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Customer Success Is Our Mission

Goal Question Model

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NDIA CMMI® Technology Conference and User Group

November 17, 2009

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Agenda

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- Process Performance Models
- Goal Question Metric Approach
- Goal Question Model
- Raytheon IDS Example: SLAM
- Summary
- References

"All models are wrong but some are useful."

George E.P. Box

Overview

- Process Performance Models are an expected component of CMMI® high maturity
  - OPP SP 1.5: Establish and maintain the process-performance models for the organization's set of standard processes. [1]
- The concepts of process performance models are often misunderstood
  - What is and what is not a model?
  - How are models developed?
  - When are models used?
- Adapting the traditional Goal Question Metric (GQM) approach to Goal Question Model can lead to the development of effective, value-added process performance models in an organization.
- Example from Raytheon Integrated Defense Systems (IDS)

Process Performance Models

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- Process Performance Model Definition from CMMI
  - A description of the relationships among attributes of a process and its work products that are developed from historical process-performance data and calibrated using collected process and product measures from the project and that are used to predict results to be achieved by following a process. [1]
- CMMI V1.2 Maturity Level 4 and 5 appraisals are expected to show evidence of using process performance models
  - During project planning/tailoring to compose the project's defined process
  - Throughout project lifecycle to determine if project will achieve its quality and process performance objectives
  - May be used to support Organizational Innovation and Deployment (OID) and Causal Analysis and Resolution (CAR) activities

Process Performance Models
(continued)

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- Healthy Ingredients of CMMI Process Performance Models [2]
  - 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

Goal Question Metric Approach

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- Developed by Dr. Victor Basili working with NASA [3]
  - Develop a set of business goals and associated measurement goals
  - Generate questions that define those goals quantitatively
  - Specify metrics to be collected to answer those questions

- Key is the trace from business goal to metric
  - Focus on what is most meaningful to the business

- Example:
  - Goal: Improve the timeliness of change request processing from the project manager's viewpoint
  - Question: what is the current change request processing speed?
  - Metrics: Average cycle time, standard deviation, % cases outside of the upper limit
  - Question: Is the performance improving?
  - Metric: (current average cycle time/Baseline average cycle time) * 100

Goal Question Model Approach

- Goal
  - Business goals
    - Often not quantitative in nature
    - Example: Improve customer satisfaction
  - Quality and process performance objectives
    - Quantitative characterizations decomposed (if necessary) from business goals[4]
    - Often relate to cost, schedule, quality, technical performance
    - Example: Reduce defects in work products delivered to customer by 10% (without additional cost to customer).
- Questions
  - What factors influence the achievement of the goal?
    - Example: defect detection capability during development and test
  - What controllable sub-processes relate to those factors?
    - Example: peer reviews, test development and execution

Goal Question Model Approach

(continued)

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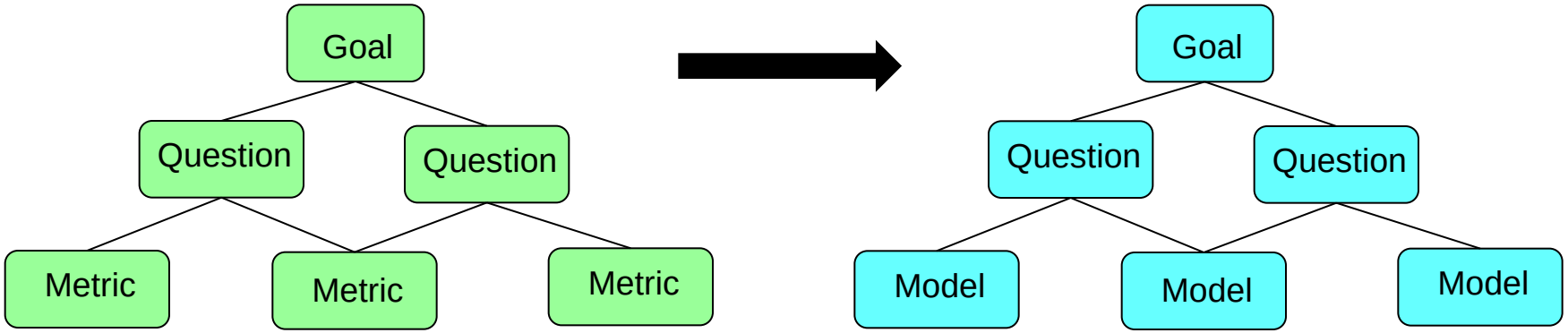
- Model
  - Identify associated measures
    - Example: defect containment, peer review measures (preparation, conduct, size, etc.), tools usage (code static analyzers, simulations)
  - Collect data
  - Analyze data for statistical correlations
  - Develop a model relating factors to results



Now Models are connected to business goals.

