have larger budgets/more resources
- Nemawashi - Ground work - seeking guidance and building consensus
    - "The work will teach you how to do it." Estonian Proverb
    - The people most intimately involved in a process often understand the challenges very well and can identify areas for Quality Improvement.
- Start Small. Go after low-hanging fruit. Live close to the data.

"A bad system will beat a good person every time."

–W. Edwards Deming

SYSTEMS THINKING

- The focus is on the whole system, interdependencies within it, and optimizing the system over time.
- Processes are viewed as series of interconnected steps.
  - View problems holistically
  - We often forget how interconnected we are!

HOW TO TACKLE SYSTEMS THINKING

- People often tend towards working in silos with blinders on
    - It takes consistent effort and time to change this cultural phenomenon - patience is your best weapon
        - Authority vs Influence - choose the latter whenever possible
- Build trust to foster open communication
    - Strive to maintain an attitude of unconditional positive regard
    - Run efficient, multi-disciplinary meetings. Listen to the quiet ones.
    - Thank people for their work. Praise success. Learn from failure.

"In God we trust. All others bring data."

–W. Edwards Deming

ANALYTIC PROBLEM SOLVING

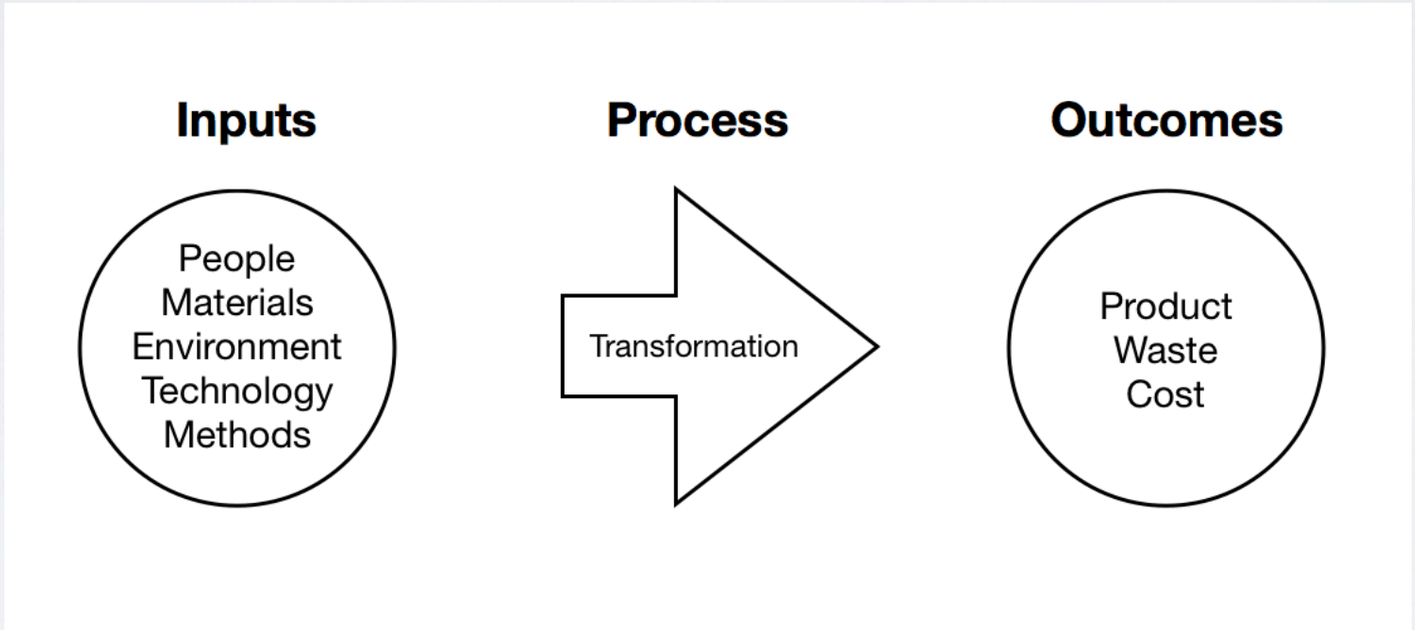
- Data Science!
    - The Theory of Variation:
        - Understanding sources of variation is key.
        - Eliminating sources of variation is the chief goal.
- Inputs - Process - Outcomes
- Output is a combination of:

  Signal (Product)+ Noise (Waste)

HOW TO TACKLE ANALYTIC PROBLEM SOLVING

- Apply QI framework - Flexibly & Consistently
- Ensure quality data collection
    - Do not assume that easily accessible data is of high quality.
    - "Garbage in, Garbage out"
- Democratize Data Consumption
    - Fewer touches are better
    - Automate whenever possible

PROCESS MAPPING



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VISUAL SIX SIGMA

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- Frame the problem
- Collect Data
- Uncover Relationships (EDA)
- Model Relationships (CDA)
- Revise Knowledge
- Utilize Knowledge

VSS GUIDE

Frame the problem
- Identify the core problem, or outcomes of interest
- Assemble a multi-disciplinary team
- Assign a champion, a coordinator, team members
- Conduct Concept Mapping (e.g. Root Cause Analyses, FMEA)
- Conduct brainstorming
- Identify needed resources for project (personnel, budget, etc.)
- Establish a timeframe to achieve benchmarks (Gantt Chart)

Collect Data
- Collect baseline data
- Ensure accuracy of data collection systems
- If necessary, adjust or add data collection systems and recollect data

Uncover Relationships (statistics as Detective - EDA)
- Dynamically visualize the variables one at a time (Histograms, Densities, Box plots)
- two at a time (scatterplots, mosaic plots)
- more than two at a time (3-D, bubble charts, Decision Trees, Dimension Reduction
- Visually, determine the Input factors that affect variation in the Outcomes

Model Relationships (statistics as Judge - CDA)
- For each Outcome, identify the Input factors to include in the signal function
- Model the Outcome as a function of the influential Input factors; check noise function
- Use weights to optimize multiple outcomes, simultaneously, using Desirability functions
- Select the best model; If needed, revise the model
- If required, return to the Collect Data step and use DOE to optimize learning efficiency

Revise Knowledge
- Identify the best Input settings
- Visualize the effect on the Outputs, should those input settings vary
- Verify improvements with a pilot study or confirmatory trials

Utilize Knowledge
- Change processes to implement optimal input settings
- Monitor processes for variation
- Alert team should phase shift occur, or new, special causes of variation are identified

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RECOMMENDED READING

- Our Iceberg is Melting
  John Kotter; Leadership, Story describes Group dynamics in QI

- Read this Before Our Next Meeting
  Al Pittampalli; Running efficient meetings

- Peace And Power: Creative Leadership For Building Community
  Peggy L. Chin; Running productive meetings of different types

- Visual Six Sigma: Making Data Analysis Lean, 1st Edition
  Ian Cox, Marie Gaudard, Philip Ramsey, Mia Stephens, Leo Wright;
  Framework to use statistics in a QI setting, with Case Studies

QUALITY IMPROVEMENT TERMINOLOGY

- **Kaizen** (kai="change", zen="good") - Japanese term that emphasizes continuous QI that is inclusive of entire organizations: management, staff, processes. https://en.wikipedia.org/wiki/Kaizen

- **Lean** - Maximizing customer value while minimizing waste; creating more value for customers with fewer resources. https://www.lean.org/WhatsLean/

- **Six Sigma** (6σ) is a set of techniques and tools for process improvement. As a manufacturing goal, it represents produce some feature of a part are statistically expected to be virtually free of defects (6 standard deviations, or 3.4 defects per million). https://en.wikipedia.org/wiki/Six_Sigma

- **Total Quality Management** (TQM) - consists of organization-wide efforts to install and make a permanent climate in which an organization continuously improves its ability to deliver high-quality products and services to customers. (Motorolla, General Electric) http://asq.org/learn-about-quality/total-quality-management/overview/overview.html

REFERENCES

- Nemawashi - https://www.youtube.com/watch?v=Nz-X4cZRoCI
- Visual Six Sigma: Making Data Analysis Lean, 1st Edition
  Ian Cox, Marie Gaudard, Philip Ramsey, Mia Stephens, Leo Wright, SAS & Wiley.