SEI Webinar: A Mini-Tutorial for Building CMMI Process Performance Models

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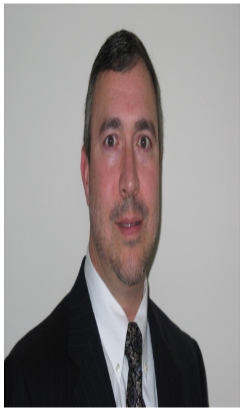
Speaker Biographies



Robert W. Stoddard currently serves as a Senior Member of the Technical Staff at the Software Engineering Institute. Robert architected and designed several leading measurement and CMMI High Maturity courses including: “Understanding CMMI High Maturity Practices”, “Improving Process Performance using Six Sigma”, and “Designing Products and Processes using Six Sigma.”

Rusty Young currently serves as the Appraisal Manager at the SEI. Rusty has 35+ years S&SW development, management, and consulting He has worked in large and small organizations; government and private industry. His recent focus has been CMMI High Maturity.

Dave Zubrow currently serves as the Manager of the Software Engineering Measurement and Analysis (SEMA) initiative within the Software Engineering Institute (SEI). Prior to joining the SEI, Dave served as Assistant Director of Analytic Studies for Carnegie Mellon University. He is a SEI certified instructor and appraiser, member of several editorial boards of professional journals, and active in standards development.

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The Web page for Crystal Ball is available at http://www.crystalball.com

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Topics

Introduction

Review of Process Performance Models (PPMs)

Technical Process of Building PPMs

Questions

Review of CMMI Process Performance Models (PPMs)

What is a PPM?

OPP SP 1.5

- **PPMs** are used to estimate or predict the value of a process-performance measure from the values of other process, product, and service measurements
- **PPMs** typically use process and product measurements collected throughout the life of the project to estimate progress toward achieving objectives that cannot be measured until later in the project's life

Glossary

- A description of the relationships among attributes of a process and its work products that is developed from historical process-performance data and calibrated using collected process and product measures from the project and that is used to predict results to be achieved by following a process

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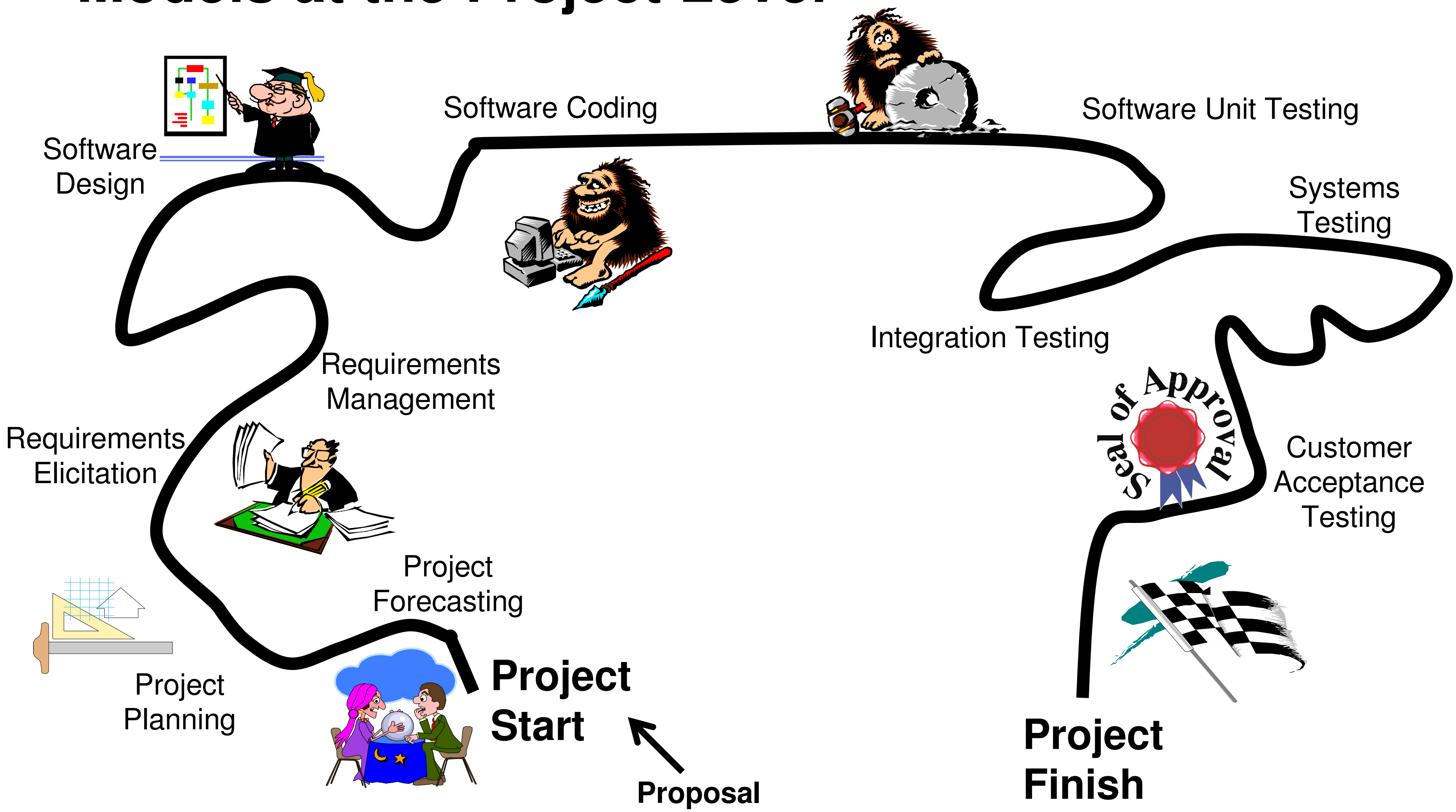
Purpose and Usage of Process Performance Models at the Project Level



Healthy Ingredients of CMMI Process Performance Models

Statistical, probabilistic or simulation in nature

Predict interim and/or final project outcomes

Use controllable factors tied to sub-processes to conduct the prediction

Model the variation of factors and understand the predicted range or variation of the outcomes

Enable “what-if” analysis for project planning, dynamic re-planning and problem resolution during project execution

Connect “upstream” activity with “downstream” activity

Enable projects to achieve mid-course corrections to ensure project success

Interactive Question #1

Do you now feel comfortable with your knowledge of the healthy ingredients of a CMMI Process Performance Model that were just presented?

1) Yes

2) No

Technical Process of Building PPMs

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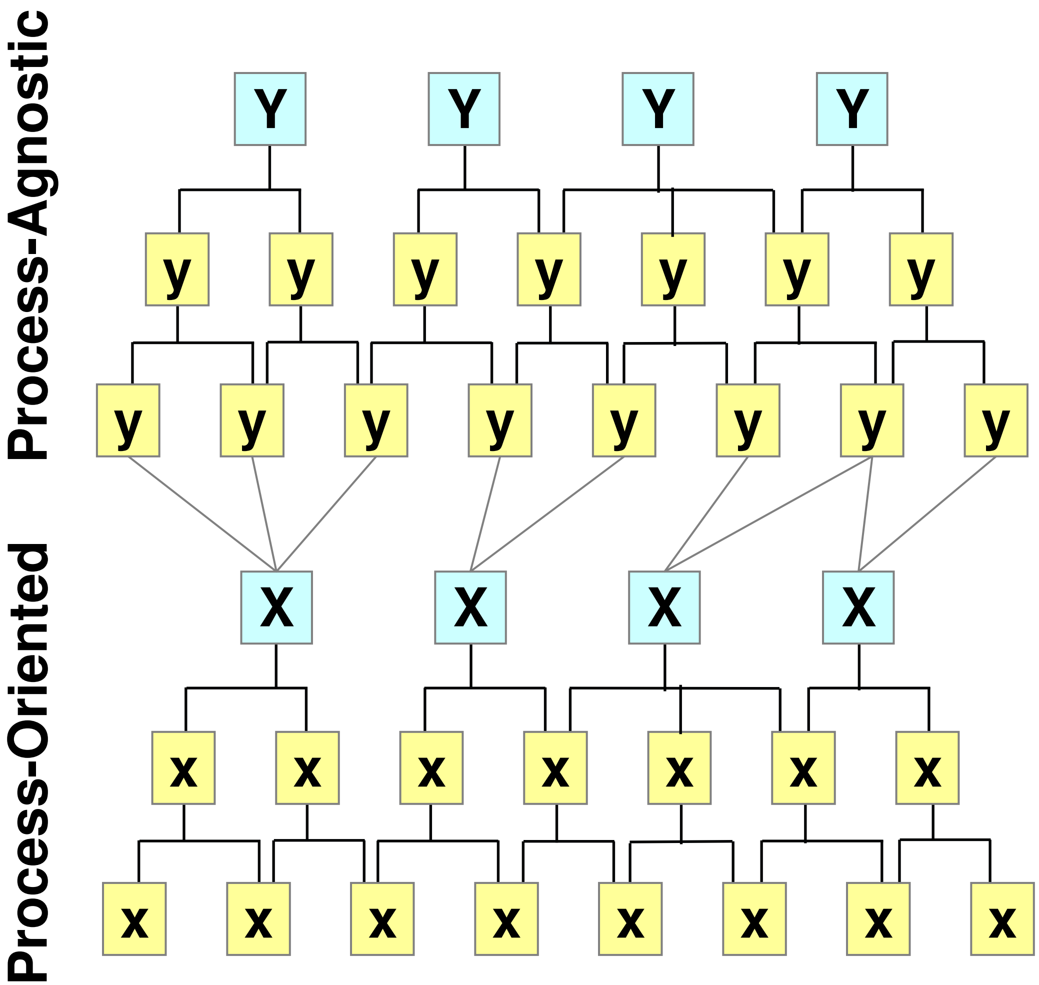
Topics