Raytheon IDS Example: SLAM*

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- Goal: Raytheon Integrated Defense Systems (IDS) has business / project cost and schedule performance goals of CPI, SPI
- Question: What are the factors influencing IDS projects' ability to meet these goals?
  - Aggressive program schedules have increased the overlap between life cycle phases
    - Design begins at risk before requirements are complete
  - Requirements Volatility
    - Changing requirements causes rework for software and hardware development
  - *Projects have been unable to quantify the risks associated with these factors.*
- Question: What controllable sub-processes relate to those factors?
  - Requirements management, requirements development, technical solution

* Patent pending

Raytheon IDS Example: SLAM
(continued)

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- Model
  - Identify associated measures
    - CPI, SPI and Requirements Volatility are required measurements collected and reported by every development project across Raytheon Company.
    - Requirements/design overlap
      - A non-standard project measurement collected and analyzed during the SLAM development piloting & deployment.
      - SLAM piloting effort worked closely with a cross-section sampling of our IDS development projects in defining an objective measurement that is easily collected and readily available.
      - Up-front collection defining dialogue with SLAM pilot project teams provided highly valuable analytical and deployment insight.

Raytheon IDS Example: SLAM

(continued)

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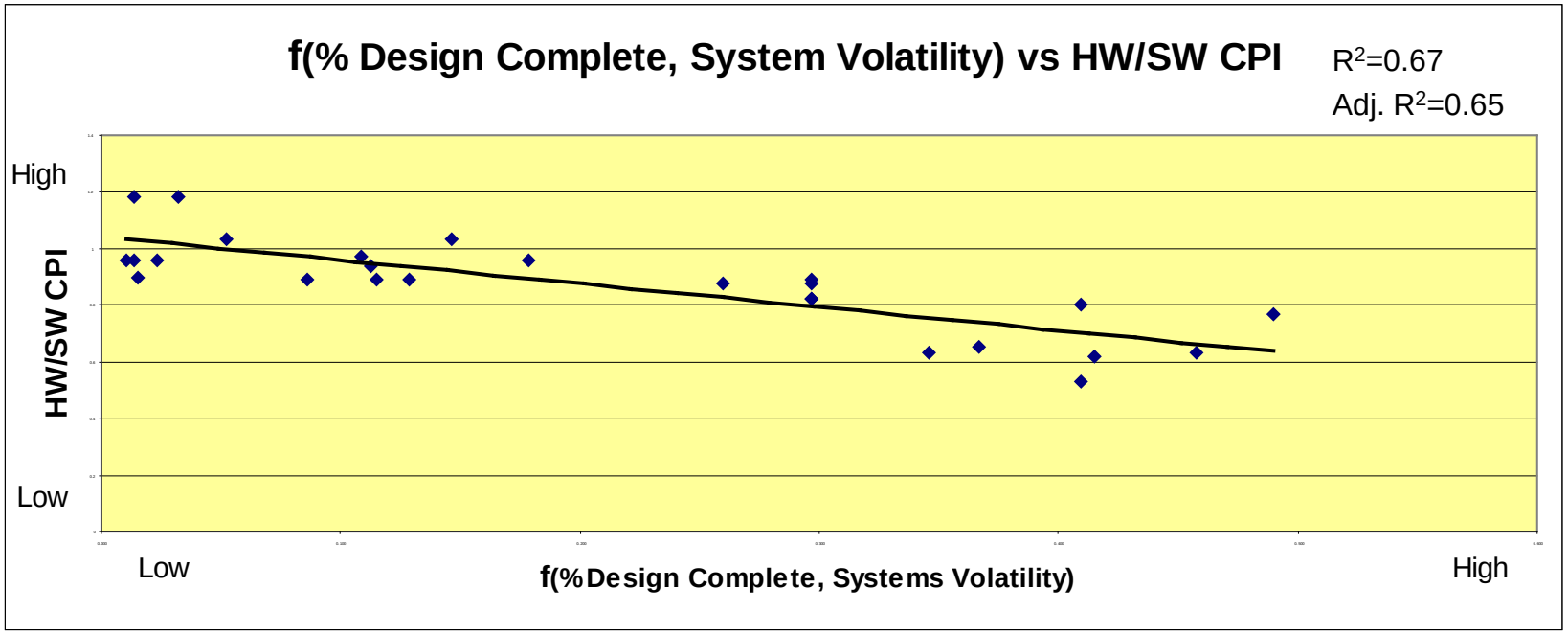
- Model (continued)
  - Collect and analyze data
    - A mathematical function of the input factors was reasonably well correlated with the output responses using linear regression techniques (with an adjusted r-squared value = 0.65, p= .000). Additionally collected project data from SLAM piloting and deployment further confirmed the strength of this underlying statistical relationship.



