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The ROI of CMMI: Using Process Simulation to Support Better Management Decisions

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Acknowledgements

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Introductions and Logistics

Introductions

Workshop leader introductions

Participant introductions

- Name
- Position
- Expectations
  - What do you want to get out of the workshop?
  - Do your expectations match the workshop agenda?

Logistics

Workshop time/duration

Rest Rooms

Breaks

Smoking Rules

Phones

Messages

Workshop Approach

Lecture/presentation

Examples

Ask questions

Participate!!!

Audience

- Executive/leaders of organizations seeking to understand
  - The costs/benefits of CMMI-based process improvement
  - How to quantify them
  - How simulation can help them achieve higher CMMI levels
- Executives/leaders seeking to benchmark their processes and performance with industry
- Process improvement/EPG personnel seeking ways to communicate more effectively to senior management about the costs/benefits of CMMI-based process improvement
- Personnel seeking to transition to the CMMI, or implement higher-maturity process areas
- Personnel working to define process and estimate performance based upon quantitative measurements.

Overview

Process simulation is a high leverage way to determine which process improvement opportunities are likely to have the best outcome

Goals of the tutorial:

- Familiarize participants with Process Simulation – What, Why, How
- Show participants how to utilize simulation ***results*** to support process improvement decisions

This tutorial will focus on one simulation method – the Process Tradeoff Analysis Method (PTAM) and will briefly touch on others

Overview

The tutorial is not intended to be comprehensive, some topics are presented at a high-level only

No knowledge of simulation or finance is assumed

Agenda

1. Introduction: What is Process Simulation?
2. Motivation: Why do Process Simulation?
3. Overview of Process Simulation Alternatives
4. How do we build process simulation models?
5. Process Tradeoff Analysis Method (PTAM)
6. Examples of Process Simulation Applications in Industry and Government.
7. Wrap-Up/ Conclusions

1 – Introduction: What is Process Simulation?

What Is a Simulation Model?

- A simulation model is a computerized model (*not a maturity model*) designed to display significant features of the dynamic system it represents.
- Simulations are generally employed when
  - behavior over time is of particular interest or significance, and
  - the economics or logistics of manipulating the system being modeled are prohibitive
- Common purposes of simulation models are:
  - to provide a basis for experimentation,
  - to predict behavior,
  - to answer “what if” questions,
  - to teach about the system being modeled.

Process Simulation Models

- Process simulation models focus on the dynamics of software and ***systems*** development, maintenance and acquisition.
- They represent the process
  - as currently implemented (as-is, as-practiced, as-documented), or
  - as planned for future implementation (to-be)
- The models represent only selected *relevant* aspects of a *defined* process.

Simulation Features

- Use Graphical interfaces
- Utilizes actual data/ metrics
- Predict performance
- Supports “What if” Analyses
- Support business case analyses
- Reduces risk

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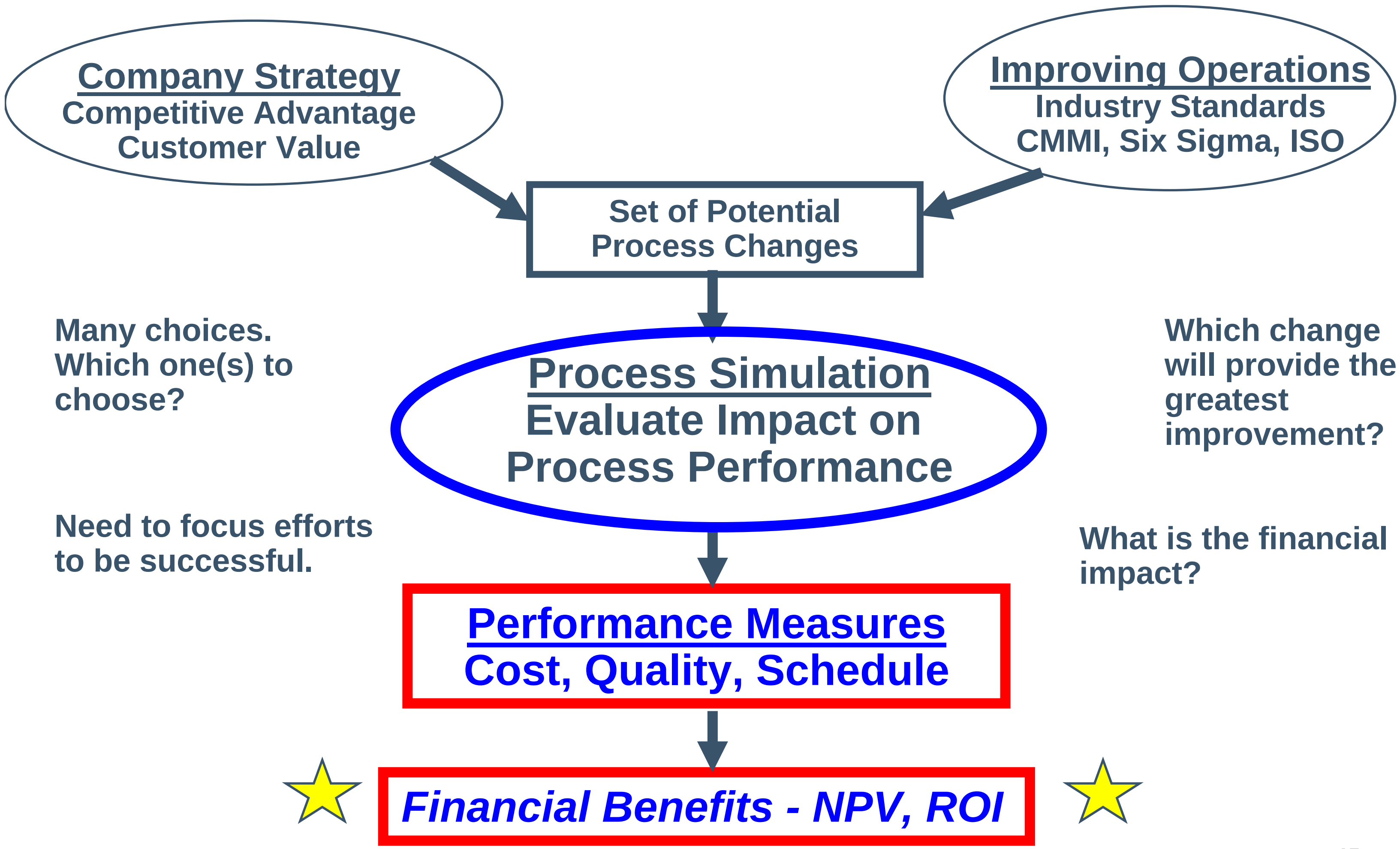


2 – Motivation: Why Do Process Simulation?

Benefits of Process Simulation

	Option	Project									NPV	ROI
		Total Effort (PM) Dev Eff + Dev Rwk	Rework Effort Devel Defects (PM)	Project Duration *(Calendar Months)*	Projected Cost or Revenue delta due to Duration Change	Total Injected Defects	Corrected Defects	Escapted Defects	Rework Effort for Field Defects *(PM)*	Implementation Costs ($)		
0	Base Case	200	90	18	$0.00	1150	990	160	40	$0.00	n.a.	n.a.
1	Implement QFD	190	75	17.5	$0.00	1150	1020	130	30	$100,000	$165,145	15%
2	Implement VOC	185	75	17	$ 100,000	1150	1050	100	20	$120,000	$185,231	29%
3	Add QuARS Tool	175	65	16	$ 300,000	1150	1090	60	10	$ 80,000	$289,674	88%
4	Eliminate	230	130	22	$(400,000)	1150	900	250	80	$0.00	-$378,043	-129%
5	Additional Process											

Benefits of Process Simulation

- Decision Support and Tradeoff Analysis
- Sensitivity Analysis – “What if”
- Supports Industry Certification and process improvement programs including CMMI, Six Sigma, and others
- Benchmarking
- Design and Define Processes/Metrics
- Bring Lessons Learned Repositories Alive
- Can save cost, effort, and expertise
- Can be used to address project manager concerns such as….

Software Project Manager Concerns

- What development phases are essential?
- Which phases could be skipped or minimized to shorten cycle time and reduce costs without sacrificing quality?
- Are inspections worthwhile?
- What is the value of applying automated tools to support development activities?
- How do we predict the benefit associated with implementing a process change?
- How do we prioritize process changes?
- How to achieve higher levels of the CMMI?
- What is the level of Risk associated with a change?

