Improving Quality through Self-Sustaining Process Improvements

QUEST, Baltimore, 2014

Dr. Richard Bechtold; SEI CLA ID# 0600749-02
Abridge Technology: www.abridge-tech.com
Tutorial Agenda

- Top 10 Methods for Successful Change
  - Exercise 1: Decision Dynamics
- Key Measurement Principles to Ensure Self-Sustainment
  - Exercise 2: Answering Impossible Questions
- Summary and Next Steps
Top 10 Methods for Successful Change

1) * Choose Your Battles
2) Leverage World-Class Frameworks
3) Identify Feasible Improvement Options
4) Extend and Upgrade Decision Techniques
5) Select Improvement Strategy and Lifecycle
6) Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) Identify and Manage Risks
9) Evaluate and Adopt/Adapt Emerging Trends
10) Prepare for the Distant Future (2 Years?)
1) Choose Your Battles

First questions:
- What are you MISSION objectives?
- What are your BUSINESS objectives?

Mission Perspective: What is the value of your actions as delivered external to your organization?

Business Perspective: What is the value of your actions as received internal to your organization?
1) Choose Your Battles

Who are the primary stakeholders behind process improvement decisions and initiatives?

- Sponsors / Funding Sources
- Visible Advocates
- Process Engineers (Designers / Implementers)
- Process Performers
- End-Process (Product or Service) Recipients
1) Choose Your Battles

- Process improvement objectives are derived from stakeholder objectives
- However, objectives may be any or all of:
  - Unclear
  - Highly localized
  - Subject to a conflict of interest
  - Outright contradictory
  - Regularly or even frequently changing
  - Unrealistic
  - Dangerous
1) Choose Your Battles

- As discussed throughout this tutorial
  - Align yourself, and your actions, so that if you win, the organization wins
  - Respect your track record—or lack thereof
  - Pay your dues (homework, preparation, small steps, successful tests)
  - Listen carefully and collect data
  - Predict, plan, drive, evaluate, and adapt
Top 10 Methods for Successful Change

1) Choose Your Battles
2) * Leverage World-Class Frameworks
3) Identify Feasible Improvement Options
4) Extend and Upgrade Decision Techniques
5) Select Improvement Strategy and Lifecycle
6) Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) Identify and Manage Risks
9) Evaluate and Adopt/Adapt Emerging Trends
10) Prepare for the Distant Future (2 Years?)
2) Leverage World-Class Frameworks

- Numerous options to choose from
  - Agile *
  - Lean *
  - ISO 9000
  - ISO 27000 *
  - CMMI-DEV, CMMI-SVC *
  - ISO 20000
  - CMMI-ACQ
  - Six Sigma
  - Malcolm Baldrige *
  - Business Process Re-engineering
Overview: Agile Development

- Agile development is a group of software development methodologies based on iterative, adaptive, and incremental development
- Solutions emerge from self-organizing, cross-functional teams
- Teams rapidly adapt to change
- Typically, time determines how much work is attempted and accomplished

Overview: Lean Development

- Lean software development is based upon concepts from
  - Agile software development
  - Lean Manufacturing
  - Lean Information Technology

- Premise: “Think big, act small, fail fast, learn rapidly.”

Overview: Lean Development

- 7 basic principles of Lean software development
  - 1. Eliminate waste
  - 2. Amplify learning
  - 3. Decide as late as possible
  - 4. Deliver as fast as possible
  - 5. Empower the team
  - 6. Build integrity in
  - 7. See the whole

Agile/Lean Challenges

- In the context of Agile and Lean development environments, how do you
  - Leverage experience gained during business or mission performance?
  - Reduce the likelihood of key corporate or mission knowledge from being lost every time someone leaves the company?
  - Avoid incurring technical debt?
2) Leverage World-Class Frameworks

- ISO 27000: Specification for an Information Security Management System
  - Purpose: Provide best practice recommendations relating to information security and related risk management and control
2) Leverage World-Class Frameworks

- ISO 27000: Specification for an Information Security Management System (cont.)
  - Major sections:
    - (A1..A4 are general and informational)
    - A.5: Security Policy
    - A.6: Organization of Information Security
    - A.7: Asset Management
    - A.8: Human Resource Security
    - A.9: Physical and Environmental Security
2) Leverage World-Class Frameworks

ISO 27000: Specification for an Information Security Management System (cont.)