Raytheon IDS Example: SLAM
(continued)

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- Model (continued)
  - Crystal Ball was selected as the statistical modeling tool of choice both because of its availability to all (Raytheon has a Corporate license) and because of its general ease of use for project teams.
  - Using the correlated regression equation and estimates of mean and variance for each of the factors (from the collected data), a Monte Carlo simulation model was developed with an Excel-based User interface.
  - The SLAM Model User Interface also includes:
    - Crystal Ball download instructions
    - Step-by-Step Guidance for Projects on “Running SLAM”
    - Guidance on how “Interpreting the Results”
    - A Listing of Potential Mitigation Strategies

Raytheon IDS Example: SLAM
(continued)

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- Model (continued)
  - SLAM Model Inputs
    - Estimated % Design Complete at Requirements Release
      - Confidence Range (+/- 5, 10, or 15%)
    - Requirements Volatility Estimate
      - Enter in best estimate based on historical baseline for product line, process tailoring, etc.
      - Variance estimates built into model based on historical actuals
  - SLAM Model Output
    - Projected Software / Hardware Cost Performance (CPI)
      - Mean, Standard Deviation
      - 95% Upper & Lower Prediction Interval Limits

Raytheon IDS Example: SLAM (Example 1)

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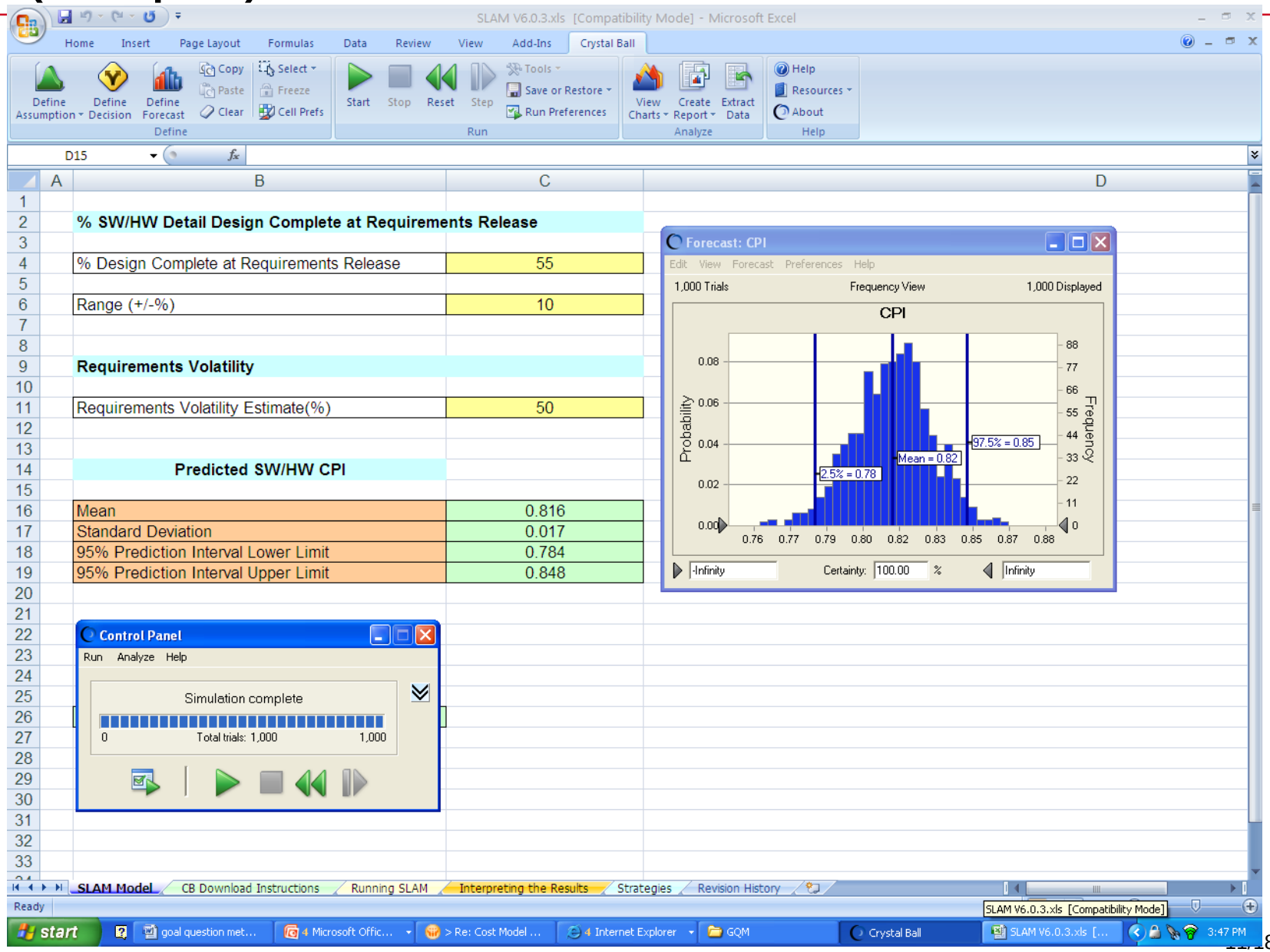