- Review of CMMI Process Performance Models (PPMs)
- Technical Process of Building PPMs
  1. Identify or Reconfirm Business Goals
  2. Identify the sub-processes/process
  3. Identify Outcomes to Predict (y's)
  4. Identify Controllable factors (x's) to predict outcomes
  5. Include Uncontrollable x factors
  6. Collect Data
  7. Assess Data Quality and Integrity
  8. Identify data types of all y outcomes and x factors
  9. Create PPBs
  10. Select the proper analytical technique and/or type of regression equation
  11. Create Predictions with both Confidence and Prediction Intervals
  12. Statistically manage sub-processes with PPMs
  13. Take Action Based on PPM Predictions
  14. Maintain PPMs including calibration and reconfirming relationships
  15. Use PPMs to assist in CAR and OID
- Questions

1) Business Goal Flowdown (Y-to-x)



High Level Business Goals
(Balanced Scorecard)

Subordinate Business Goals
(e.g., $ Buckets, % Performance)

High Level Process
(e.g., Organizational Processes)

Subordinate Processes
(e.g., Down to a Vital x sub-process to be tackled by DMAIC team)

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2) Identify the Sub-Process/Process

- Start with the Organization's Business Objectives
- Decompose to Quality and Process Performance Objectives (QPPOs)
- For the QPPOs that can be Measured Quantitatively
  - Perform Analysis to Determine which Sub-Process/Process Drives the Relevant Objective
  - Determine if Sufficient Data is Available or can be Obtained to Establish a Process Performance Baseline(s) and/or Build a Process Performance Model(s)

Identify the Sub-Process/Process Example

- Given Organizational Business Objectives:
  - Improve quality
  - Improve cycle time
  - Improve productivity
- Translate to measureable QPPOs
  - Post-delivery defect density of less than 0.5 Defects/KSLOC
  - Achieve 85% defect detection before System testing
  - Ensure requirements duration is within 15% of plan
  - Achieve a 5 % software productivity improvement

Identify the Sub-Process/Process Example continued

- The QPPOs after analysis were determined to be driven by the following processes
  - Peer Review
  - Test
  - Requirements Development

- The processes were then decomposed to the following related sub-processes to be statistically managed
  - Inspection
  - Integration Test
  - Requirements Analysis

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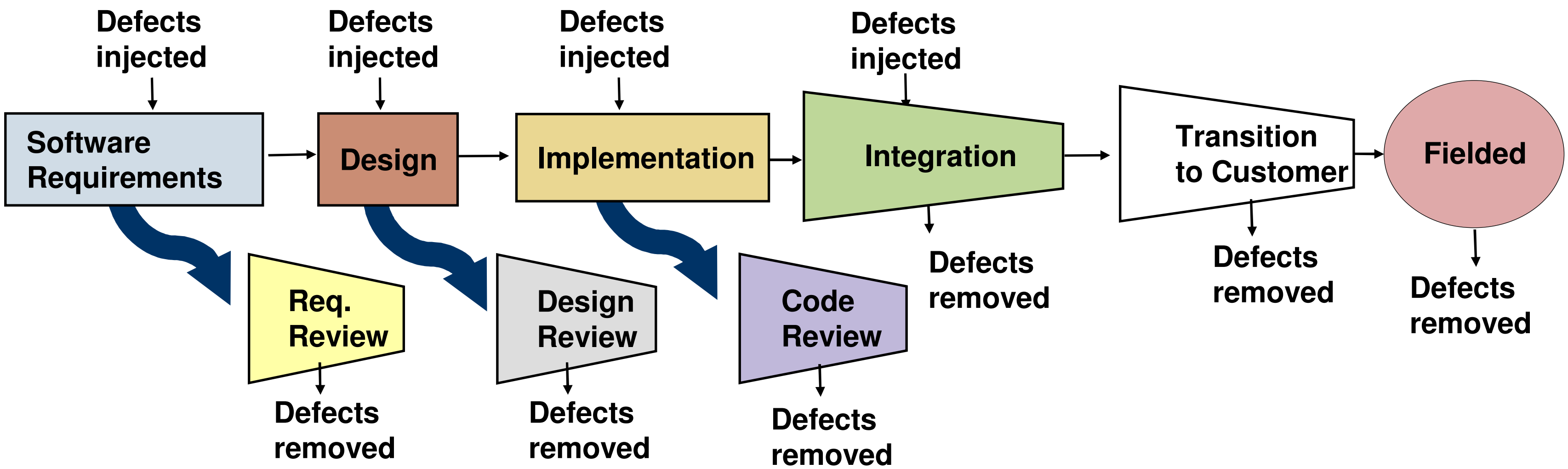
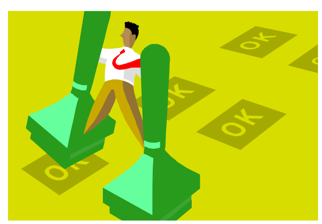
3) Identify Outcomes to Predict



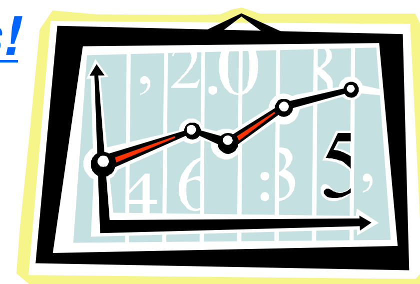
Across business functions and disciplines!

Outcomes related to key handoffs of work during project



Outcomes related to interim milestones and mgt reviews

Outcomes related to risks during the project execution



Outcomes related to project completion

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Examples of Outcomes

Injected Defects Volume by type

Escaped defects by phase*

Task duration

Availability of resources*

Task delay

Schedule Variance

Task effort

Cost Variance

Earned Value Metrics (CPI, SPI)

Latent defect content of artifact*

Difficulty*

Productivity*

Rework

Req’ts Volatility*

Cost of Poor Quality

Customer Satisfaction

Time to Market

Progress*

“ilities” such as Reliability

Warranty Costs

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4) Identify Controllable factors (x's) to Predict Outcome(s) - 1

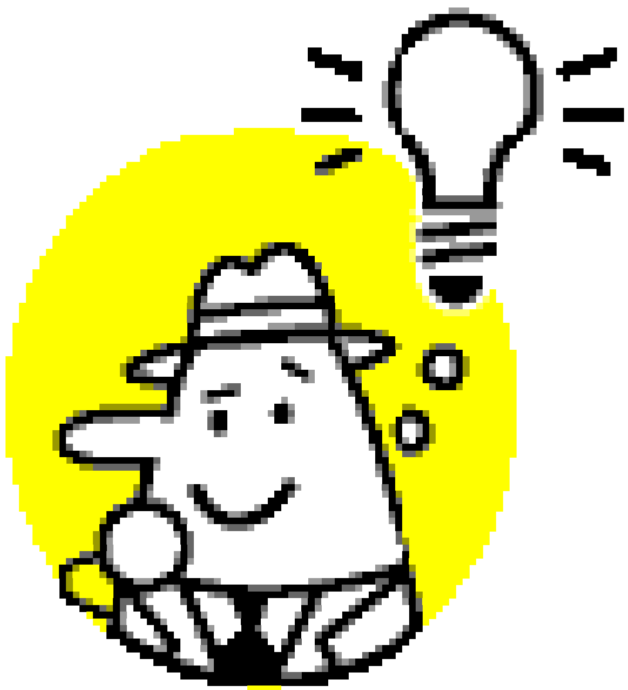
"Controllable" implies that a project has direct or indirect influence over the factor prior to or during the project execution

A common misconception is that factors are not controllable and thus disregarded from consideration for modeling. Requires out-of-the-box thinking to overcome this. Some organizations employ individuals known as "assumption busters"

Identify Controllable factors (x's) to Predict Outcome(s) - 2

As we view process holistically, controllable factors may be related, but not limited, to any of the following:

- People attributes
- Environmental factors
- Technology factors
- Tools (physical or software)
- Process factors
- Customers
- Suppliers
- Other Stakeholders



5) Identify Uncontrollable Factors

- Normally these are constraints placed by the customer or concrete terms of a contract or government regulation

- Can also be factors for which the project team truly has no direct nor indirect influence over

- Can be factors that are unchanging for a given project but can be changed for future projects

- Often includes external factors or factors related to other teams outside of the project