- Major sections (cont.):
  - A.10: Communications and Operations Management
  - A.11: Access Control
  - A.12: Information Systems Acquisitions, Development, and Maintenance
  - A.13 Information Security Incident Management
  - A.14: Business Continuity Management
2) Leverage World-Class Frameworks

- CMMI Frameworks, “Capability Maturity Model, Integration”
  - Originally (circa late 1980s) intended for software engineering
  - Progressively expanded to cover
    - Systems engineering
    - Hardware engineering
  - Eventually extended or “translated” for application in the services context
2) Leverage World-Class Frameworks

- CMMI Models: Five-level models, with higher levels representing higher organizational capability
  - Level 1: Work is done in whatever manner
  - Level 2: Internally proven methods for success are reliably repeatable
  - Level 3: Externally and internally proven methods for success are standardized, simplified, integrated, and leveraged
  - Level 4: Increased use of statistical principles and techniques
  - Level 5: The organization exhibits a culture of rapid and effective agility, adaptation, and innovation
2) Leverage World-Class Frameworks

- CMMI ‘Core’ (or common) Process Areas for Maturity Level 2
  - Requirements Management
  - Project/Work Planning
  - Project/Work Monitoring and Control
  - Measurement and Analysis
  - Configuration Management
  - Quality Assurance
  - Supplier Agreement Management *
2) Leverage World-Class Frameworks

- CMMI for Development Unique Process Areas
  - Requirements Development
  - Technical Solution
  - Product Integration
  - Verification
  - Validation
2) Leverage World-Class Frameworks

- CMMI for Services Unique Process Areas
  - Service Delivery
  - Capacity and Availability Management
  - Incident Resolution and Prevention
  - Service Continuity
  - Service System Development *
  - Service System Transition
  - Strategic Service Management
2) Leverage World-Class Frameworks

- Malcolm Baldrige Award for Performance Excellence
  - Purpose: Achieving high performance, sustainability, and survivability in your marketplace, and with integrity
  - Results can help you choose among ISO, CMMI, Lean, Agile, and other tools
  - Awarded once per year in different sectors (Manufacturing, Health, Education)
2) Leverage World-Class Frameworks

- 1000 points awarded
  - Leadership: 120
  - Strategic Planning: 85
  - Customer Focus: 85
  - Measurement, Analysis, and Knowledge Management: 90
  - Workforce Focus: 85
  - Operations Focus: 85
  - Outcomes/Results: 450

Top 10 Methods for Successful Change

1) Choose Your Battles
2) Leverage World-Class Frameworks
3) * Identify Feasible Improvement Options
4) Extend and Upgrade Decision Techniques
5) Select Improvement Strategy and Lifecycle
6) Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) Identify and Manage Risks
9) Evaluate and Adopt/Adapt Emerging Trends
10) Prepare for the Distant Future (2 Years?)
3) Identify Feasible Improvement Options

- Prioritize your improvement opportunities as follows:
  - Relevance and contribution to objectives
  - Likelihood of success
    - Your understanding of the current state
    - Your confidence in the intended impact
    - Receptivity of pilot participants
  - Low visibility
3) Identify Feasible Improvement Options

- Example: Product Quality Management
  - Consider and plan your efforts
    - What products need quality management?
    - What do you need to investigate quality?
    - How will you investigate quality?
    - How will you determine acceptable quality?
3) Identify Feasible Improvement Options

- Example: Product Quality (cont.)
  - Review and identify defects in items
    - Have teams (2 or more people) involved in quality detection
    - Keep track of detection methods, effort, and results
    - Analyze resulting data and evaluate coverage, effectiveness, and efficiency
  - Review and identify defects in systems
    - Repeat the above on products with behavior (i.e., software systems, hardware systems, etc.)
Top 10 Methods for Successful Change

1) Choose Your Battles
2) Leverage World-Class Frameworks
3) Identify Feasible Improvement Options
4) * Extend and Upgrade Decision Techniques
5) Select Improvement Strategy and Lifecycle
6) Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) Identify and Manage Risks
9) Evaluate and Adopt/Adapt Emerging Trends
10) Prepare for the Distant Future (2 Years?)
4) Extend and Upgrade Decision Techniques