Raytheon IDS Example: SLAM (Example 2)

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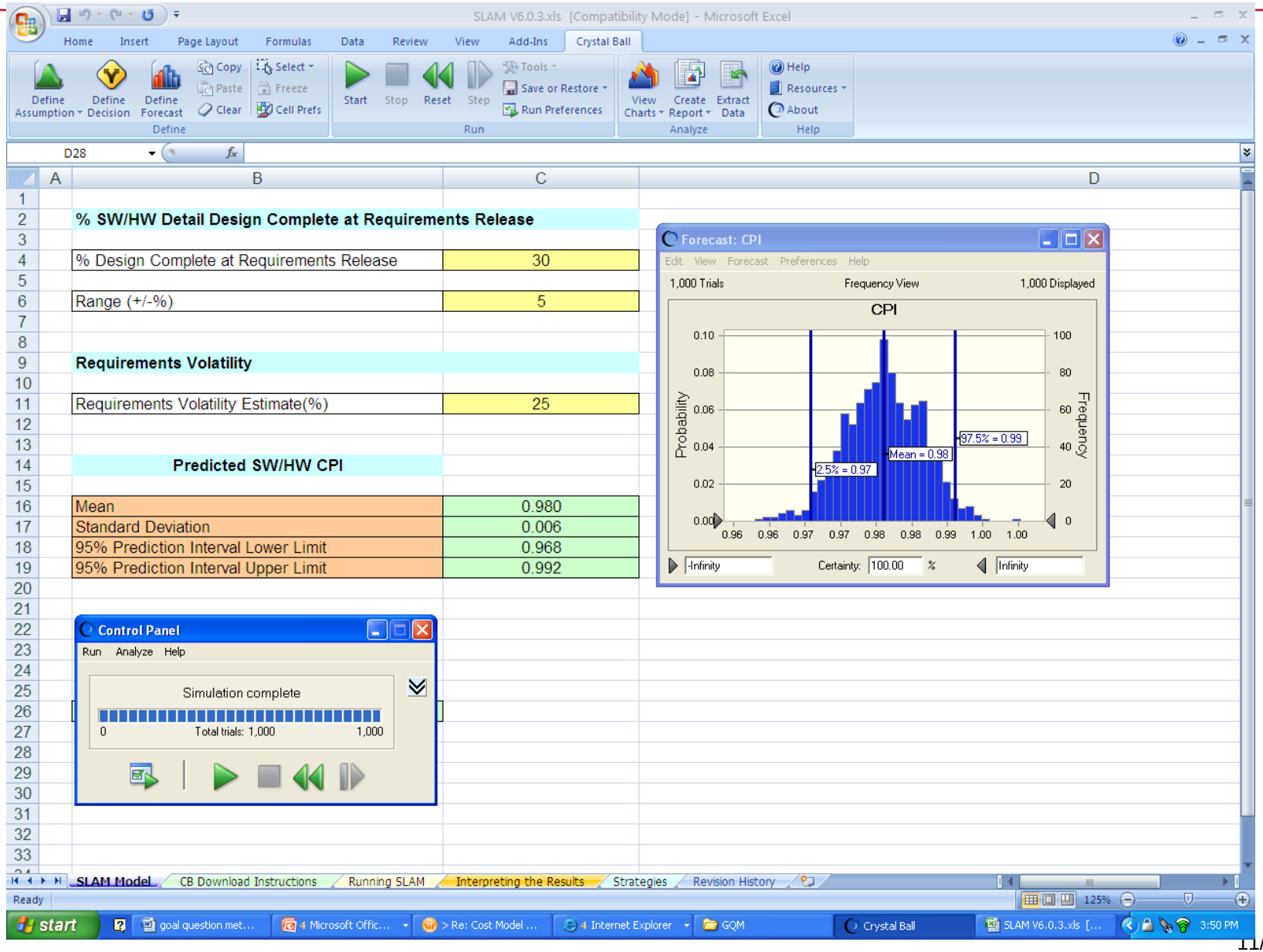