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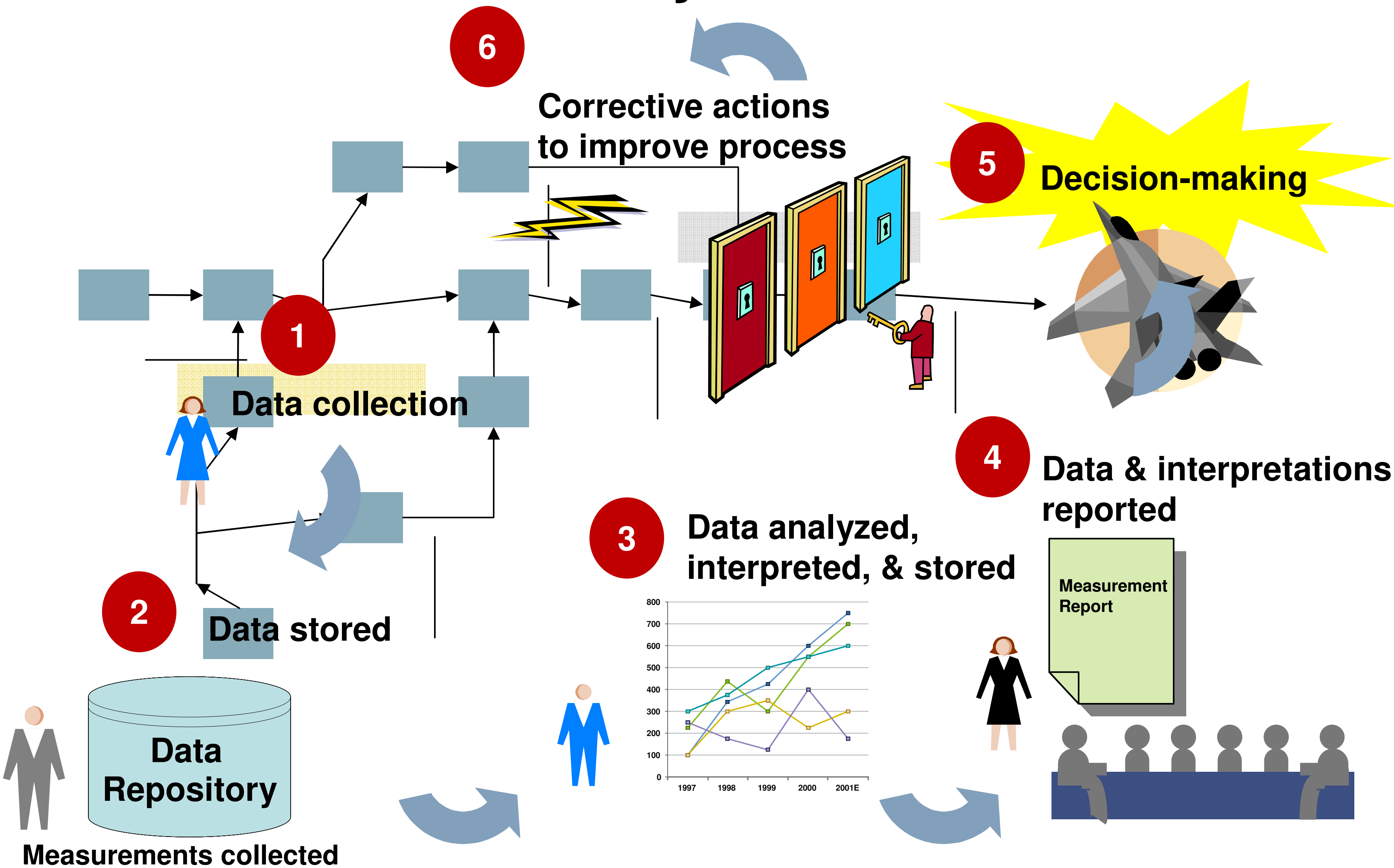
Interactive Question #2

Of the steps presented so far, which step do you believe would be the most challenging for your organization?

1) Business Goal formulation to drive PPMs
2) Identification of critical subprocesses supporting goals
3) Identify outcomes to predict with PPMs
4) Identify controllable factors to make predictions with
5) Identify uncontrollable factors to make predictions with

6) Measurement and Analysis in Action



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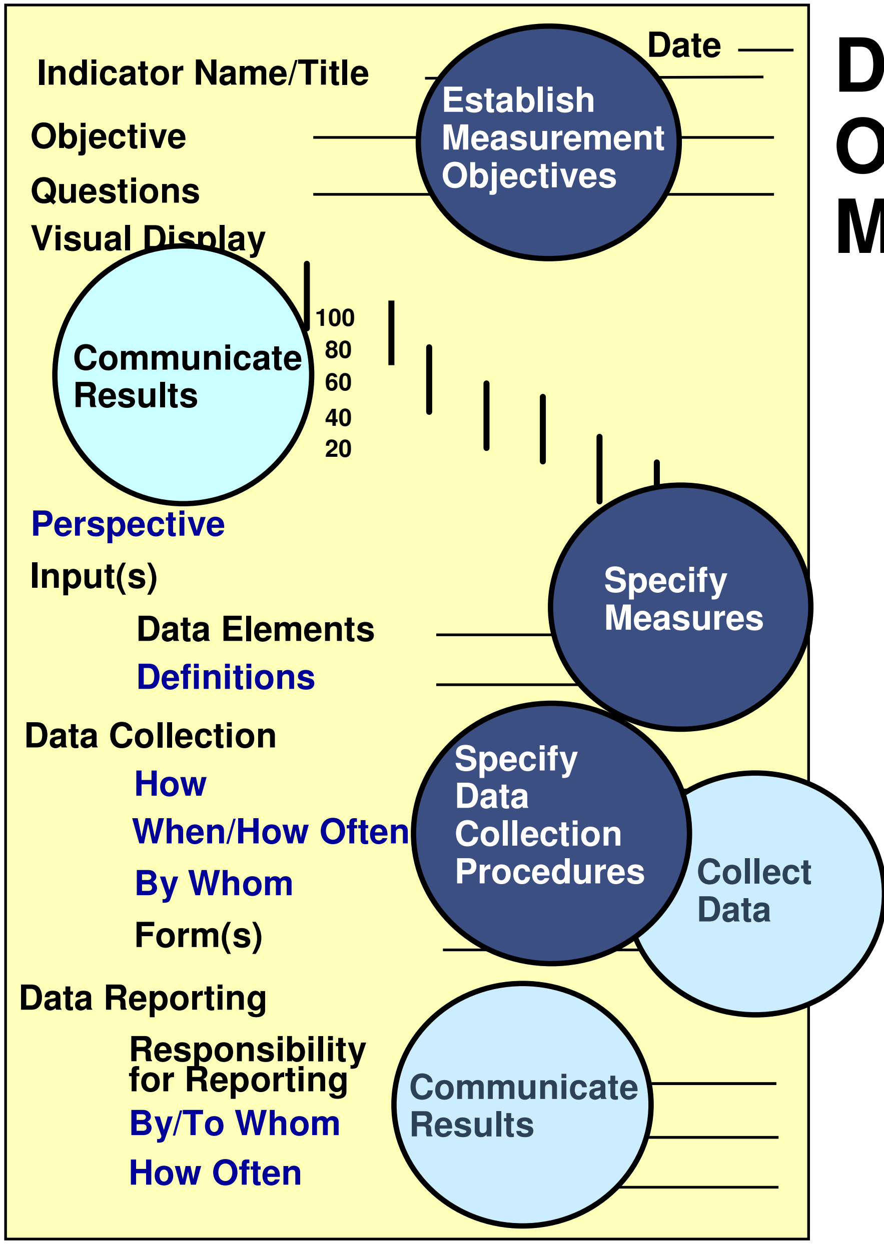
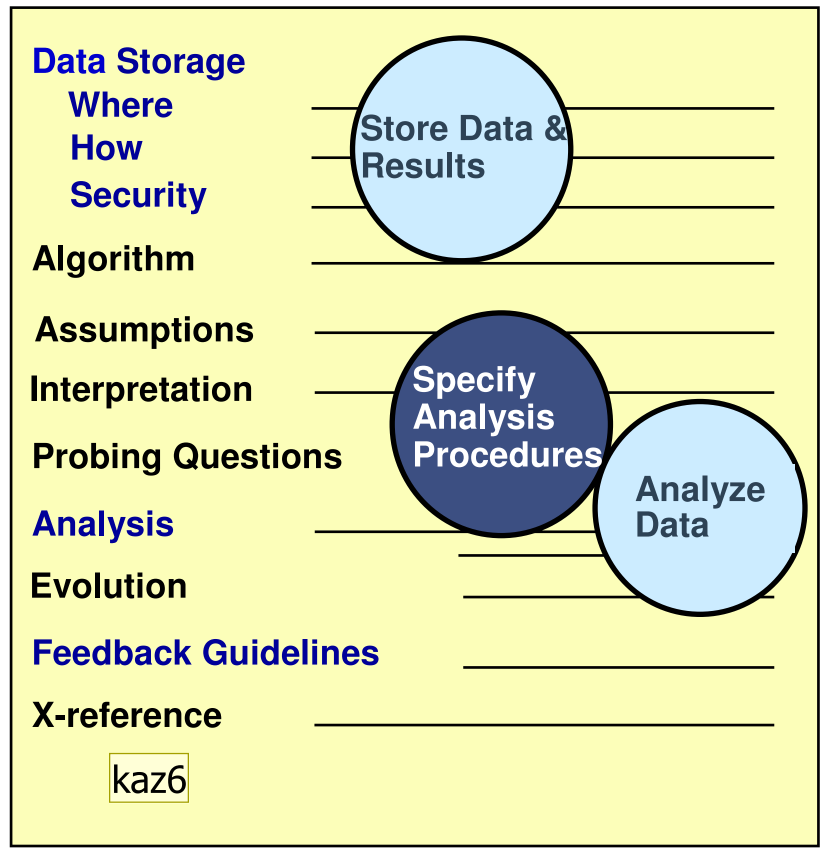
Documenting Measurement Objectives, Indicators, and Measures





Slide 24

kaz6 This slide seems out of place to me ... since the slides that follow cover some of the things noted in the template. the template.