3 – Overview of Alternative Process Simulation Approaches

Alternative Process Simulation Approaches

Modeling Paradigms
- Knowledge-Based Systems
- Agent Based
- State-Based
- Discrete Event
- System Dynamics
- Hybrid

Research Outlets
- Software Process: Improvement and Practice
- Journal of Systems and Software

- Tools
  - Arena
  - ProModel
  - Extend
  - Stella
  - VenSim
  - Research tools
- Conferences
  - Winter Simulation Conference
  - ProSim
  - SEPG
  - SSTC

Alternative Process Simulation Approaches

Knowledge Based Systems

- Person-in-the loop
- Fine level of granularity
- Supports process enactment

Agent Based Systems

- Fine level of granularity
- Supports detailed work interactions

State Based Systems

- Captures flow of control (work activities, parallelism) well
- Multi-view graphical representations
- Difficult to capture task, work package and resource details

Alternative Process Simulation Approaches

Discrete Event Simulation

- Able to represent richness of processes, work packages and resources
- Good for modeling quantitative process performance
- Good tool support

System Dynamics

- Captures feedback well
- Often used for high level qualitative issues

Hybrid

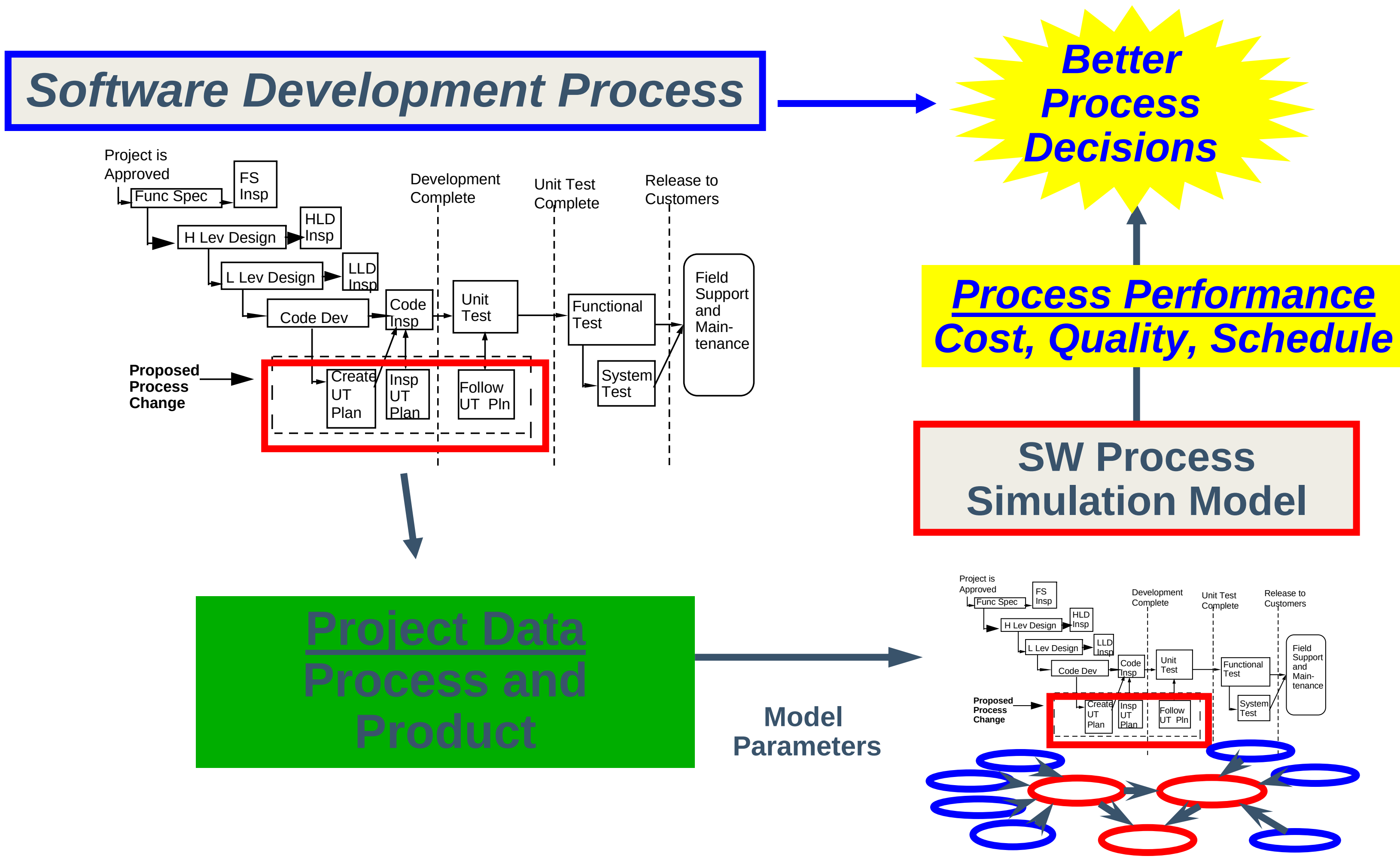
- Captures best aspects of Discrete Event and System Dynamics
- Models are complex
- Being used to predict performance of multi-site development

Common Applications of Each Approach

	STRAT	PLAN	MGMT	IMPR	UNDR	TRAIN
KBS					X	X
Agent Based					X	X
State-Based		X		X	X	X
Discrete Event	x	X	X	X	X	X
System Dynamic	X	x		x	X	X
Hybrid	X	X	X	X	X	X

4 –How to Build Process Simulation Models

How it works


Software Development Process
Better Process Decisions
Project is Approved
Func Spec
FS Insp
H Lev Design
HLD Insp
L Lev Design
LLD Insp
Code Dev
Code Insp
Development Complete
Unit Test
Unit Test Complete
Functional Test
System Test
Release to Customers
Field Support and Main-tenance
Proposed Process Change
Create UT Plan
Insp UT Plan
Follow UT Pln
Process Performance
Cost, Quality, Schedule
SW Process Simulation Model
Project Data Process and Product
Model Parameters

Process Tradeoff Analysis Method (PTAM)

- **Based on extensive research** into Software Process Modeling conducted in academia, SEI and industry.
- **Graphical user interface** and models software processes
- **Integrates SEI methods** to define processes and supports CMMI PAs
- **Integrates metrics** related to cost, quality, and schedule into understandable project performance picture.
- **Predicts project-level impacts** of process improvements in terms of cost, quality and cycle time
- **Support business case analysis** of process decisions - ROI, NPV and quantitatively assessing risk.

Process Tradeoff Analysis Method (PTAM)

- **Reduces risk** associated with process changes by predicting the probability of improvement
- **Saves time, effort and expertise** over other methods

5 – The Process Tradeoff Analysis Method (PTAM)

Process Tradeoff Analysis (PTA) Method

Company Strategy
Competitive Advantage
Customer Value

Improving Operations
Industry Standards
CMM, ISO 9000

Set of Potential
Process Changes

Many choices.
Which one(s) to choose?

Process Simulation
Evaluate Impact on
Process Performance

Which change will provide the greatest improvement?

Need to focus efforts to be successful.

What is the financial impact?

Performance Measures
Cost, Quality, Schedule

Financial Benefits - NPV, ROI

Overview of PTAM

Set-up Phase

- Set the Goal of the Modeling Effort
- Specify Questions for the Model to Address
- Define Process Performance Measures
- Identify Input Parameters

Gather Information

Modeling Phase

Analysis Phase

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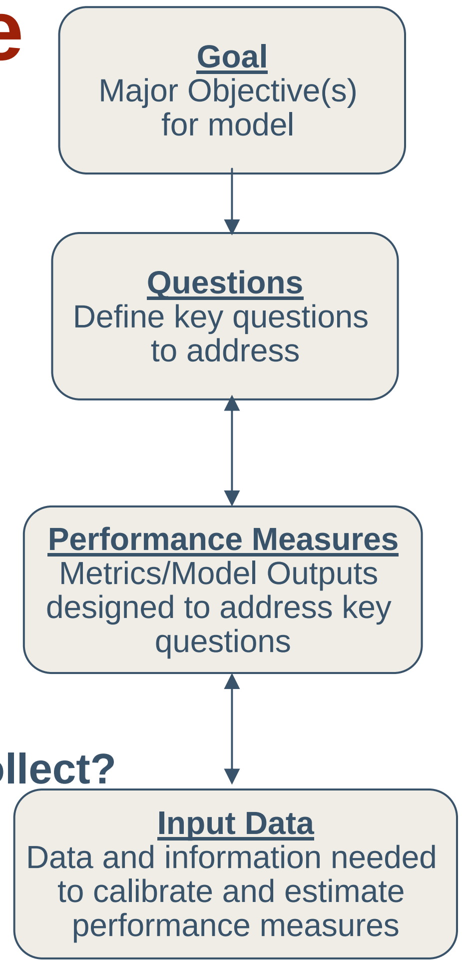
Set-up Phase

What decision(s) am I trying to make?

What questions does management have?

What do I need to know to answer the questions?

What information should we collect?



Overview of PTAM

- Set-up Phase
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- Gather Information
- Modeling Phase
- Analysis Phase

Why Simulate?

- There are a variety of reasons / purposes for undertaking process simulation.