Raytheon IDS Example: SLAM
(continued)

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- The System Lifecycle Analysis Model (SLAM) was developed and deployed at Raytheon Integrated Defense Systems in order to quantitatively assess the cost performance risk associated with requirements volatility and requirements / design lifecycle overlap.
- SLAM has been used to identify risks during early planning as part of proposal activity
- SLAM is used by integrated project teams made up of Systems, Software, Hardware and Quality Engineering during project planning and execution
  - Quantifies risk
  - Enables composition of project's defined process
  - Manages against quality and process performance objectives
- The Engineering Process Group has used SLAM to estimate benefits of process improvement proposals and to measure changes in performance due to process improvements.

IDS Process Performance Modeling Lessons Learned

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- SLAM was built to aid IDS programs in their ability to achieve objectives. The users of the model felt it recognized their issues, validated their program concerns, and would help them support resolution of these issues.
- Keeping the model simple and fast to use was seen as a plus by users. No training beyond a short demo was required.
- Reviewing data with project people revealed insights that led model to be developed in a different manner than planned and contributed to buy-in from users. The iteration back to the data providers was invaluable to the developers.
- Demonstrating the model with Engineering managment helped them understand the tool, provided commitment to pilot and deploy.
- Let the data lead you to a solution. Original SLAM concept was different than what was actually created.
- Start small, get buy-in, and build from there. Expectation is for SLAM to expand with more granularity across the lifecycle.

Summary

- The Goal Question Metric approach emphasizes defining measurements in a top down fashion
  - Measure what is most meaningful to the business or a project
  - This is consistent with the CMMI expectations
    - Measurement objectives are derived from information needs (MA)
    - Establish quality and process performance objectives (OPP, QPM)
- Using the same top down approach with process performance modeling produces value-added, effective results
  - Model what is most meaningful to the business or project focuses resources where the value is greatest
  - Leads to acceptance and use of the models at various levels of the organization
  - Helps the business or project achieve its objectives

Questions

References

1. CMMI® Models and Reports, http://www.sei.cmu.edu/cmmi/models/
2. Zubrow, Schaff, Stoddard, Young, *"A Practical Approach for Building Process Performance Models"*, SEPG North America 2009.
3. Basili, Victor R.; Caldiera, Gianluigi; Rombach, H. Dieter, *"The Goal Question Metric Approach",* 1994, http://wwwagse.informatik.uni-kl.de/pubs/repository/basili94b/encyclo.gqm.pdf
4. Stoddard, Robert; Goethert, Wolf, *"Guidance on Business and Project Goal Formulation in CMMI High Maturity Settings*", SEPG North America 2009.

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