Quite honestly, I would remove the slide since it is only repeating some of the criteria that is already being listed.
Mark Kasunic, 10/7/2008

7) Cost of Poor Data Quality to an Enterprise – Typical Issues and Impacts

Typical Issues

- Inaccurate data [1-5% of data fields are erred]
- Inconsistencies across databases
- Unavailable data necessary for certain operations or decisions

Typical Impacts

Operational

- Lowered customer satisfaction
- Increased cost
- Lowered employee satisfaction

Tactical

- Poorer decision making & decisions take longer
- More difficult to implement data warehouses
- More difficult to engineer
- Increased organizational mistrust

Strategic

- More difficult to set strategy
- More difficult to execute strategy
- Contribute to issues of data ownership
- Compromise ability to align organization
- Divert management attention

Source: Redman, 1998

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Impacts of Poor Data Quality

Inability to

- manage the quality and performance of software or application development
- Estimate and plan realistically

Ineffective

- process change instead of process improvement
- and inefficient testing causing issues with time to market, field quality and development costs

Products that are painful and costly to use within real-life usage profiles

Bad Information leading to Bad Decisions

Where do Measurement Errors come From[1]

Data Entry Errors

- Manual data entry
- Lack of integrity checks

Differing Operational Definitions

- Project duration, defect severity or type, LOC definition, milestone completion

Not a priority for those generating or collecting data

- Complete the effort time sheet at the end of the month
- Inaccurate measurement at the source

Double Duty

- Effort data collection is for Accounting not Project Management
  - Overtime is not tracked
  - Effort is tracked only to highest level of WBS

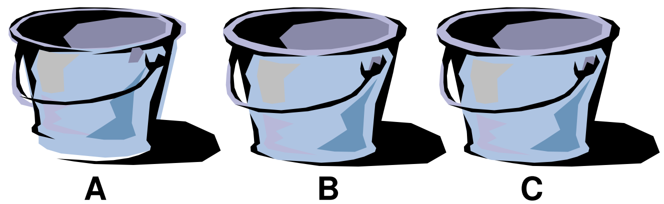
8) Types of Data

Attribute
(aka categorized or discrete data)

Increasing information content

Nominal

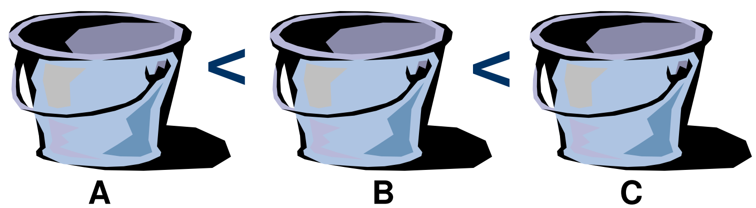
Categorical data where the order of the categories is arbitrary



Examples
Defect types
Labor types
Languages

Ordinal

Nominal data with an ordering; may have unequal intervals



Examples
Severity levels
Survey choices 1-5
Experience categories

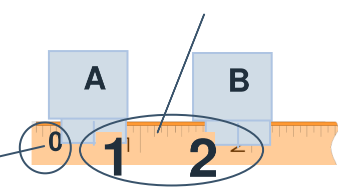
Continuous
(aka variables data)

Interval

Continuous data that has equal intervals; may have decimal values

Ratio

Interval data set that also has a true zero point



Examples
Defect densities
Labor rates
Productivity
Variance %'s
Code size SLOC

Appropriate Analysis: Types of Hypothesis Tests

Data Type →	Interval or Ratio (Parametric Tests)		Ordinal (Non-Parametric Tests)		Nominal	Proportion
# Samples (Data groups) ↓	Mean	Variance	Median	Variance / Fit	Similarity	Similarity
1 Sample	1-sample t test	1-sample Chi-Square test	1 sample Wilcoxon Signed Ranks test	Kolmogorov-Smirnov Goodness of Fit test	*>2 cells* Chi-Square; Binomial Sign Test *=2 cells*	1 Proportions test
2 Samples	*Independent* 2-sample t test; Paired t test *Paired*	*Normal* F test; Levene test *Not Normal*	*Independent* Mann Whitney U test; Wilcoxon matched *Paired*	*= Medians* Siegel-Tukey test; Moses test *≠ Medians*	Fisher Exact test (1-way ANOVA); Chi-Square test	2 Proportions test
3+ Samples	ANOVA (1 & 2 way ANOVA; Balanced ANOVA; GLM) MANOVA (General & Balanced)	*Normal* Bartlett test; Levene test *Not Normal*	*Independent* Kruskal-Wallis 1-way ANOVA; Friedman 2-way ANOVA *Paired*	Van der Waerden Normal scores test	Chi-Square test	ANOM (Analysis of Means)

9) Creating Process Performance Baselines

- Definition: A Process Performance Baselines (PPB) is a documented characterization of the actual results achieved by following a process
- Therefore a PPB needs to reflect actual project performance
- CMMI-DEV OPP PA informative material:
  - Establish a quantitative understanding of the performance of the organization's set of standard processes in support of objectives
  - Select the processes that summarize the actual performance of processes in projects in the organization
- Alternatively Practical Software and Systems Measurement (PSM) recommends an organization follow three basic steps:
  - Identify organization needs
  - Select appropriate measures
  - Integrate measurement into the process

Creating Process Performance Baselines Misconceptions

- We only need one baseline
- Once we establish the initial set of baselines we are done
- One data point constitutes a baseline
- We can't use the baseline until it is stable
- If the initial baseline is unstable we just remove the data points outside of the control limits and recompute the control limits until we get a plot that appears stable

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10) Select the Proper Analytical Model

Statistical Modeling and Regression Equations

Monte Carlo Simulation

Probabilistic Modeling including Bayesian Belief Networks

Discrete Event Process Simulation

Other Advanced Modeling Techniques

Markov, Petri-net, Neural Nets, Systems Dynamics

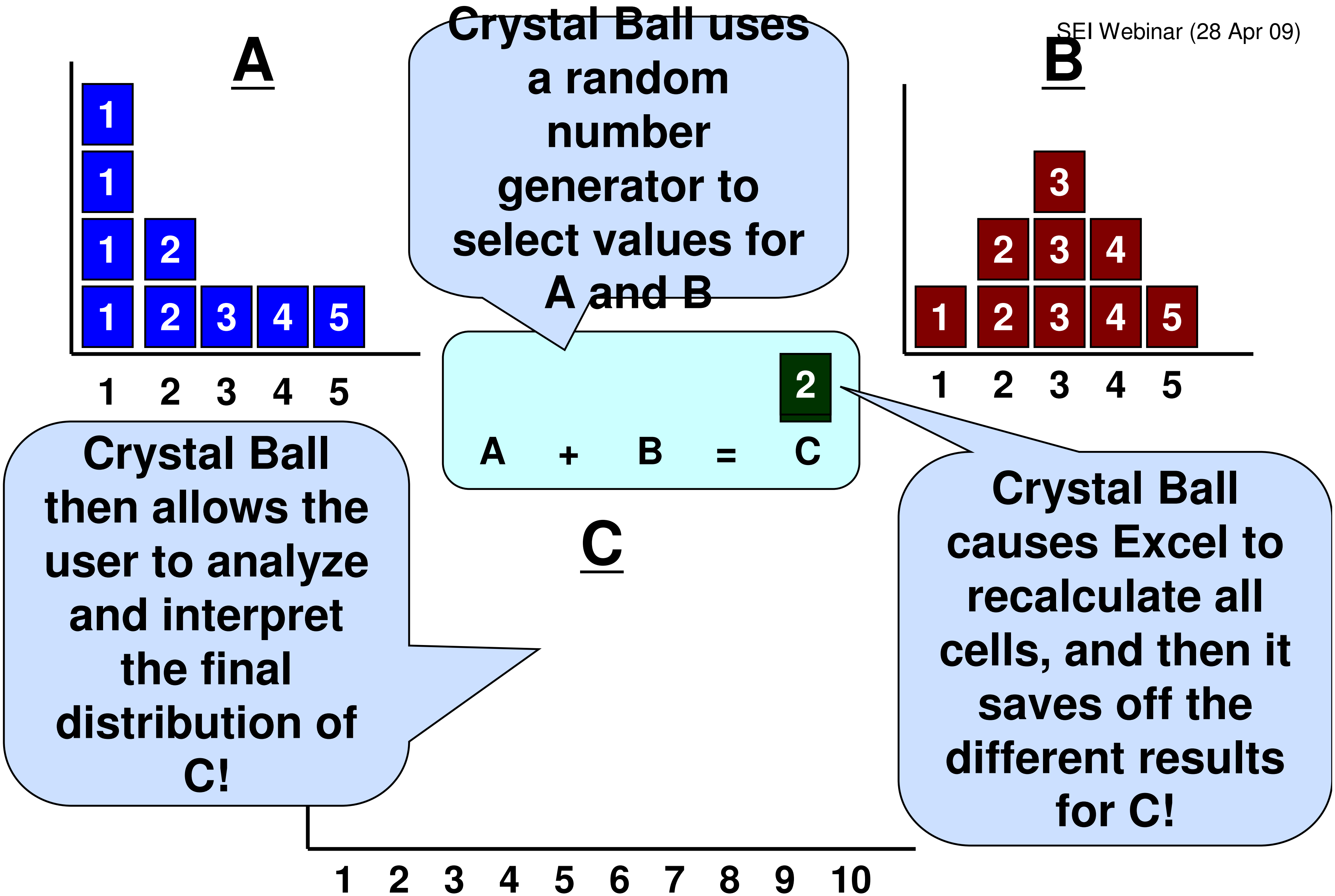
Statistical Regression Analysis

X \ Y	Continuous	Discrete
Discrete	ANOVA and Dummy Variable Regression	Chi-Square, Logit & Logistic Regression
Continuous	Correlation & Linear Regression	Logistic Regression

Why Use Monte Carlo Simulation?