- Decisions are sometimes made based on
  - Intuition
  - Guesswork
  - Frustration
  - Lack of identified options
  - Delay and loss of options
  - Pretty packaging (software)
  - Dramatic effect
4) Extend and Upgrade Decision Techniques

- Decision evaluation methods, related influences, and selection criteria are often undocumented.
- When decision fundamentals are undocumented:
  - Actual final decisions can become lost.
  - The same decisions may be revisited with different outcomes.
  - Very similar or related decisions may be made with conflicting or contradictory outcomes.
  - Decision rationale may be lost.
- Without a somewhat reliable approach to critical decisions, suboptimal choices may be made resulting in unintended adverse consequences.
4) Extend and Upgrade Decision Techniques

- Implementing a Dynamic Decision Process
  - Benefits: Increased likelihood of beneficial decisions
  - Principles:
    - *Know what is important to you* *before* you make *the decision*
    - Strive to consider choices among alternative solutions (versus binary yes/no scenarios)
4) Extend and Upgrade Decision Techniques

Dynamic Decisions (and possible Lab Exercise):

- 1) Decide where and when to apply these principles
- 2) Decide what is important to you ("selection criteria")
- 3) Determine some type of relative ranking system indicating "more" vs. "less" important
- 4) Identify at least three tentatively plausible alternatives or choices
- 5) Determine some type of evaluation approach
- 6) Select the best alternative
4) Extend and Upgrade Decision Techniques

- Dynamic Decisions Lab Exercise:
  - Example Step 5 (Determine some type of evaluation approach)
    - (a) Group discussion of different criteria and scoring methods (be prepared to present at least 2)
    - (b) Group outbriefing’s regarding evaluation methods
  - Scenario: As assigned by instructor
4) Extend and Upgrade Decision Techniques

- Successful process improvement is fundamentally dependent upon
  - Identification of alternative solutions
  - Deliberate evaluation and down-selection of options
- You are always going to have more good ideas than you have the money or time to implement
- Routinely reevaluate: what now / what later?
Top 10 Methods for Successful Change

1) Choose Your Battles
2) Leverage World-Class Frameworks
3) Identify Feasible Improvement Options
4) Extend and Upgrade Decision Techniques
5) * Select Improvement Strategy and Lifecycle
6) Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) Identify and Manage Risks
9) Evaluate and Adopt/Adapt Emerging Trends
10) Prepare for the Distant Future (2 Years?)
5) Select Improvement Strategy

Improvement strategy:
- Single processes or multiple?
- Single project or multiple?
- Generally parallel or sequential?
- Degree of interdependence between areas?
  - Project Planning
  - Project Monitoring and Control
- Degree of independence between areas?
  - Configuration Management
  - Decision Analysis
- Dynamics and relationships between projects?
5) Select Improvement Strategy

- Improvement lifecycle:
  - Quickest to deploy first?
  - Least disruptive first?
  - Easiest to perform first? (Your perspective)
  - Easiest to understand first? (Process user perspective)
  - Highest likelihood of success first?
  - Highest risk first?
5) Select Improvement Strategy

- Before selecting an improvement strategy and lifecycle, know
  - What are your criteria for success?
  - How will you evaluate achievement of criteria?
  - How will you determine relative proximity to success (i.e., closer than before, farther than before, rate of change, no change since last evaluated)
5) Select Improvement Strategy

- Recommended approach (in most contexts)
  - Some type of iterative method (rapid ‘history’)
  - Simplest/easiest to adopt (end-user experience)
  - Highest likelihood of success
  - Lowest visibility (initially)
  - No claims of future benefits; only reports of actual achievements
  - Self-explanatory (to the extent possible) measurement-driven charts and displays
Top 10 Methods for Successful Change

1) Choose Your Battles
2) Leverage World-Class Frameworks
3) Identify Feasible Improvement Options
4) Extend and Upgrade Decision Techniques
5) Select Improvement Strategy and Lifecycle
6) * Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) Identify and Manage Risks
9) Evaluate and Adopt/Adapt Emerging Trends
10) Prepare for the Distant Future (2 Years?)
6) Plan and Manage Organizational Change