- CMMI-Based Process Improvement
    - Strategic management
    - Planning
    - Control and operational management
    - Technology adoption
    - Understanding
    - Training and learning

CMMI Based Process Improvement

CMMI Levels 4 and 5

- Process simulation helps to fulfill PAs (OID, CAR, OPP and QPM - Sub Goals and Generic Goals)

CMMI Levels 2 and 3

- Process simulation can be used to evaluate alternative process choices (RD, TS, PI, V&V, RM, SAM, PPQA, and CM)

- Process simulation helps to fulfill PAs (OPF, OPD, OT, IPM, Risk, DAR, PP, PMA, MA, PPQA – Multiple Sub Goals and Generic Goals)

Case Study: Organizational Setting

- Leading software development firm
- Peak staffing of 60 developers on project
- Assessed at strong Level 2 of CMM/CMMI
- Experienced development staff
- 5th release of commercial project
- Data available in electronic and paper form: quantitative and qualitative; professional estimates used to fill in gaps
- Active SEPG

Case Study: Validation and Verification

- **Problem: Releasing defective products, had high schedule variance.**
- Why? Unit Test was main defect removal stage. They did it unreliably.
- Built a model of Large-Scale commercial development process
- Based on actual project data
- Predicted project performance in terms of effort, task duration and delivered defects.
- Part of a full business case analysis - determined financial performance of the process change

Process Overview - 1

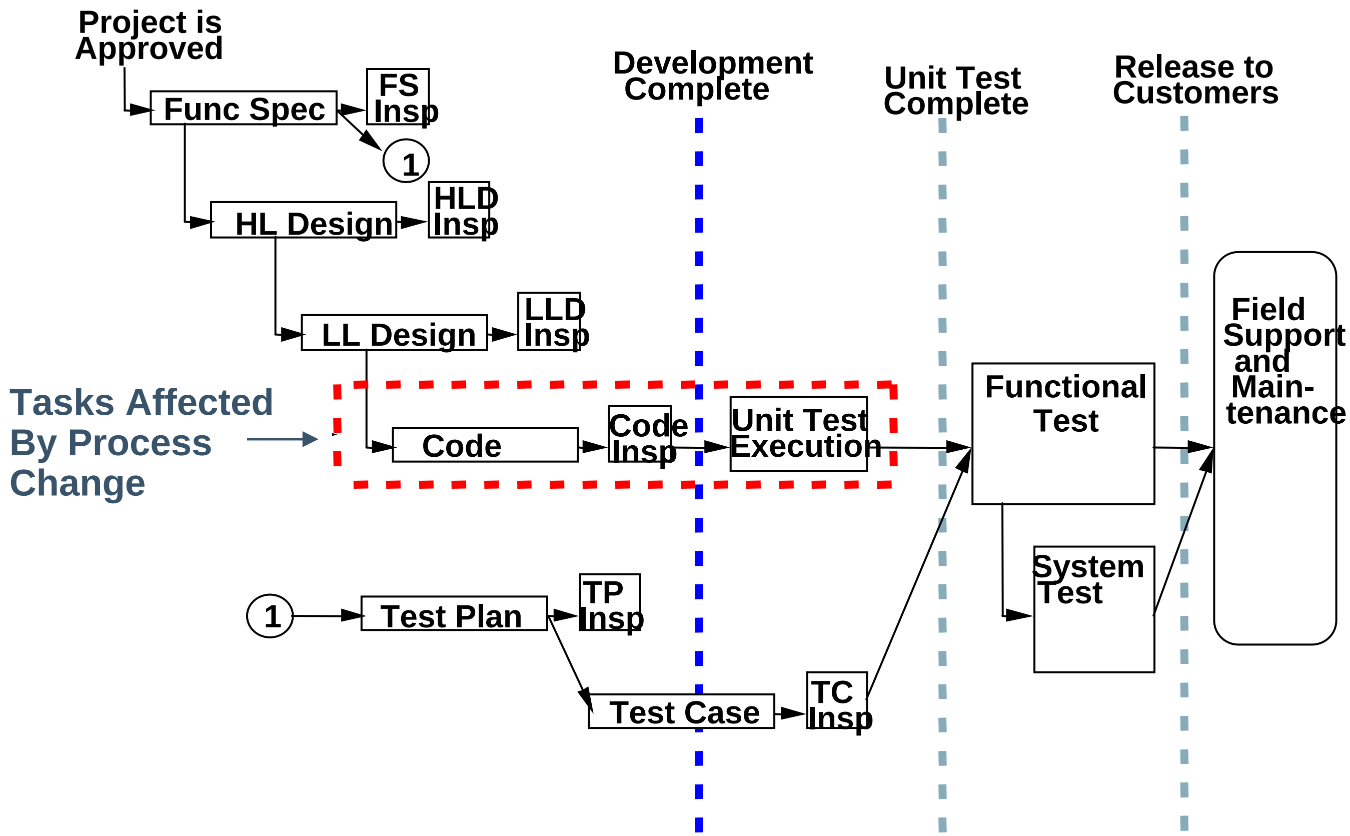
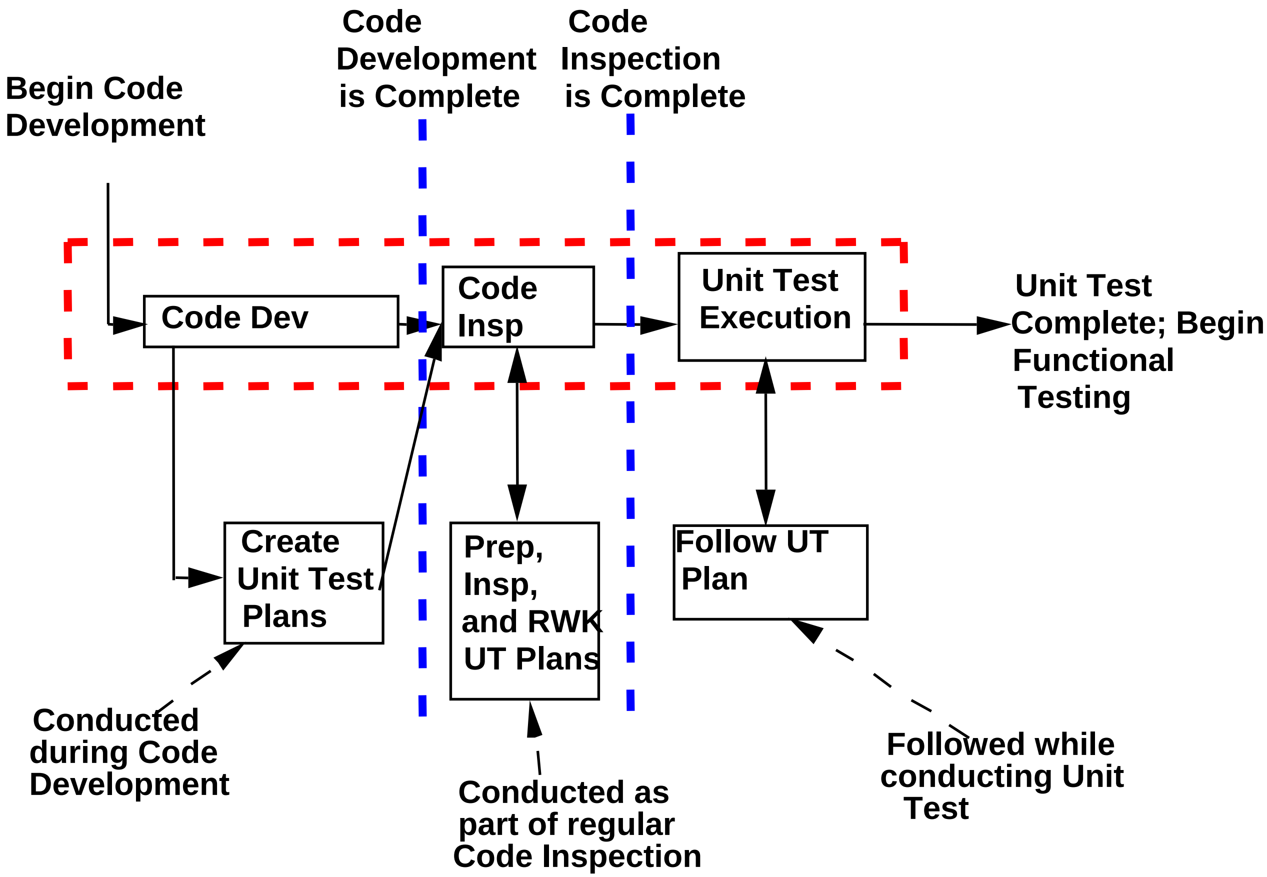


Diagram of the Field Study Life Cycle AS-IS Process

Process Overview - 2



Overview of PTAM

- Set-up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Determine Organizational Scope
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Specify Questions

- Based upon the goal/ purpose of the simulation model, specific management questions can be identified
- Questions should point to specific answers that management would like to obtain
- It should be recognized that the model may not be able to answer or even address all of the questions.
- The questions should document the full scope issues and information that need to be incorporated into the decision making process
- Questions document the use case

Example Questions

- What is the optimal V&V strategy for a specific project? For our organizational process?
- Would it be better to use Requirements process “A” or “B” for this new project?
- What combination(s) of V&V techniques enable us to meet or exceed the quality goals for the system? Which alternative is best?
- Given a budget of “X” dollars, what V&V activities should be conducted?
- What is the value of applying automated tools to support development activities?
- What is the level of Risk associated with a change?

Case Study: Questions Investigated

- Will the process change improve project performance?
- What is the cost the firm is currently paying by conducting Unit Tests incorrectly?
- Is partial implementation of the proposed process change possible?
- How would potential learning curve effects affect the performance of the process change?
- Would alternative process changes offer a greater improvement?
- Can the project benefit from reusing process artifacts?