Use Monte Carlo simulation to do the following:

- Allow modeling of variables that are uncertain (e.g., put in a range of values instead of single value)
- Enable more accurate sensitivity analysis
- Analyze simultaneous effects of many different uncertain variables (e.g., more realistic)
- Aid buy-in and acceptance of modeling because user-provided values for uncertain variables are included in the analysis
- Provide a basis for confidence in a model output (e.g., supports risk management)
- Increase the usefulness of the model in predicting outcomes

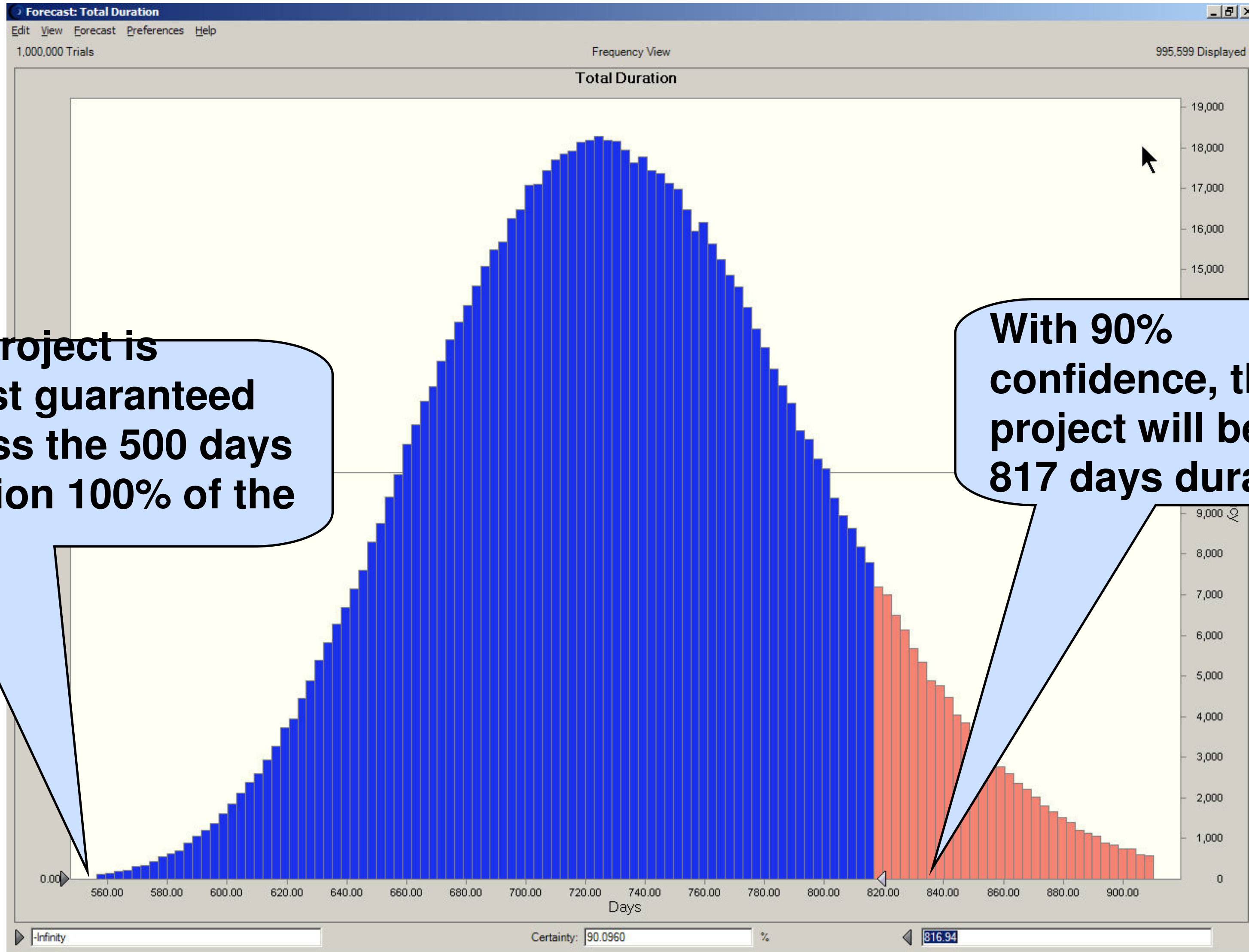

A
1
1
1 2
1 2 3 4 5
1 2 3 4 5
Crystal Ball uses a random number generator to select values for A and B
B
3
2 3 4
1 2 3 4 5
1 2 3 4 5
2
A + B = C
Crystal Ball then allows the user to analyze and interpret the final distribution of C!
C
Crystal Ball causes Excel to recalculate all cells, and then it saves off the different results for C!
1 2 3 4 5 6 7 8 9 10

Example: Adding Reality to Schedules-1

Process	**Durations**		
Step	Best	Expected	Worst
1	27	30	75
2	45	50	125
3	72	80	200
4	45	50	125
5	81	90	225
6	23	25	63
7	32	35	88
8	41	45	113
9	63	70	175
10	23	25	63
		500	

What would you forecast the schedule duration to be?

Adding Reality to Schedules-2



The project is almost guaranteed to miss the 500 days duration 100% of the time.

With 90% confidence, the project will be under 817 days duration.

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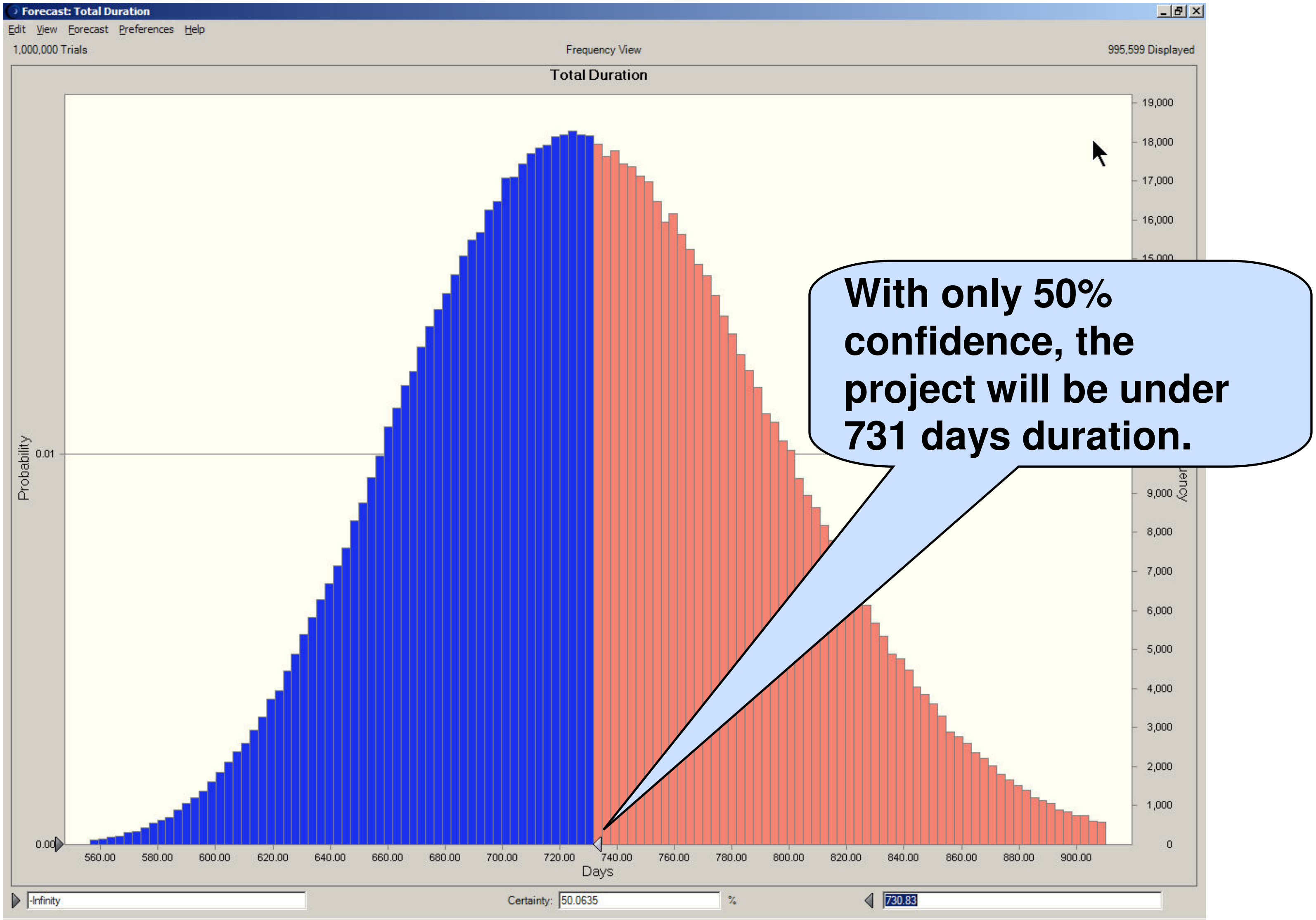
Adding Reality to Schedules-3



11) Create Predictions with Both Confidence and Prediction Intervals-1

Because the central theme of CMMI High Maturity is understanding and controlling variation, PPMs produce statistical intervals of behavior for outcomes such that individual predicted values will have an associated confidence level

All of the Process Performance models discussed provide the ability to compute both the confidence and prediction intervals of the outcomes. These intervals are defined on the next slide

Create Predictions with Both Confidence and Prediction Intervals-2

Confidence Intervals: The statistical range of behavior of a an average value computed from a sample of future data points

Prediction Intervals: The statistical range of behavior of individual future data points

Note: Prediction Intervals are almost always much wider than confidence intervals because averages don't experience the wide swings that individual data points can experience (similar to how individual grades in college compared to your grade point average)

Interactive Question #3

Based on what you now know, which analytical modeling technique do you believe would be most practical and useful in your organization?