- Strategic Reengineering and Tactical Improvement Plan
  - 1) Project Overview
  - 2) Project Objectives
    - Stakeholder Expectations
  - 3) Brief History
  - 4) Scope of Priorities and Activities
    - Work Breakdown Structure
    - Selected Out-of-Scope Priorities and Activities
6) Plan and Manage Organizational Change

- Strategic Reengineering and Tactical Improvement Plan (cont.)
  - 5) Event Milestone Overview
  - 6) Primary Resources, Tools, Stakeholders
  - 7) Primary Processes
  - 8) Known Constraints
  - 9) Risk Identification and Management Strategy
  - 10) Sustainment of this Plan
6) Plan and Manage Organizational Change

- Strategic Reengineering and Tactical Improvement Plan (cont.)
  - Appendix A: Role Assignments
  - Appendix B: Schedule
  - Appendix C: Known Risks, Mitigations, and Contingencies
  - Appendix D: Primary Measurements and Analytical Application
6) Plan and Manage Organizational Change

- Process improvement is never an organization’s top priority
- It is *very* dangerous if people start claiming and acting like process improvement is the top priority
  - Option 1: They are misinformed (regrettable)
  - Option 2: They are lying to you (bad)
  - Option 3: They are lying to themselves (really, really bad)
6) Plan and Manage Organizational Change

- Independent of your overall progress (or lack thereof)
  - Always continue to monitor—stay awake
  - Continue to replan, set new milestones, and document latest expectations (yours and others)
  - Continue to report and communicate status, progress, and the latest projections given the latest circumstances
Top 10 Methods for Successful Change

- 1) Choose Your Battles
- 2) Leverage World-Class Frameworks
- 3) Identify Feasible Improvement Options
- 4) Extend and Upgrade Decision Techniques
- 5) Select Improvement Strategy and Lifecycle
- 6) Plan and Manage Organizational Change
- 7) * Identify and Manage Resistance
- 8) Identify and Manage Risks
- 9) Evaluate and Adopt/Adapt Emerging Trends
- 10) Prepare for the Distant Future (2 Years?)
7) Identify and Manage Resistance

- As a general rule, process improvements and organizational changes involve the unknown.
- As a general rule, the unknown involves risk.
- By definition, risk is the potential for adverse consequences.
- Most healthy people take steps to avoid or resist adversity – that is, in part, why they are healthy.
7) Identify and Manage Resistance

Types of resistance

- Indirect: Actions to undermine or impede progress
- Direct: Actions in direct opposition to progress
- Passive: Resistance through inaction
- Active: Resistance through action
- Overt: Very obvious, almost demonstrative
- Covert: Hidden, stealthy, deliberately disguised as something else—especially as support
7) Identify and Manage Resistance

Rating IPC (xyz axis)

What did you encounter at your last employer?

And now?
Top 10 Methods for Successful Change

1) Choose Your Battles
2) Leverage World-Class Frameworks
3) Identify Feasible Improvement Options
4) Extend and Upgrade Decision Techniques
5) Select Improvement Strategy and Lifecycle
6) Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) * Identify and Manage Risks
9) Evaluate and Adopt/Adapt Emerging Trends
10) Prepare for the Distant Future (2 Years?)
8) Identify and Manage Risks

- **Purpose:** Identify threats, prioritize, and prepare or respond preemptively

- **Principles**
  - The probability of a risk is always greater than 0% and always less than 100%
  - Risk is defined as the potential for an adverse consequence (there is no such thing as a positive risk—unless your formula is flawed)
8) Identify and Manage Risks

- Composite Risk Formula (Classically)
  - $E = P \times I$
  - $E =$ Risk Exposure
  - $P =$ Probability of Occurrence
  - $I =$ Predicted Adverse Impact

- Often risk evaluation is a 3x3 or 5x5 matrix
## 8) Identify and Manage Risks

<table>
<thead>
<tr>
<th>Impact/Probability</th>
<th>Very Low/</th>
<th>Low/</th>
<th>Medium/</th>
<th>High/</th>
<th>Very High/</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Very High</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>/High</td>
<td>0</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>/Medium</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>/Low</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>/Very Low</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
8) Identify and Manage Risks