Overview of PTAM

- Set-up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Define Process Performance Measures

- Main output measures of the simulation
- Should capture management interests and interests of engineers responsible for implementing the process changes.
- Must enable the questions to be answered
- Helps focus data collection and modeling efforts.
- Should be defined as early as possible on the project

Examples of Common Performance Measures

Typical performance measures include the following:

- effort / cost
- cycle-time (a.k.a. interval, duration, schedule)
- defect level
- staffing requirements
- staff utilization rate
- cost / benefit, return on investment
- throughput / productivity
- queue lengths (backlogs)

Case Study: Performance Measures

Cost

- Person-Months of Development, Inspection, Testing and Rework effort
- Equivalent Manpower (Staffing levels)
- Implementation costs

Quality

- Number of delivered defects by type

Schedule

- Months of Effort

Overview of PTAM

- Set-up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Input Data (1 of 2)

- Input data are used to predict the performance measures.
- Can be derived from the organization
  - Current baseline
  - Exemplary projects
  - Pilot data
- Can also be derived from
  - Expert opinion
  - Industry data from comparable organizations
- Best judgments to describe the state of your organization

Input Data (2 of 2)

Examples:

- process documents and assessments
- amount of incoming work
- effort based on size (and/ or other factors)
- defect detection efficiency
- effort for rework based on size and number of defects
- defect injection, detection and removal rates
- decision point outcomes; number of rework cycles
- hiring rate; staff turnover rate
- personnel capability and motivation, over time
- resource constraints
- frequency of product version releases

Case Study: Input Data

- CMM Level 2+ organization
- Process documents and assessments
- Project Size
- Productivity
- Earned Value by phase
- Total number of defects removed
- Defect injection, detection and correction rates
- Effort and schedule data
- Defect detection and rework costs

Overview of PTAM

- Set-up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
  - Gather qualitative and quantitative data about processes and products from variety of sources in variety of forms
- Modeling Phase
- Analysis Phase

Overview of PTAM

- Set up phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Process Models

- First, create the graphical model
- Quantitative portion of the simulation model can be theoretical or data driven
  - Data driven models analyze actual data from past projects using statistical techniques such as correlation coefficients and regression.
  - Theoretical models are independent of data (relationships)
- Process simulation can incorporate many kinds of analytical models (data driven or theoretical)
  - COCOMO, SLIM
  - Reliability
  - Other Regression, Queuing and others

Case Study: Build the Graphical Model

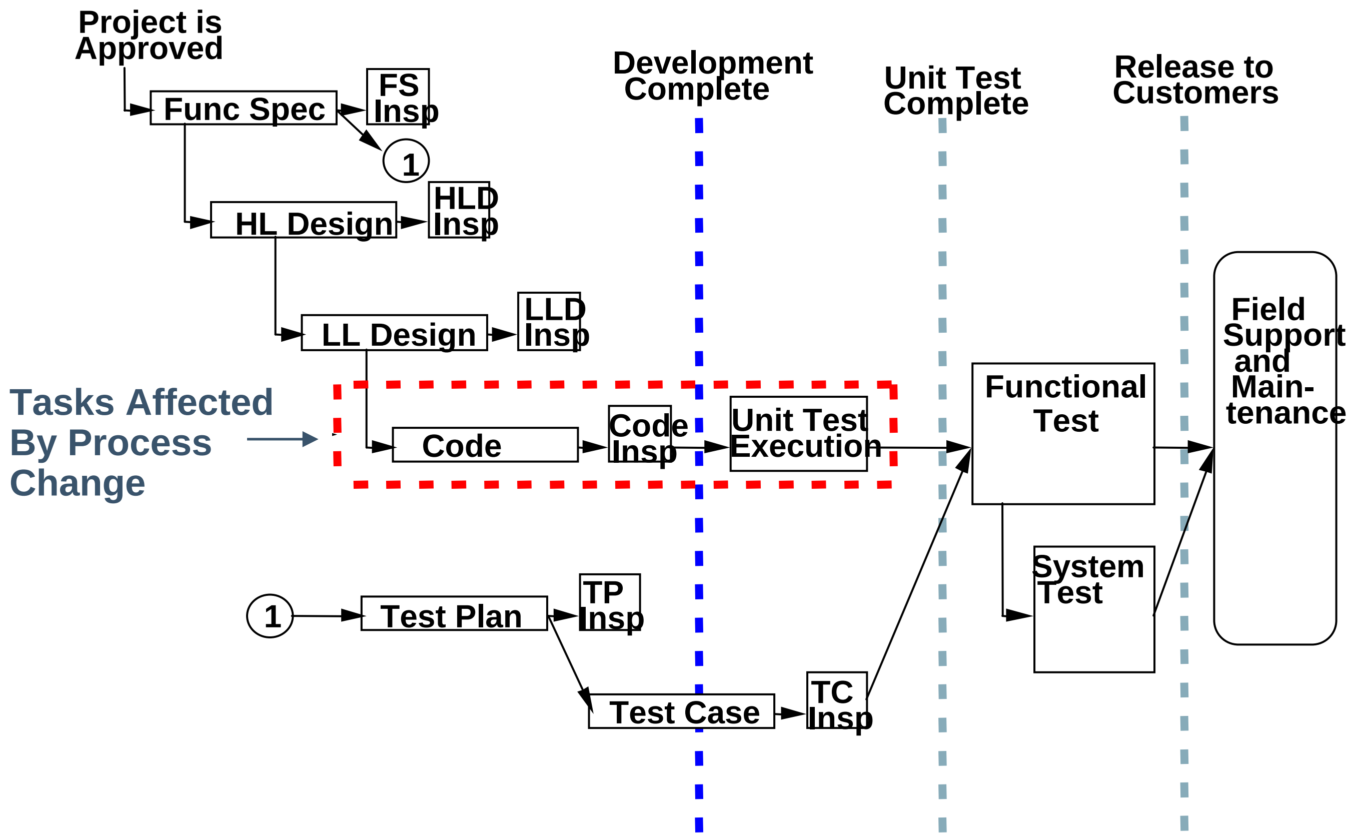
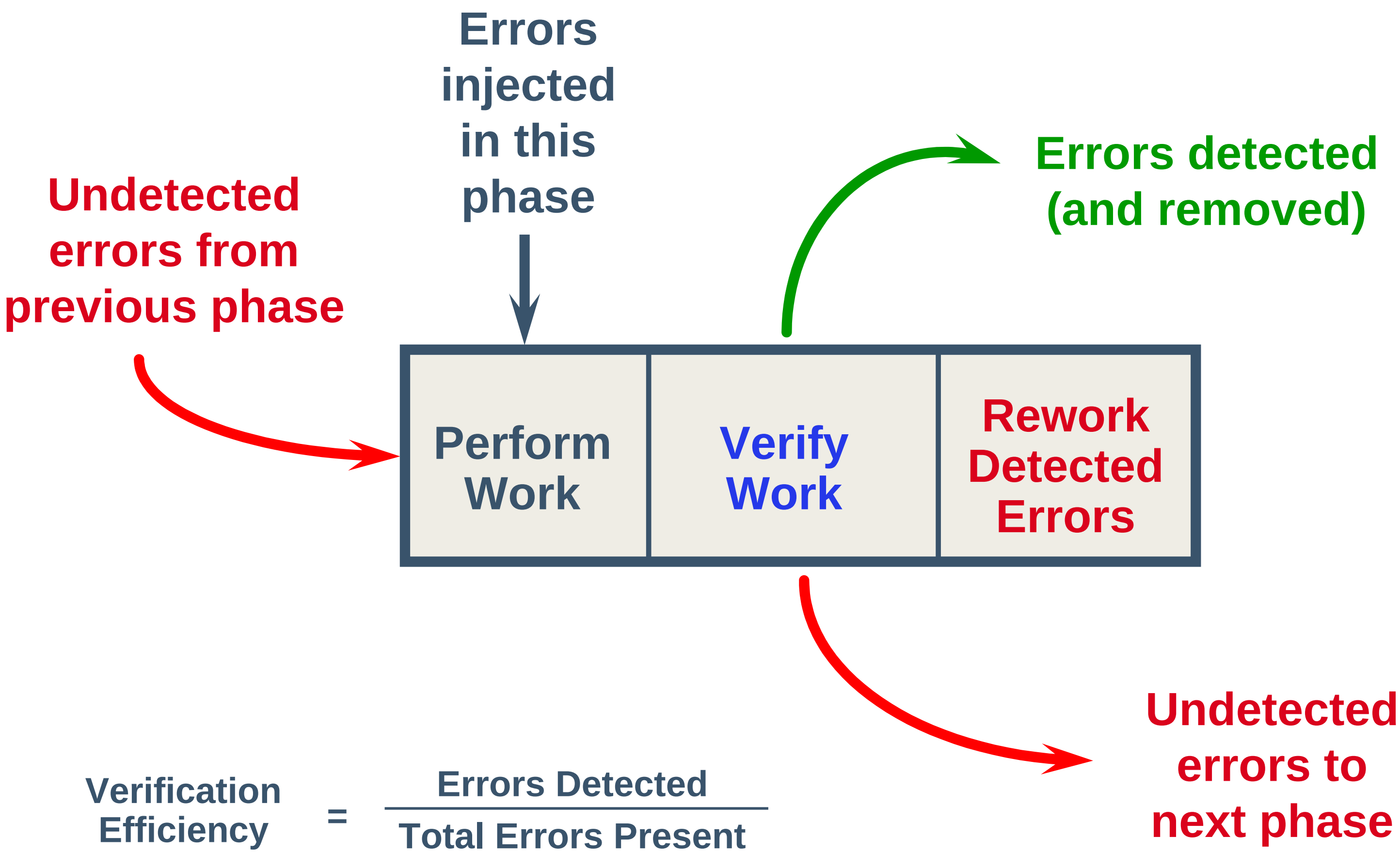