1) Statistical regression equations
2) Monte Carlo simulation
3) Probabilistic Modeling
4) Discrete Event Simulation
5) Other

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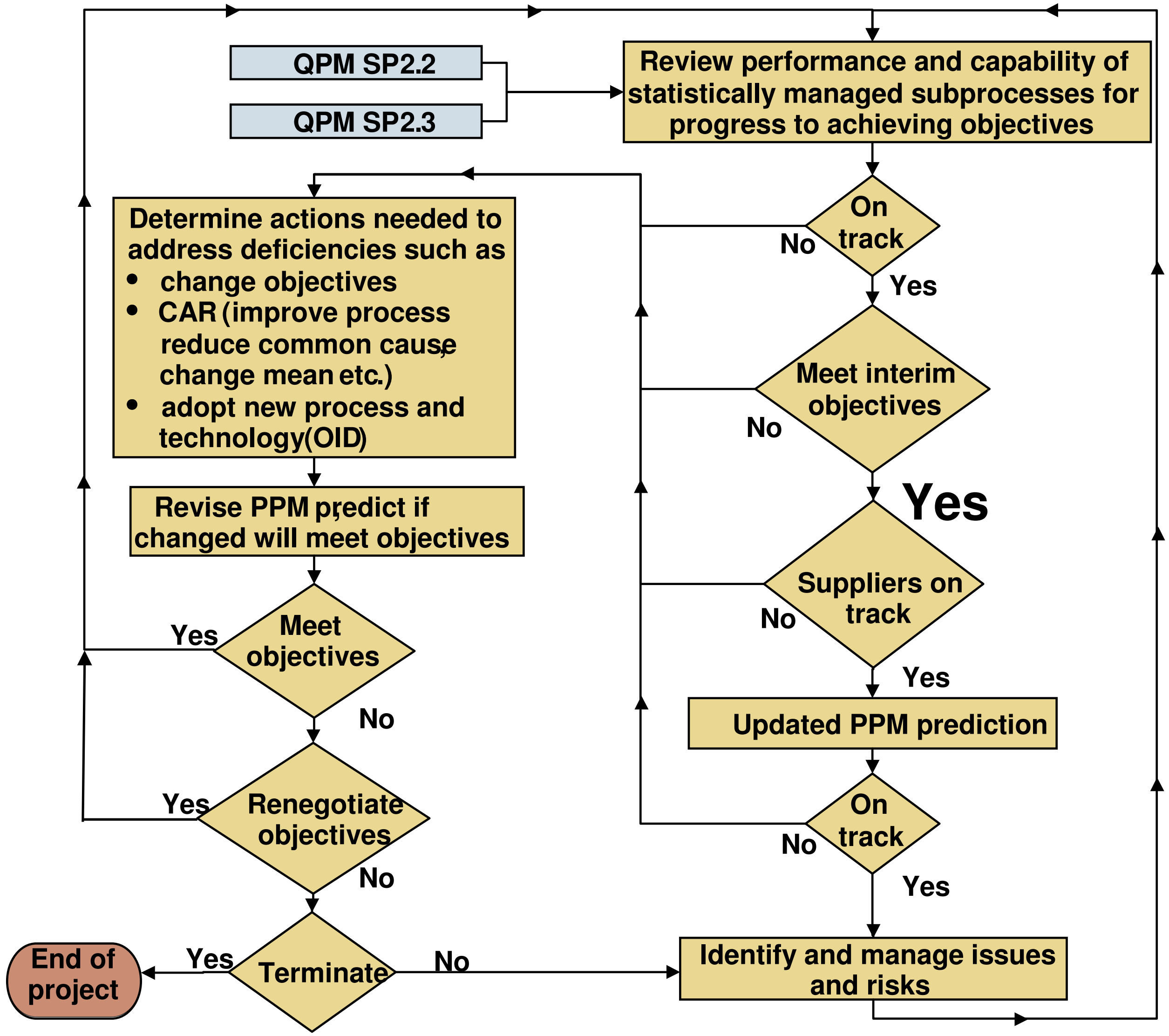
12) Statistically Manage Subprocesses w/PPMs



Note: This is not meant to be an implementation flowchart

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13) Take Action Based on Results of PPM Predictions

If a PPM model predicts an unacceptable range of values for a particular outcome, then early action can influence a more desirable range of outcome

Once a PPM model predicts a range of values for a particular outcome, then actual values can be compared to the range. If the actual values fall outside the range, it may be treated similarly to a point on a control chart falling outside of the control limits

Use PPM predictions to help inform process composition decisions so that business goals may be optimized

What is Sub-optimization and how can PPMs help?

Sub-optimization is where one parameter is optimized at the expense of other(s)

- Reduce delivered defects, but are late and over budget
- Meet the cost goal but don't deliver desired functionality

PPMs allow you to

- Gage the trade-offs amongst multiple goals
- Gage the effects of changes to multiple parameters

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14) Validating and Maintaining PPMs

Initial estimation of a PPM typically yields

- Equation or function describing the relationship between independent variables (x's) and the dependent variable (y)
- An indication of the goodness-of-fit of the model to the data (e.g., R-square, Chi-square)

These do not necessarily indicate whether the model provides sufficient practical value

- Track and compare predictions with actual results
- Failure to meet business criteria (e.g., +/- 10%) indicates need to recalibrate (i.e, same variables with different data) or remodel (new variables and data)

15) How PPMs Assist CAR

- Aid impact, benefit, and ROI predictions for
  - Selecting defects for analysis
  - Selecting action proposals for implementation
- Use PPMs to identify potential sources of the problem or defect
- Use PPMs to understand the interactions among selected improvements; and the combined predicted impacts, costs, and benefits of the improvements (considered as a set)
- Compare the result versus the original PPM-based prediction

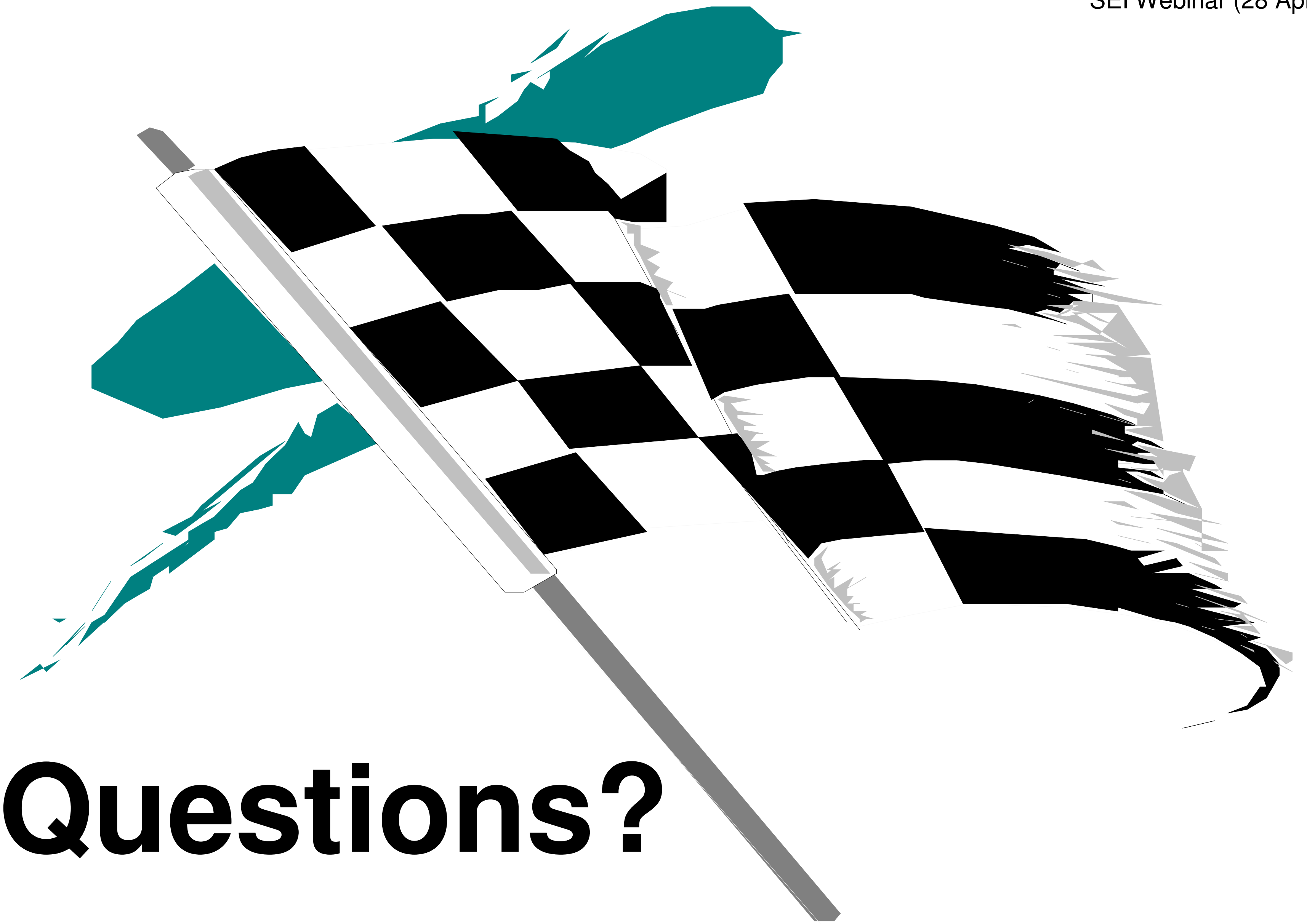
How PPMs Assist OID

- Select process improvement proposals for implementation by aiding impact, benefit, and ROI predictions
- Identify opportunities for improvement
- Use PPMs to understand the interactions among selected improvements; and the combined predicted impacts, costs, and benefits of the improvements (considered as a set)
- Prioritize improvements based on ROI, cost, risk, etc.
- Confirm the prediction (provides input to maintaining PPMs)

Interactive Question #4

Based on the information you saw in this mini-tutorial, would you be interested in attending a full day tutorial on this subject?