- Interesting question: How many hours per month should be spent on risk management?
  - Or maybe, per week?
- If at all feasible, involve others in all aspects of risk management (identification, tracking, mitigation, recovery planning, recovery performance)
- Considering risk management stages, the most difficult challenge by far is risk identification
Top 10 Methods for Successful Change

1) Choose Your Battles
2) Leverage World-Class Frameworks
3) Identify Feasible Improvement Options
4) Extend and Upgrade Decision Techniques
5) Select Improvement Strategy and Lifecycle
6) Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) Identify and Manage Risks
9) * Evaluate and Adopt/Adapt Emerging Trends
10) Prepare for the Distant Future (2 Years?)
9) Evaluate, Adopt, Adapt Emerging Trends

- Any technology intensive industry or company is being subject to change at continuously and dramatically increasing rates
- Striving to maintain things “as is” is actually an unsustainable strategy—you will eventually lose
- Organizational evolution can generally happen either
  - Accidentally
  - Intentionally
9) Evaluate, Adopt, Adapt Emerging Trends

- Technologies with exponentially increasing self-accelerating influences and impact include
  - Social networking
  - Mobile devices
  - Big-data analytics
  - “Bring Your Own Device” environments (deliberate or otherwise)
  - Crowd sourcing
  - Enterprise App stores
9) Evaluate, Adopt, Adapt Emerging Trends

http://science.nasa.gov/realtime/jtrack/3d/JTrack3D.html/
Top 10 Methods for Successful Change

1) Choose Your Battles
2) Leverage World-Class Frameworks
3) Identify Feasible Improvement Options
4) Extend and Upgrade Decision Techniques
5) Select Improvement Strategy and Lifecycle
6) Plan and Manage Organizational Change
7) Identify and Manage Resistance
8) Identify and Manage Risks
9) Evaluate and Adopt/Adapt Emerging Trends
10) * Prepare for the Distant Future (2 Years?)
10) Prepare for the Distant Future (2 Years?)

- There is an extremely strong tendency in many cultures to excessively focus on short-term results.
- This same tendency exists in many organizations—often as a function of executive level priorities.
- Process improvement motivation and actions are sometimes tactical, but are best evaluated and prioritized strategically.
10) Prepare for the Distant Future (2 Years?)

- It may not take much time or effort to implement and deploy selected new processes—some might only take a day or so
  - Risk management
  - Dynamic decision management
  - Product reviews
- But it almost always takes time for a new or changed process to become the normal, proven, and accepted way of accomplishing goals
10) Prepare for the Distant Future (2 Years?)

- Organizational process improvement is not only about identifying and addressing past and current weaknesses.
- A key priority must be to preemptively position the organization, and prepare the organizational culture, for emerging threats and opportunities.
- From one perspective, two years is a long time out—but then again, it might be barely enough time.
Tutorial Agenda

- Top 10 Methods for Successful Change
  - Exercise 1: Decision Dynamics
- >> Key Measurement Principles to Ensure Self-Sustainment
  - Exercise 2: Answering Impossible Questions
- Summary and Next Steps
Measurement Motivation

- From “Software Defect Reduction Top-10 List” (Barry Boehm USC; Victor Basili U. of Maryland)
  - Finding and fixing a software problem after delivery is often 100 times more expensive than finding and fixing it during the requirements and design phase
  - About 40-50% of the effort on current software projects is spent on avoidable rework
  - About 80% of the avoidable rework comes from 20% of the defects
  - About 80% of the defects come from 20% of the modules
  - Approximately 50% of the modules are defect free)
Measurement Motivation

- From “Software Defect Reduction Top-10 List” (Barry Boehm USC; Victor Basili U. of Maryland) (cont.)
  - About 90% of the downtime comes from at most 10% of the defects [a study at IBM found that 90% of downtime was due to 0.3% of the defects]
  - Peer reviews catch 60% of the defects
  - About 40-50% of user programs enter use with nontrivial defects
    - Spreadsheets
    - Active web pages
    - Web/Internet scripting languages; cyberspace agents
Measurement Motivation

- Ultimately, the value of measurements and quantitative methods is that they are both
  - Convincing
  - Compelling
- However, simply having the evidence available is not enough, you must effectively communicate that information in a manner that is conducive to perceptive understanding
Measurement Motivation

**Rule #1**, if measurement data isn’t convincing to you, it won’t be convincing to anyone else.

The first phase of your measurement implementation or enhancement initiative should focus on measurements where:

- You can ready access to the data for collection.
- You can use the resulting analysis to improve the utilization of your own resources and efforts.