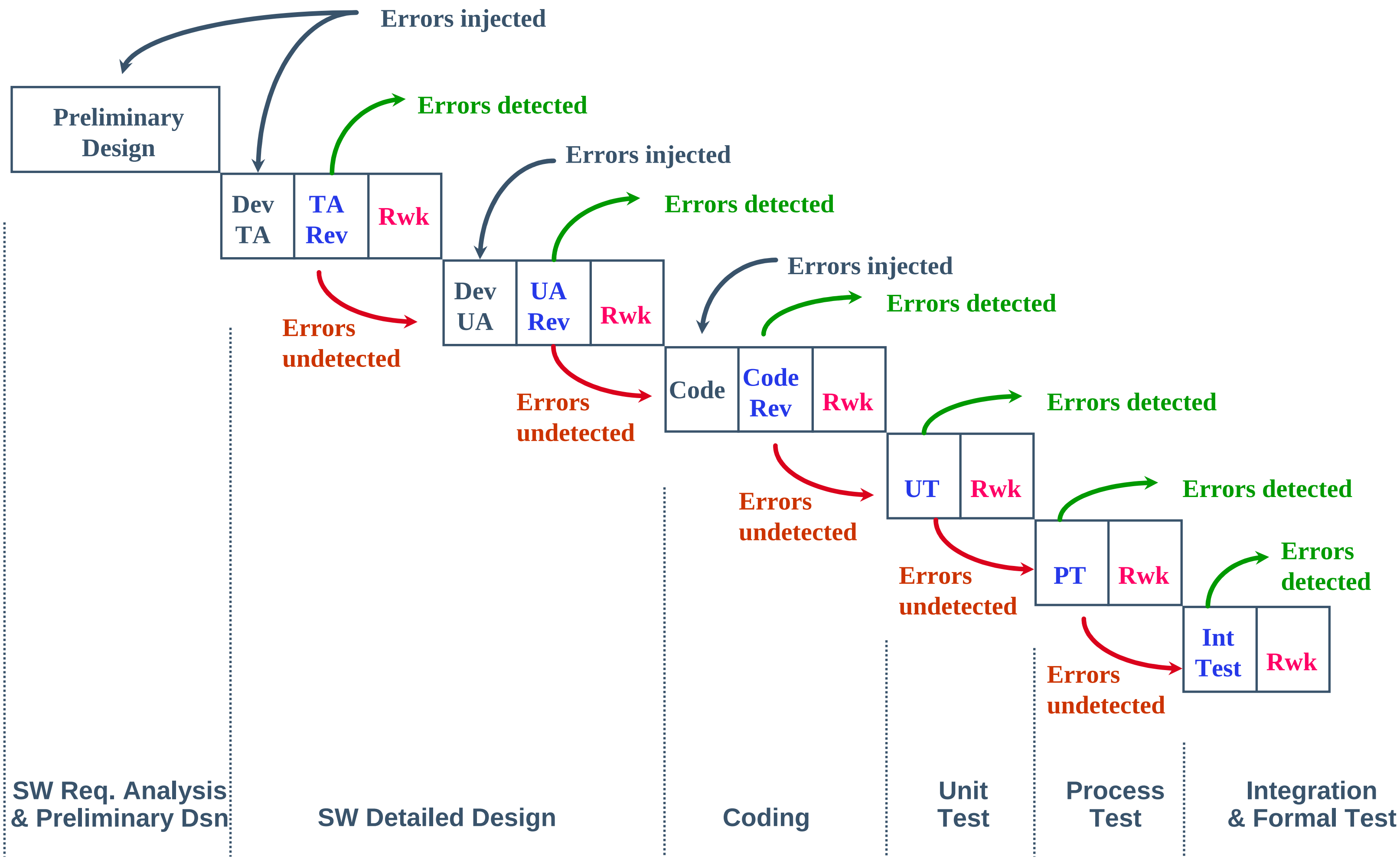
Diagram of the Field Study Life Cycle AS-IS Process

Case Study: Simplified Error Model

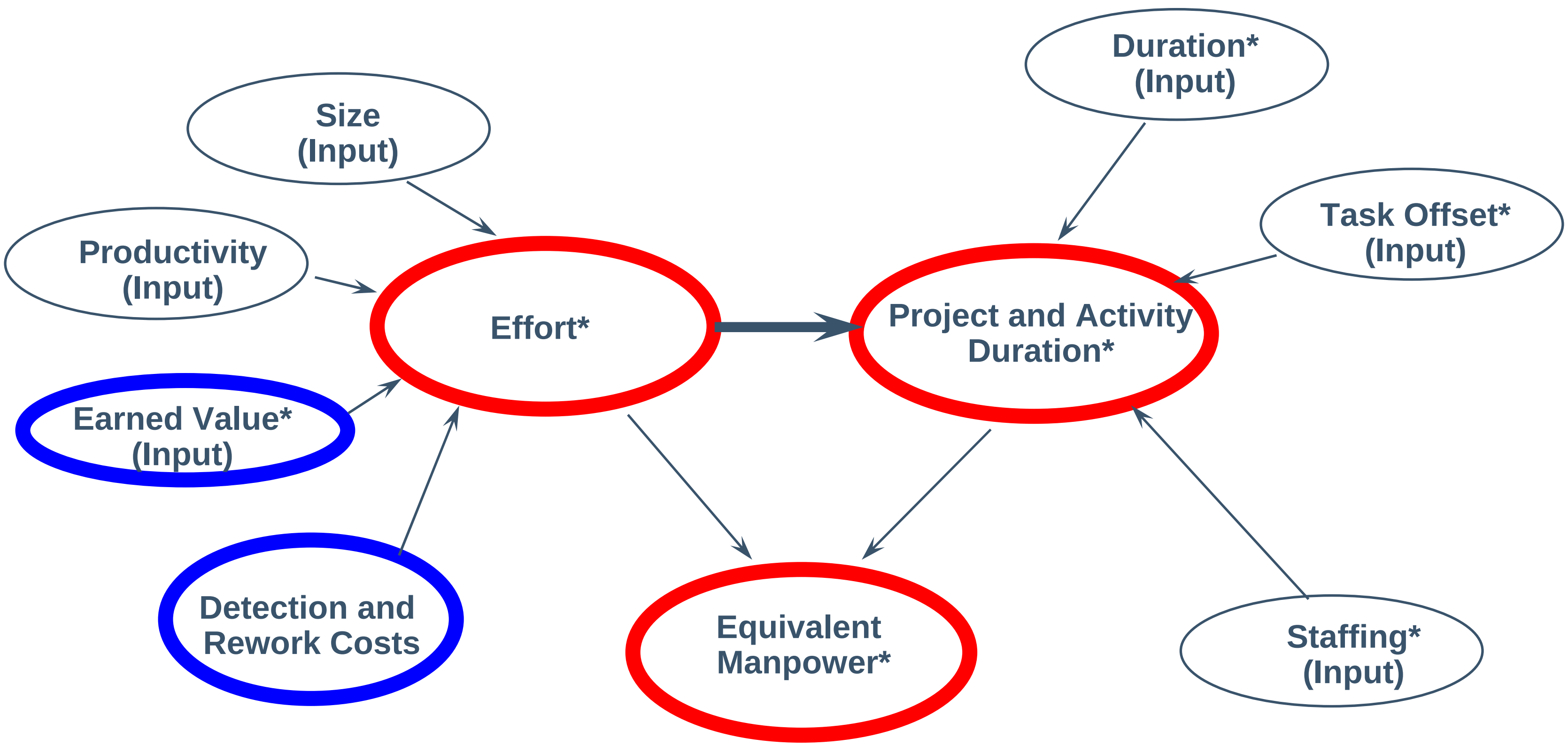


$$\text{Verification Efficiency} = \frac{\text{Errors Detected}}{\text{Total Errors Present}}$$

More Detailed Error Model



Linking Effort, Duration, and Staffing



Overview of PTAM

- Set up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Analysis Phase

Once the model results are validated and viewed as being credible, they can be used to support decisions.

Major Steps

- Evaluate Baseline Process Alternatives
- Determine Tradeoff Rule(s)
- Conduct Sensitivity Analyses
- Select Alternative(s) for Implementation

Project Level Outputs – Which Alternative to Choose?