1) Yes
2) No



Questions?

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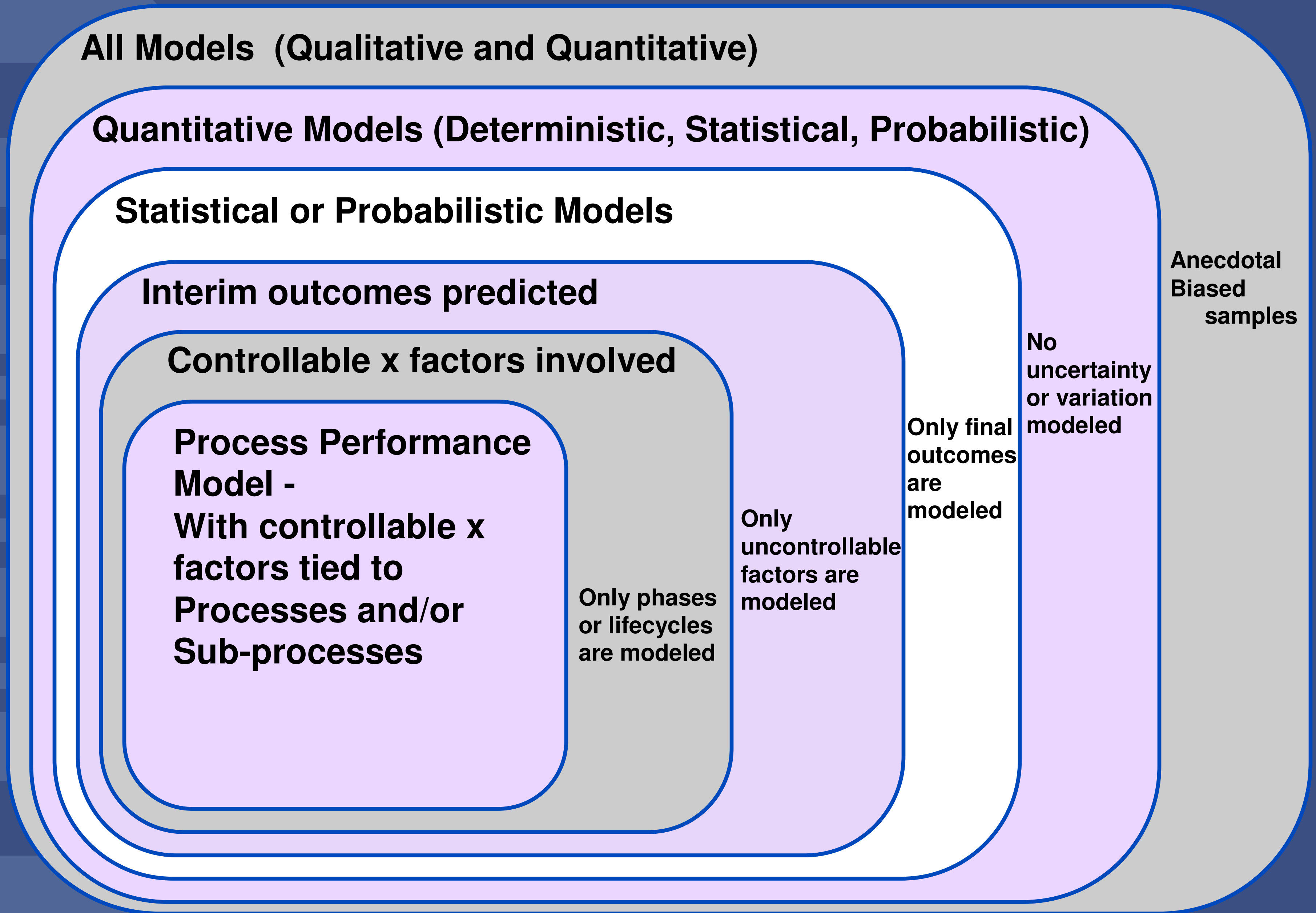
Backup Slides


All Models (Qualitative and Quantitative)
Quantitative Models (Deterministic, Statistical, Probabilistic)
Statistical or Probabilistic Models
Interim outcomes predicted
Controllable x factors involved
Process Performance Model - With controllable x factors tied to Processes and/or Sub-processes
Only phases or lifecycles are modeled
Only uncontrollable factors are modeled
Only final outcomes are modeled
No uncertainty or variation modeled
Anecdotal Biased samples

How are PPM Used? (OPP SP 1.5)

The **PPMs** are used as follows:

- The organization uses them for estimating, analyzing, and predicting the process performance associated with the processes in the organization's set of standard processes
- The organization uses them to assess the (potential) return on investment for process improvement activities
- Projects use them for estimating, analyzing, and predicting the process performance for their defined processes
- Projects use them for selecting processes or subprocesses for use

- Refer to the Quantitative Project Management process area for more information about the use of **PPMs**

How are PPMs Used? (QPM)

SP 1.4

- **PPMs** calibrated with obtained measures of critical attributes to estimate progress toward achieving the project's quality and process-performance objectives
- **PPMs** are used to estimate progress toward achieving objectives that cannot be measured until a future phase in the project lifecycle

SP 2.2

- When a subprocess is initially executed, suitable data for establishing trial natural bounds are sometimes available from prior instances of the subprocess or comparable subprocesses, process-performance baselines, or **PPMs**

How are PPMs used? (OID)

PPMs are used to quantify the impact and benefits of innovations.

SP 1.1

- **PPMs** provide insight into the effect of process changes on process capability and performance

SP 1.2

- **PPMs** can provide a basis for analyzing possible effects of changes to process elements

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Examples of Controllable People x factors

Absolute performance of a task or topic

Training

Variability of performance of a task or topic

Skills

Interruptions

Degree of Mentoring and Coaching

Traits

Degree of Multi-tasking

Staff Availability

Experience Levels

Geographic dispersion of staff

Diversity of staff

Attitudes and Outlooks

Communication Mechanisms

Various Teaming Attributes

Knowledge Sharing Mechanisms

Organizational Dynamics

Degree of Cross Training

Multi-capable staff

Nature of Leadership

Example of Controllable Environmental x Factors

Nature of work facilities

Access to breakout rooms

Proximity to team members

Access or proximity to customers

Access or proximity to suppliers

Access or proximity to management and other stakeholders

Other Visual or Audio Distractions

Degree of noise or distractions

External interferences including other organizations

Ergonomics

Temperature

Accomodations for specific needs

Available Training Rooms

Degree of Security Classification

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Example of Controllable Technology x Factors

Degree of modern development tools

Mature tools

Degree technology proven

Newness of Technology

Availability of equipment, test stations

Availability of Technology

Complexity of Technology

Documentation of Technology

Newness of Technology

Programming Language Used

Competition use of technology

Platform or Operating System Used

Technology Trends

Nature of Legacy or Reuse

Technology Roadmap

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Example of Controllable Process x Factors

Resolution time of technical inquiries

Efficiency of a work task

Compliance of a work task

Quality of a work task

Timeliness of a work task

Measures of bureaucracy

Resource contention between tasks

Difficulty of a work task

Number of people involved with a work task

Degree of Job Aids, Templates, Instructions

Choices of subprocesses

Peer Review Measures

Test Coverage Measures

Modifications to how work Tasks are performed

Quality of artifacts (Input to or Output from a work task)

Timeliness of Artifacts

Task Interdependence

Complexity of Artifacts

Readability of Artifacts

Any of the criteria for good reqts statements

Any of the criteria for good designs

Code measures (Static and Dynamic)

Example of Controllable Customer, Supplier and Other Stakeholder x Factors

"Maturity" assessment

Volatility of Staff

Early Involvement

Conflicts among Stakeholders

Health of relationship

Degree of Documentation of Expectations

Degree of communication

Image and Perceptions

Speed of feedback loops

Complexity of relationship such as simultaneously a competitor and partner and supplier

Trust

Longevity of relationship

Degree of oversight

Style

Degree of partnership, collaboration

Bias on Quality vs Schedule

Geographic location

Culture

Domain Experience

Language

Degree of access and participation

Tradeoffs, Compromises, Optimization

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Criteria for Evaluation: Measurement Planning Criteria$_1$

Measurement Objectives and Alignment

- business and project objectives
- prioritized information needs and how they link to the business, organizational, regulatory, product and/or project objectives
- necessary organizational and/or software process changes to implement the measurement plan
- criteria for the evaluation of the measurement process and quality assurance activities
- schedule and responsibilities for the implementation of measurement plan including pilots and organizational unit wide implementation

Adapted from ISO 15939.

Measurement Planning Criteria$_2$

Measurement Process

- Definition of the measures and how they relate to the information needs
- Responsibility for data collection and sources of data
- Schedule for data collection (e.g., at the end of each inspection, monthly)
- Tools and procedures for data collection
- Data storage
- Requirements for data validation and verification procedures
- Confidentiality constraints on the data and information products, and actions/precautions necessary to ensure confidentiality
- Procedures for configuration management of data, measurement experience base, and data definitions
- Data analysis plan including frequency of analysis and reporting

Adapted from ISO 15939.

Criteria for Evaluation: Measurement Processes and Procedures

Measurement Process Evaluation

- Availability and accessibility of the measurement process and related procedures
- Defined responsibility for performance
- Expected outputs
- Interfaces to other processes
  - Data collection may be integrated into other processes
- Are resources for implementation provided and appropriate
- Is training and help available?
- Is the plan synchronized with the project plan or other organizational plans?