When you are comfortable with clarity and effectiveness of your approach, start communicating your measurement information.
Measurement Challenges

- Generally, people don’t like to be measured
- People are already busy enough, and it takes extra time to do measurement
- Money is already too tight, and it costs extra money to do measurement
- Nobody likes math anyway
Measurement Challenges

- What would you prefer?
  - No information at all?
  - Incorrect information?

- Suppose you are collecting the measurements, do you know:
  - Who will see the information?
  - How they will interpret the information?
  - What their behavior will be once they have the information?
Exercise #2:

Answering Impossible Questions
(aka: “Introduction to Structured Opinion Wars”)

- **Objective:** To develop a reasoned response to difficult or impossible questions
- **Group exercise**
- **Question(s) / Challenge:** From instructor
- **Method:** Modified Delphi Technique
  - First: Each person evaluates personally / quietly
  - Next: Each person in a group (in order) discusses their thoughts – no arguments or debates; no realtime changes; clarifications ok
  - Repeat
  - Until, after a few rounds, either consensus or polarization emerges
- **Outbrief**
Implementing and Deploying Measures

- Checklists
- Histograms
- Pareto Charts
- Scatter Diagrams
- Pie Charts
- Radar Diagrams
- Flow Charts
- Cause and Effect Diagrams
- Run Charts
- Control Charts
Check Sheets

- Check sheets are usually simple forms or checklists, and are one of the easiest and least expensive techniques for helping to track or improve quality.

- Checklists ensure important steps are not inadvertently skipped (e.g., aviation pre-flight and emergency landing checklists).

- Forms ensure important information is gathered at appropriate times (e.g., change request forms).
Histograms

- A histogram is a graphical display of a table, tabulated frequencies, or data.
- Histograms show what proportion of the data falls into the various categories.
- Typically categories provide complete coverage of the data of interest without any overlaps.
Histograms
Histogram: Quality Management

- Inspection Hours
- Training Hours
- Rework Hours
- Dev Hours

Month: Jan - Dec
Histogram: Non-Compliances

PPQA-Reported Project Non-Compliances
CMMI ML 2

- New
- Closed
- Remaining

Month
Pareto Charts

- A Pareto chart is a special case of the bar chart or histogram
- Pareto charts show data in descending order (usually) from left to right
- In quality systems it is not uncommon for 80% of undesirable impact to originate from 20% of the causes
Pareto Charts

Example: Cost of Rework by Defect Type

$\begin{align*}
\text{Boolean} & \quad \text{Mathematical} & \quad \text{Data} & \quad \text{Parameter} & \quad \text{Looping} \\
\end{align*}$
Scatter Diagrams

- Scatter diagrams are visual charts used to display and compare two or more sets of data.
- Both the X axis (horizontal) and the Y axis (vertical) must be labeled, typically in relatively detailed units.
- No need for either scale to be zero-oriented.
Scatter Diagrams

Avg Defects Created / Month

Programmer Years of Experience

Abridge Technology
www.abridge-tech.com

Slide #: 80
rbechtold@abridge-tech.com
Pie Charts

- Similar use to Histograms
- Sometimes used after transforming underlying data counts into relative percentages, totaling 100%
- Unlike Histograms, generally not used to show negative values
- Can show multiple data sets via grouping, color, symbols, etc.
Pie Charts

Requested Functionality of Software
(DoD Survey; SEI, CMU)

- Ordered, but Not Delivered: 3%
- Not Usable: 3%
- Usable with Large Changes: 19%
- Usable with Small Changes: 30%
- Used as Delivered: 45%
Radar Charts

- Radar charts (also called spider diagrams) are useful for showing data in a variety of dimensions.
- Typically, lowest values are toward the middle of the chart, larger values to the outside.
- You can use a different scale on each arm of the chart (however, the resulting scale may be hard to read).
- Alternatively, assume 0 as the lowest value of each scale, then only vary the upper limits and show relative distances.
Radar Chart: Practice Compliance