CONFIG	Delivered Defects	Life Cycle Effort	Project Duration
W W N N	13.4	51.72	17.81
F F N N	12.6	52.83	17.26
W W N W	9.1	48.79	14.92
W W W W	6.6	47.25	12.85
F F F F	3.3	48.60	12.11

Comparison by Mean Difference

CONFIG	Reduced Defects	Reduced Effort	Reduced Duration
W W N N	0.00	0.00	0.00
F F N N	0.80	-1.11	0.55
W W N W	4.34	2.92	2.89
W W W W	6.82	4.47	4.96
F F F F	10.18	3.12	5.71

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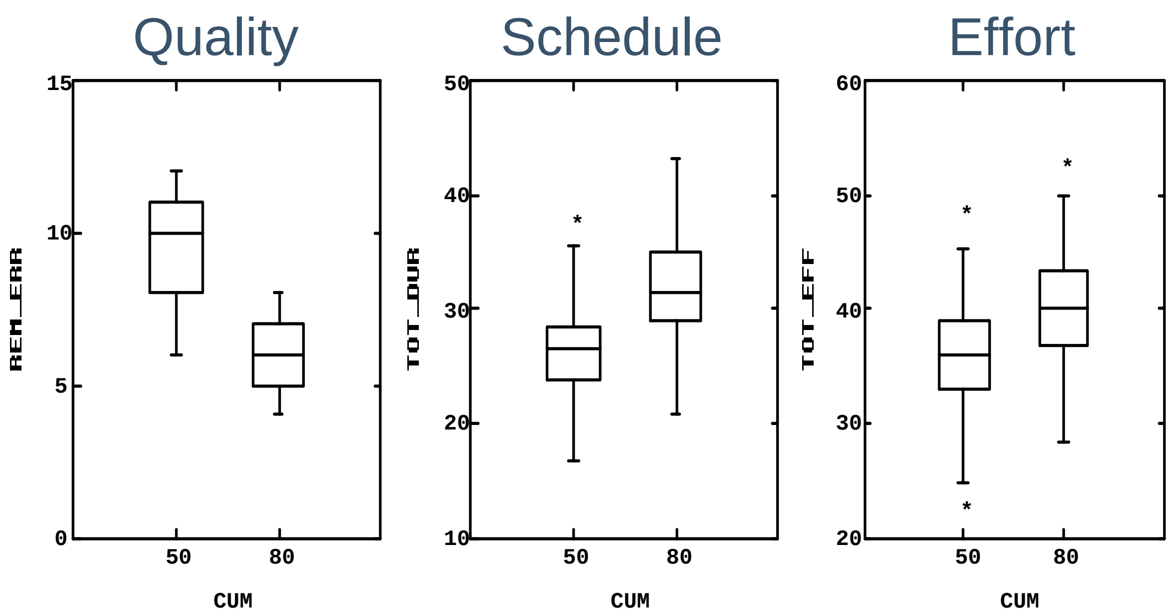
Case Study: Baseline Comparison



REM_ERR = Number of remaining errors; TOT_DUR = Total project duration (in days);
TOT_EFF = Total staff effort (in days); CUM = Cumulative error detection capability
(% of initial errors detected); 50 = "AS-IS" No Inspection Baseline; 80 = "TO-BE" Inspection Baseline

FIGURE 2 - PERFORMANCE MEASURE DISTRIBUTIONS

Analysis Phase

- Evaluate Baseline Process Alternatives
- Determine Tradeoff Rule(s)
- Conduct Sensitivity Analyses
- Select Alternative(s) for Implementation

Determine Tradeoff Rule(s)

Which alternative is best?

Need to reduce multiple performance measures to one decision statistic that can be used to rank process alternatives.

Possible Options

- Utility functions
- Financial measures (e.g. Net Present Value (NPV), Internal Rate of Return (IRR aka ROI), etc.)
- Optimization techniques (e.g. Data Envelopment Analysis (DEA))
- Analytic Hierarchy Process (AHP)
- Combination

Financial Measures of Performance

- Gets management interest (and excitement)
- Supports building a business case
- Trick is to convert performance measures to cash equivalents
- Examples:
  - Net present value (NPV)
  - Internal rate of return (IRR aka ROI), etc.
  - Discounted Payback period

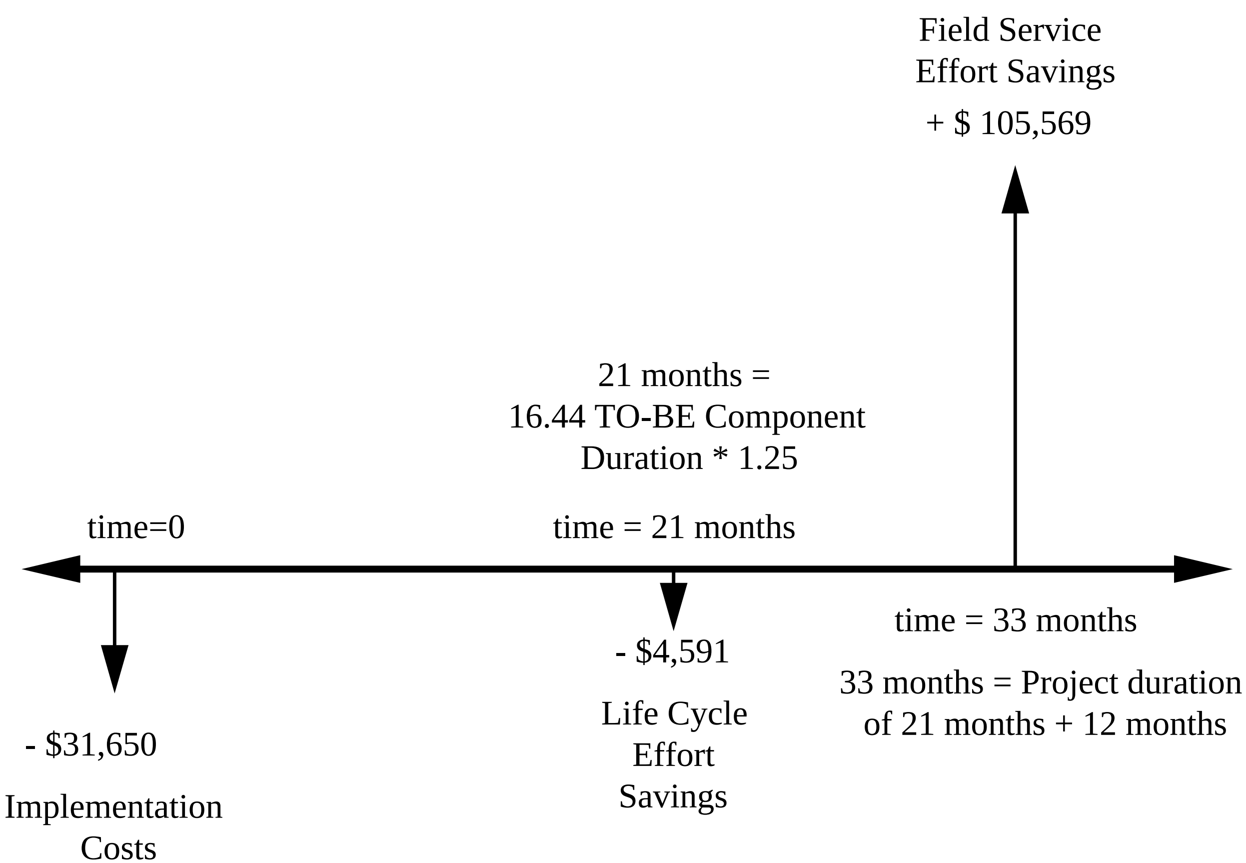
Determining Financial Benefits

- Need to reduce all benefits to cash equivalents
- Implementation costs are easy to include
- Effort is a straight forward conversion
- Some measures can be converted to effort (e.g. number of customer defects are converted to the effort to correct them)
- Other measures (e.g. time to market) can be difficult to convert.

Ranking by Financial Performance

Rank	CONFIG	NPV(15%) Mean	NPV(15%) STDev	PR(NPV<0) (Risk)
1	F F F F	$362,291.35	$118,344.45	0.11%
2	W W W W	$253,041.92	$68,513.12	0.08%
3	W W N W	$157,874.18	$44,518.84	0.09%
4	F F N N	$27,836.80	$26,910.00	15.15%
5	W W N N	$0.00	NA	NA

Case Study: Cash Flows



Case Study: Results

- The process change offered significant reductions in remaining defects, staff effort to correct field detected defects, and project duration. The expected ROI was 56% for a typical 30 KLOC release.
- Pilot implementations indicated that the process change provided a 37% ROI even under worst case conditions.

Analysis Phase

- Evaluate Baseline Process Alternatives
- Determine Tradeoff Rule(s)
- Conduct Sensitivity Analyses
- Select Alternative(s) for Implementation

Conduct Sensitivity Analyses

- "What if" analyses allow managers to apply the model to evaluate the proposed process change(s) under different business conditions and assumptions.

- Provides added insight and confidence into the potential process change

Case Study: Questions Investigated

- Will the process change improve project performance?
- What is the cost the firm is currently paying by conducting Unit Tests incorrectly?
- Is partial implementation of the proposed process change possible?
- How would potential learning curve effects affect the performance of the process change?
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Case Study: Results Obtained

- Compressing Unit Test causes significant increases in schedule (+18%) and effort costs (+8%) during the later testing phases and reduces overall product quality(+48% increase in defects).
- Partial implementation of the process change is possible for complex portions of the code. Estimated ROI is 72%.
- Potential learning curve effects significantly enhance the performance of the process change. Expected ROI of 72% assuming only moderate improvements.

Case Study: Results Obtained

- Improving inspections would be a more effective process improvement than the Creating Unit Test Plans process change.