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Criteria for Evaluation: Data Definitions

Completeness of definitions

- Lack of ambiguity
- Clear definition of the entity and attribute to be measures
- Definition of the context under which the data are to be collected

Understanding of definitions among practitioners and managers

Validity of operationalized measures as compared to conceptualized measure (e.g., size as SLOC vs. FP)

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Criteria for Evaluation: Data Collection

Is implementation of data collection consistent with definitions?

Reliability of data collection (actual behavior of collectors)

Reliability of instrumentation (manual/automated)

Training in data collection methods

Ease/cost of collecting data

<u>Storage</u>

- Raw or summarized
- Period of retention
- Ease of retrieval

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Criteria for Evaluation: Data

Quality

- Data integrity and consistency
- Amount of missing data
  - Performance variables
  - Contextual variables
- Accuracy and validity of collected data
- Timeliness of collected data
- Precision and reliability (repeatability and reproducibility) of collected data
- Are values traceable to their source (meta data collected)

Audits of Collected Data

Criteria for Evaluation: Data Analysis

Data used for analysis vs. data collected but not used

Appropriateness of analytical techniques used

- For data type
- For hypothesis or model

Analyses performed vs. reporting requirements

Data checks performed

Assumptions made explicit

Identifying Outliers

Interquartile range description – A quantitative method for identifying possible outliers in a data set

Procedure

- Determine 1st and 3rd quartiles of data set: Q1, Q3
- Calculate the difference: interquartile range or IQR which equals Q3 minus Q1
- Lower outlier boundary = Q1 – 1.5*IQR
- Upper outlier boundary = Q3 + 1.5*IQR

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Interquartile Range: Example

2

Interquartile Range
30 – 16 = 14

1

333
50
40
Q3 → 30
27
25
22
20
18
Q1 → 16
16
13

4

Upper outlier boundary
30 + 1.5*14 = 51

3

Lower outlier boundary
16 – 1.5*14 = -5

Procedure

1. **Determine 1st and 3rd quartiles of data set: Q1, Q3**
2. **Calculate the difference: interquartile range or IQR**
3. **Lower outlier boundary = Q1 – 1.5*IQR**
4. **Upper outlier boundary = Q3 + 1.5*IQR**

Tips About Outliers

Outliers can be a clue to process understanding

If outliers lead you to measurement system problems,

- repair the erroneous data if possible
- if it cannot be repaired, delete it

Charts that are particularly effective to flag possible outliers include: box plots, distributions, scatter plots, and control charts

Rescale charts when an outlier reduces visibility into variation.

Be wary of influence of outliers on linear relationships

Modeling and Outliers

Even if outliers are valid they can distort “typical” relationships

So you might

- delete the observations
- recode outliers to be more in line with the expected distribution
- for more information, research robust techniques

In any case, do so with caution

Run your models using different techniques to see if they converge

Programmatic Aspects of Building PPMs

Topics

- Review of CMMI Process Performance Models (PPMs)
- Technical Process of Building PPMs
- Programmatic Aspects of Building PPMs
    - Skills needed to develop PPMs
    - Forming the PPM Development Team
    - Up front Critical Thinking Needed
    - Barriers to Building PPMs
    - Documentation needed when building PPMs
    - Evidence from the building and usage of PPMs that may help SCAMPI teams
- Questions

Skills Needed to Develop PPMs

- Business Acumen
- Product Expertise
- Process Expertise
- Understanding of Measurement and AnalysisTechniques
- Understanding of Advanced Statistical Techniques
- Understanding of Quantitative Management

Forming the PPM Development Team

Statistical Skills

- PPM builder needs a good understanding of statistics or Six Sigma Black Belt skill level or better
- PPM builder needs to be an expert user of the selected statistical tools
- User of PPMs needs to be an educated consumer

Process knowledge

- Build team needs to understand the process
- Build team needs to understand the context in which the PPMs will be used

Forming the PPM Development Team
Statistical and Modeling Techniques

Basic statistical methods

- Using basic statistics to predict outcomes
- ANOVA; regression; multiple regression; chi-square; logistic regression;
- Hypothesis testing
- Design of experiments;

Monte Carlo simulation and optimization

- Using automated “what-if” analysis of uncertain factors and decisions in a spreadsheet

Process simulation

- Modeling process activities with a computer
- Discrete event process simulation

Probabilistic networks

- Using the laws of probability instead of statistics to predict outcomes

Topics

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Considerations for Developing Models - 1

Think Process – what are the x's and y's

Be sensitive to scope of application – what works in one setting may not work in another

Formulate and Compare Competing/Alternative Models

Beyond prediction, what else might the model imply for improvement or risk

Considerations for Developing Models - 2

Three Criteria for Evaluating Models

- Truth : correctly explains and predicts behavior
- Beauty : simple in terms of underlying assumptions and number of variables, and more broadly applicable
- Justice : implications for action lead to "a better world"

Topics

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Barriers to Building PPMs

Lack of compelling outcomes to predict due to misalignment with critical business goals, usually caused by insufficient management sponsorship and involvement

Lack of a connection to a work process or sub-process such that direct changes in that process or sub-process can help cause changes in predicted outcomes

Insufficient process and domain knowledge which is necessary to identify the probable x factors to predict the outcome

Insufficient training and practice with modeling techniques

Documentation Needed when Building PPMs-1

Similar to the existing SEI Indicator Template but with some additional information content:

1. Identity of associated processes and subprocesses
2. Identity of the outcome measure (y) and the x factors
3. Data type of all outcome (y) and x factors
4. Statistical evidence that the x factors are significant (e.g. p values of individual x factors)
5. Statistical evidence of the strength of the model (e.g. the adjusted R-squared value)
6. The actual prediction equation for the outcome (y)
7. The performance baselines of the x factors

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Documentation Needed when Building PPMs-2

Similar to the existing SEI Indicator Template but with some additional information content (continued):

8. The resulting confidence interval of the predicted outcome
9. The resulting prediction interval of the predicted outcome
10. Use case scenarios of how the PPM is intended to be used by different audiences for specific decisions
11. Description of how often the PPM is updated, validated, and calibrated
12. Description of how often the PPM is used to make predictions with results shown to decision-makers
13. Description of which organizational segment of projects the PPM applies to

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Topics

- Review of CMMI Process Performance Models (PPMs)
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  - Skills needed to develop PPMs
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- Questions

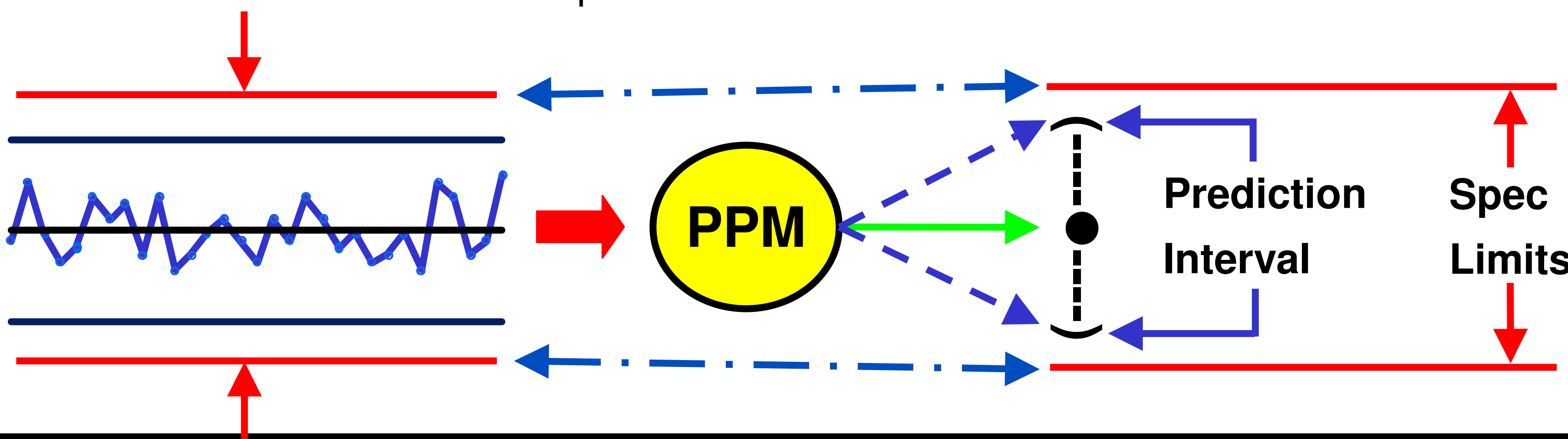
Its not the Data/Chart, it is How it is Used

A wall full of control charts does not make a Level 4

- Who is using them for management
- How are they using them
- How timely is the use
  - Retrospective vs. real-time
  - As the events occur vs. end-of-phase

Using natural bounds

- Natural bounds vs. trial bounds
- Natural bounds vs. specification limits



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Evidence for Establish

Statistical analysis leading to which controllable and uncontrollable factors are selected

- ANOVA or any of the other basic statistical methods discussed
- Monte Carlo/Discrete Event simulation calibration vs past performance (back testing)
- Hypothesis tests
- p values, R-squared, etc.

Flags

- Apparent p value chasing
- Inordinately high R-squared

Awareness

- When unstable data used
- Source of data

Evidence for Maintain

Similar to establish, but analyzing changes to recalibrate models

Rules for when models are recalibrated

- Process changes
- Process drift
- New platforms, domains, etc.
- Voice of the Customer
- Changing business needs

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Evidence for Usage

Composing projects defined process

Usage during routine project management to gauge process behavior

Usage for evaluating alternative solutions when process/project performance inadequate to meet goals/objectives

Usage within CAR/OID to evaluate proposal, search for opportunities/causes

Usage to check if predicted performance is being achieved and if not, why

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