Percent Compliance

Proj 1
Proj 2
Proj 3
Proj 4

PP
PMC
CM
PPQA
MA
RM

0 20 40 60 80 100

Slide #: 84
rbechtold@abridge-tech.com
Flow Charts

- Flow charts have been used since the earliest days of the computer industry to show:
  - Data flows
  - Control flows
  - Process sequencing

- Generally, keep icons and semantics simple, and most readers will understand.
Flow Charts
Cause and Effect Diagrams

- Cause and effect diagrams are used to help identify root causes of a particular effect.
- The general premise in quality management is that an undesirable event likely has a variety of causes.
- Once understood, selected causes can be identified for appropriate action.
Cause and Effect Diagrams
Run Charts

- Run charts are typically used to plot data across time.
- Usually, the X-axis of the chart is time and the Y-axis is the item (or items) of interest.
- Run charts can be used to track:
  - Number of defective items vs. number of produced items over time.
  - Help desk call rate over time.
  - Number of tests planned vs. number of tests performed, over time.
Run Charts

Total Tests Performed Vs. Planned

- PLANNED
- ACTUAL

Sun  Mon  Tue  Wed  Thr  Fri  Sat  Sun  Mon  Tue  Wed  Thr  Fri  Sat
Control Charts

- Control charts (also known as process behavior charts) are a statistical tool to identify (and subsequently analyze) variation within an observed process.

- In addition to data, control charts typically include three lines:
  - Upper Control Limit
  - Center Line
  - Lower Control Limit
Control Charts

- Control charts can help you rapidly distinguish between normal variation and unusual variation.
- Any data point outside the control limits is considered a usual variation.
- Other rules exist for identifying other unusual situations.
- Generally, normal variation is due to “common causes”, and unusual variation is due to “special causes”.
Control Charts

- Traditionally, control limits are placed at 3 standard deviations (or 3 sigma) from the norm (or mean).
- 99.7% of data points from a set of normally distributed data will fall inside the 3 sigma control limits.
Sigma / Standard Deviation

GRAPHIC DERIVED FROM: http://science.kennesaw.edu/biophys/gened/1101labs/modules/basics/exercise2/2-4.htm
Sigma / Standard Deviation

- A standard deviation is a measure of variance and is determined by taking the square root of the sum of each data point’s difference from the average, squared, and then dividing by $N - 1$.

$$SD = \sqrt{\frac{1}{N - 1} \sum_{i=1}^{N} (X_i - \bar{X})^2}$$

and then dividing by $N - 1$
Sigma / Standard Deviation

- For purists, the prior formula is used when you are using a sample of data randomly selected from a larger set.
- When the data is the complete set, use:

\[ SD = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (X_i - \bar{X})^2} \]
Control Charts

Avg Defects Found / Staff Hour of System Testing

- **UCL**: 18.9
- **CL**: 14.5
- **LCL**: 10.1

New test platform installed
Visualizing and Verifying Results

- Basic Rules
- Identify the Audience
- Maximize the Medium
- Select High Impact Displays
Basic Rules

- Remember the primary purpose of visual (and other) models: communication
- Simplicity usually equates with clarity
- Complexity is only impressive to the model creator
- Look for the classic 80/20 tradeoff
  - If you can communicate 80% of the message by using only 20% of the data, that’s likely the most effective (understandable) approach
- Ask yourself, “Is there any possible way this data might be misinterpreted?”, then adjust accordingly
Identify the Audience

- As with other less-visual means of communications, displays of data must accommodate the context of the audience.
- Keep in mind that you may have a “cascading” audience, where you only present to the first tier.
  - However, that group forwards your material to others, who may then forward it to still others, etc.
- Create visual displays that tell a very “rich” story and which also minimize complexity.
Quality Profile

- Inspection Hours
- Training Hours
- Rework Hours
- Dev Hours

Inspection Hours
Training Hours
Rework Hours
Dev Hours

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Slide #: 101 rbechtold@abridge-tech.com
Cost Profile

- Shows current
  - Budgeted cost of work scheduled (BCWS)
  - Budgeted cost of work performed (BCWP)
  - Actual cost of work performed (ACWP)
  - Cost Variance = ACWP / BCWP
  - Schedule Variance = BCWS / BCWP
  - Earned Value = BCWP
Cost Profile