- Reusing the Unit Test Plans on the next development cycle provided an overall ROI of 73% (compared to 56% expected improvement without reuse)

Analysis Phase

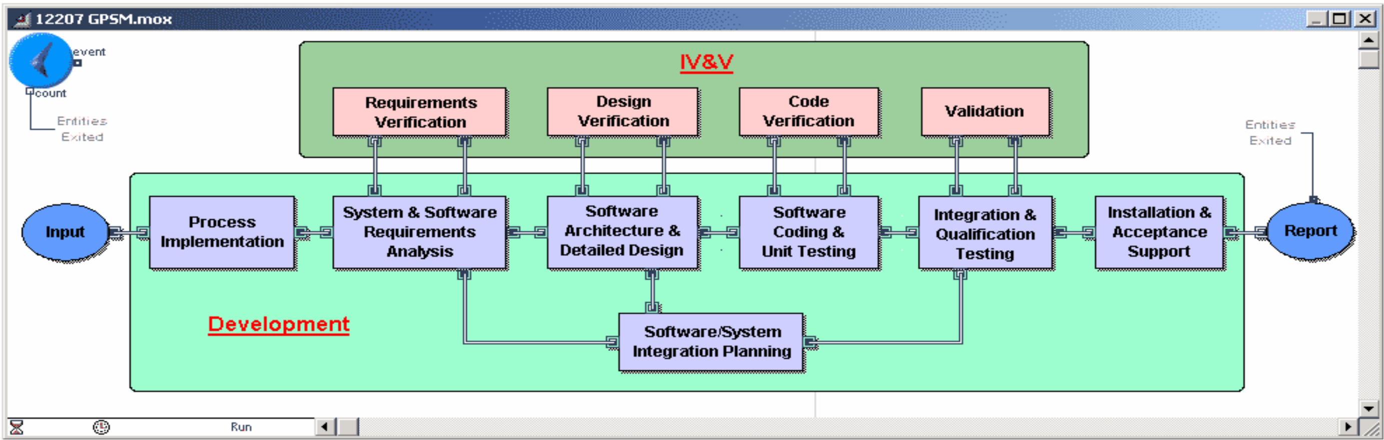
- Evaluate Baseline Process Alternatives
- Select Evaluation Method and Criteria
- Conduct Sensitivity Analyses
- Select Alternative(s) for Implementation

Select Alternative(s) for Implementation

- Process simulation can be used to estimate the ROI and risk
- Results are traded-off with other factors not included in the model such as budget and political considerations
- Utilize all the information at hand (quantitative and qualitative) to choose the best alternative

6 – Examples of Process Simulation Applications in Industry and Government

NASA IV&V



- Mission: To independently verify and validate software on all missions that are life critical or have significant vehicle cost involved.
- Problem: Limited resources to conduct IV&V. Critical need to deploy IV&V in most effective manner possible (biggest return on investment)
- Goal to optimize IV&V within a project and across projects.

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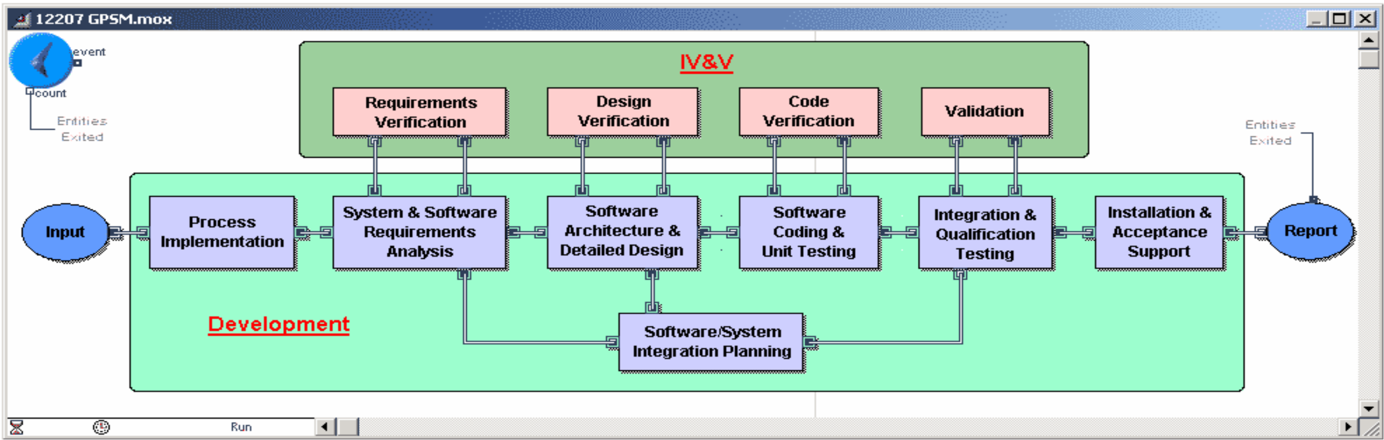
NASA IV&V



Description of Model

- Based on IEEE 12207 Software Development Process
- Tuned for large-scale NASA projects (Size >100 KSLOC) (uses actual data)
- 8 major life cycle phases; 86 process steps
- Includes IV&V Layer
- Compares alternative IV&V configurations (ROI)

NASA IV&V

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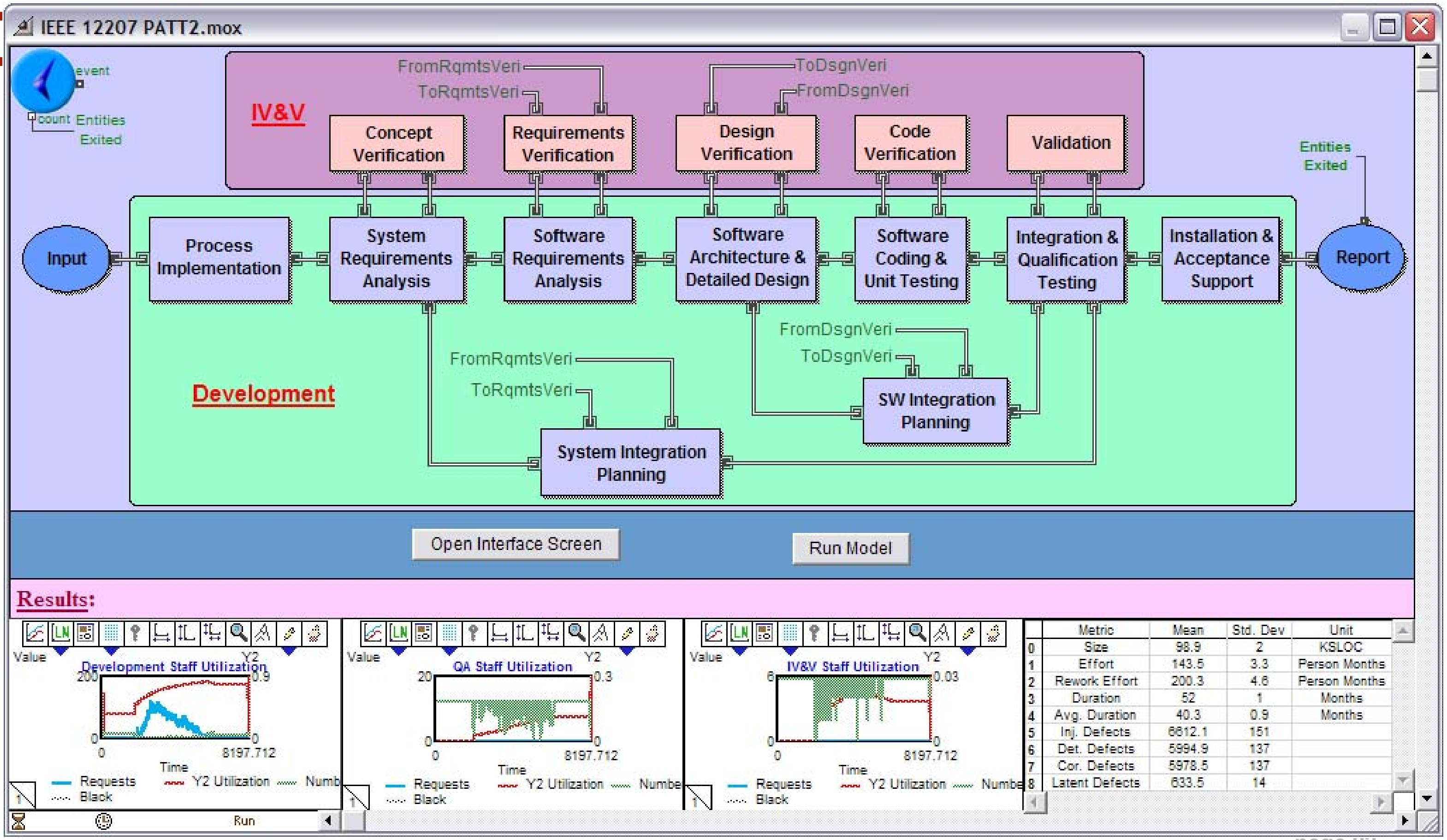
NASA Model – Includes IV&V Layer with IEEE 12207 Software