Cost vs. Time Graph:
- BCWS (Budgeted Cost of Work Scheduled)
- BCWP (Budgeted Cost of Work Performed)
- ACWP (Actual Cost of Work Performed)

Schedule var

Cost var

Schedule var

BCWS

BCWP

ACWP

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Resource Profile

% Modems in Use: Box->1st Hr/Last Hr; Line->Max/Min
(If Box is white, 1st Hr < Last Hr)
Risk Profile

Risk Probability

Risk Impact

DIAMETER OF CIRCLE IS RELATIVE AMOUNT OF CONTINGENCY FUNDS SPENT
Select High Impact Displays

- Note, the upcoming graphics were downloaded from the following excellent websites:
  - “Milestones in the History of Thematic Cartography, Statistical Graphics, and Data Visualization”
    - www.math.yorku.ca/SCS/Gallery/milestone
  - “Gallery of Data Visualization, The Best and Worst Statistical Graphics”
But Only if You Know What You’re Doing…
Carte Figurative des postes de contact en chemin de l'Armée française dans la Compagnie de Russie. 1812-1813.

TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Brincker au dessous de zéro.
Causes of Mortality in the Army in the East
April, 1854 to March 1855

From: F. Nightingale, "Notes on Matters Affecting the Health, Efficiency and Hospital Administration of the British Army", 1858
CHART, Showing at One View
The Price of the Quarter of Wheat,
& Wages of Labour by the Week,
From the Year 1566 to 1684,
by WILLIAM PLAYFAIR.
NEW YORK CITY’S WEATHER FOR 1980

**ANNUAL TEMPERATURE**
- **HIGH**: July 21: 102°F
- **LOW**: Dec. 25: -1°F

**PRECIPITATION IN INCHES**
- **Total Precipitation for 1980**: 44.54
- **Normal Precipitation**: 40.19

**RELATIVE HUMIDITY AS OF NOON**
<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend:  
- 0.00 - 0.08 PPM  
- 0.08 - 0.12 PPM  
- 0.12 - 0.20 PPM  
- 0.20 - 0.40 PPM
Validating Measurement Capability

- Ultimately, you must track the interpretation and consequences of your measurement data
  - Are decisions influenced by relevant facts?
  - Are behaviors modified as a function of new information and insights?
  - Do your measurements accurately (and precisely) reflect history, status, and projections into the future?
Key Principles

- The primary purpose of measurements is to acquire enhanced, fact-based understandings through improved objective perceptions.

- A secondary purpose is to achieve convincing and compelling communication that correctly affects decisions and behaviors.
Key Principles

- Other key objectives are for measurements to:
  - Support early insights into your process efforts
  - Act as a catalyst for you to adjust immediately for efficiency and effectiveness
  - Support self-sustaining process improvements

- *In any event, measurements involving or affecting humans are extremely powerful, and must be implemented and treated accordingly*
Tutorial Agenda

- Top 10 Methods for Successful Change
  - Exercise 1: Decision Dynamics
- Key Measurement Principles to Ensure Self-Sustainment
  - Exercise 2: Answering Impossible Questions
- >> Summary and Next Steps
Summary and Next Steps

Final principles

- First, remember that process improvement is ultimately a support function—your objective is to help
- Second, ensure objectivity, timeliness, early warning, and verification are built into your process improvement strategy (e.g., measurements)
- Third, really, all we are trying to do is make people’s lives a little better
Contact Information

Dr. Richard Bechtold
President; Senior Consultant
Abridge Technology; Broadlands, VA
703.729.6085
rbechtold@abridge-tech.com
www.rbechtold.com
Biographical Highlights

- Dr. Bechtold is a senior consultant for Abridge Technology, a Virginia-based company he founded in 1996. Abridge Technology is an SEI Partner and is authorized to provide licensed training and appraisal services.
- Dr. Bechtold is a Certified Lead Appraiser for CMMI-DEV and CMMI-SEV. Additionally, he provides consulting, training, and support services in the areas of project management, process improvement, process definition, measurement, and risk management.
- Dr. Bechtold has over 20 years experience conducting process appraisal and improvement efforts. His expertise spans organizations of all types and sizes, from multi-billion dollar companies and agencies to organizations with less than 10 personnel.