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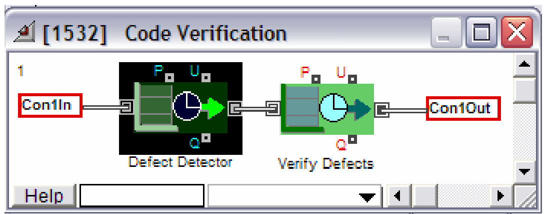
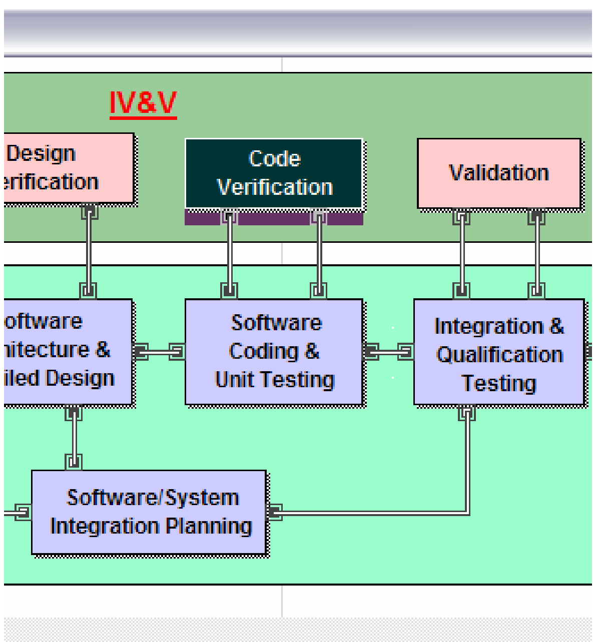
IV&V Layer – Select Criticality Levels for IV&V Techniques using pull-down

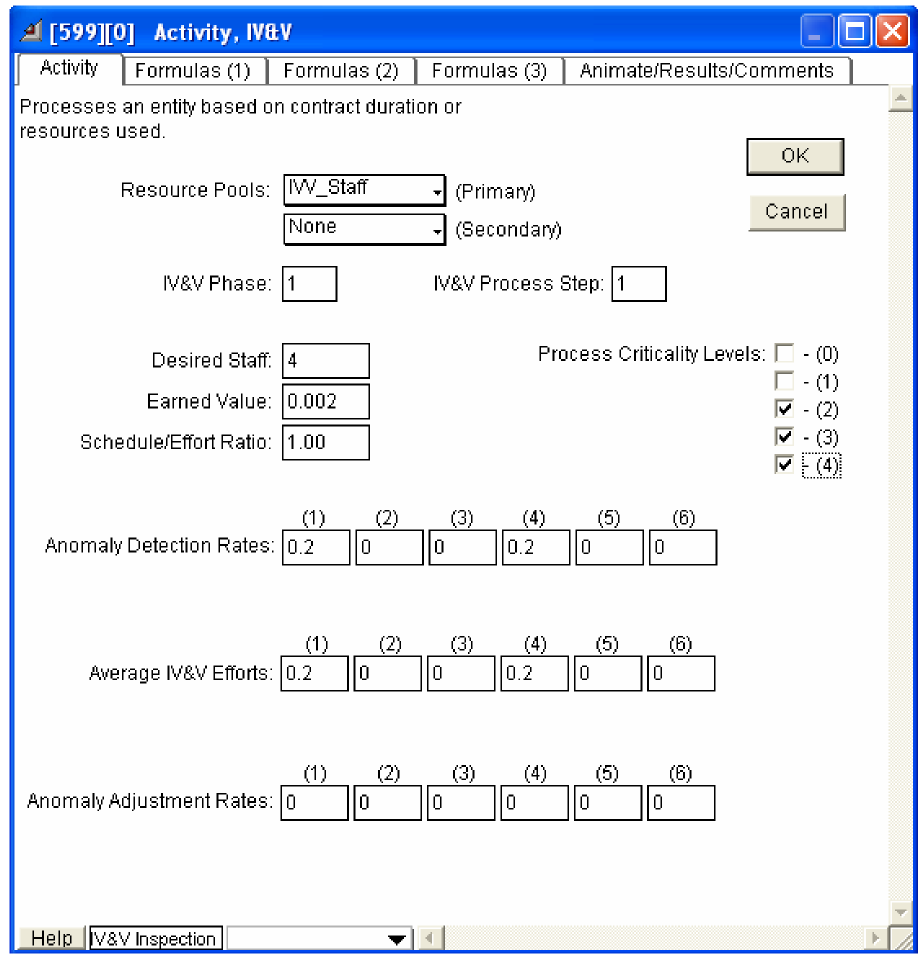
Notebook - IEEE 12207 PATT2.mox

		Concept Verification		Requirements Verification		Design Verification		Code Verification		Validation	
ID	IV&V Technique	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential
1.1	Management and Planning of Independent Verification and Validation	None	None	None	None	None	None	None	None	None	None
1.2	Issue and Risk Tracking	None	None	None	None	None	None	None	None	None	None
1.3	Final Report Generation	None	None	None	None	None	None	None	None	None	None
1.4	IV&V Tool Support	None	None	None	None	None	None	None	None	None	None
1.5	Management and Technical Review Support	None	None	None	None	None	None	None	None	None	None
1.6	Criticality Analysis	None	None	None	None	None	None	None	None	None	None
1.7	Identify Process Improvement Opportunities in the Conduct of IV&V	None	None	None	None	None	None	None	None	None	None
2.1	Reuse Analysis	None	None								
2.2	Software Architecture Assessment	None	None								
2.3	System Requirements Review	None	None								
3.1	Traceability Analysis – Requirements			None	None						
3.2	Software Requirements Evaluation			None	None						
3.3	Interface Analysis – Requirements			None	None						
3.4	System Test Plan Analysis			None	None						
4.1	Traceability Analysis – Design					None	None				

A Look Inside the Model…







What is IV&V?

- IV&V = Independent Verification and Validation
- Performed by one or more independent groups
- Can be employed at any phase with different levels of coverage

IV&V Techniques

- Traceability Analysis
- Software Design Evaluation
- Interface Analysis
- Criticality Analysis
- Component Test Plan Verification
- V&V Test Design Verification
- Hazard Analysis
- And etc.

Importance/Benefits – Enduring Needs

IV&V Level

- IV&V New Business Planning (Independent Bottoms-Up Cost Estimation for NASA Projects and for IV&V)
- IV&V Policy Research (IV&V strategies for alternative NASA Project types)
- IV&V Services Contract Bid Support
- IV&V Services Replanning
- Cost/Benefit Evaluation of new technologies and tools
- Space Science Data Mining

Macro IV&V Questions

- What is the optimal IV&V strategy for a given NASA project or NASA project type?
- What combination(s) of IV&V techniques enable us to meet or exceed the quality assurance goals for the system?
- Given a budget of “X” dollars, what IV&V activities should be conducted?
- What if the complexity or defect profiles for a particular project were different than expected?
- How is the duration of the IV&V effort impacted by the overall staffing level for the project?

Preliminary Study

- Use the model to quantitatively assess the benefits of performing IV&V on software development projects

- Comparing benefit of applying IV&V activities at different phases and in combination

Impact of IV&V at Different Points in the Development Process

Result Comparison

Case	Configuration	Total Effort Mean (Person Months)	Rework Effort Mean (Person Months)	Duration Mean (Months)	Corrected Defects Mean (Number of Defects)	Latent Defects Mean (Number of Defects)
1	Baseline	346.26	201.65	58.42	6,038.26	629.48
2	IV&V at Validation	355.35	210.75	59.95	6,113.79	574.17
3	IV&V at Code	334.13	189.53	57.38	6,134.84	573.49
4	IV&V at Design	327.93	183.33	56.56	6,123.11	581.27
5	IV&V at Requirements	326.82	182.21	56.40	6,078.87	600.04

% Improvement Compared to the Baseline

Case	Configuration	Total Effort Mean	Rework Effort Mean	Duration Mean	Corrected Defects Mean	Latent Defects Mean
1	Baseline					
2	IV&V at Validation	-2.63%*	-4.51%*	-2.63%*	+1.25%	+8.79%*
3	IV&V at Code	+3.50%*	+6.01%*	+1.77%	+1.60%	+8.90%*
4	IV&V at Design	+5.29%*	+9.09%*	+3.17%*	+1.41%	+7.66%*
5	IV&V at Requirements	+5.62%*	+9.64%*	+3.46%*	+0.67%	+4.68%*

Impact of IV&V Techniques in Combination

Result Comparison

Case	Configuration	Total Effort Mean (Person Months)	Rework Effort Mean (Person Months)	Duration Mean (Months)	Corrected Defects Mean (Number of Defects)	Latent Defects Mean (Number of Defects)
1	Baseline	346.26	201.65	58.42	6,038.26	629.48
6	IV&V at Code and Validation	342.14	197.54	58.78	6,203.66	524.96
7	IV&V at Req and Code	316.15	171.55	54.41	6,170.94	547.74
8	Two IV&V Techniques at Code	327.10	182.50	57.54	6,180.22	540.60

% Improvement Compared to the Baseline

Case	Configuration	Total Effort Mean	Rework Effort Mean	Duration Mean	Corrected Defects Mean	Latent Defects Mean
1	Baseline					
6	IV&V at Code and Validation	+1.19%	+2.04%	-0.63%	+2.74%	+16.60%*
7	IV&V at Req and Code	+8.69%*	+14.93%*	+6.86%*	+2.20%	+12.99%*
8	Two IV&V Techniques at Code	+5.53%*	+9.50%*	+1.50%	+2.35%	+14.12%*

Rapidly Deployable Software Process Simulation Models and Training

- Goal: To create a flexible decision support tool that can be easily used to support better project management, planning and tracking by quantitatively assessing the economic benefit of proposed process alternatives.

- **Motivation: Companies need to get useful results from simulation models quickly.**

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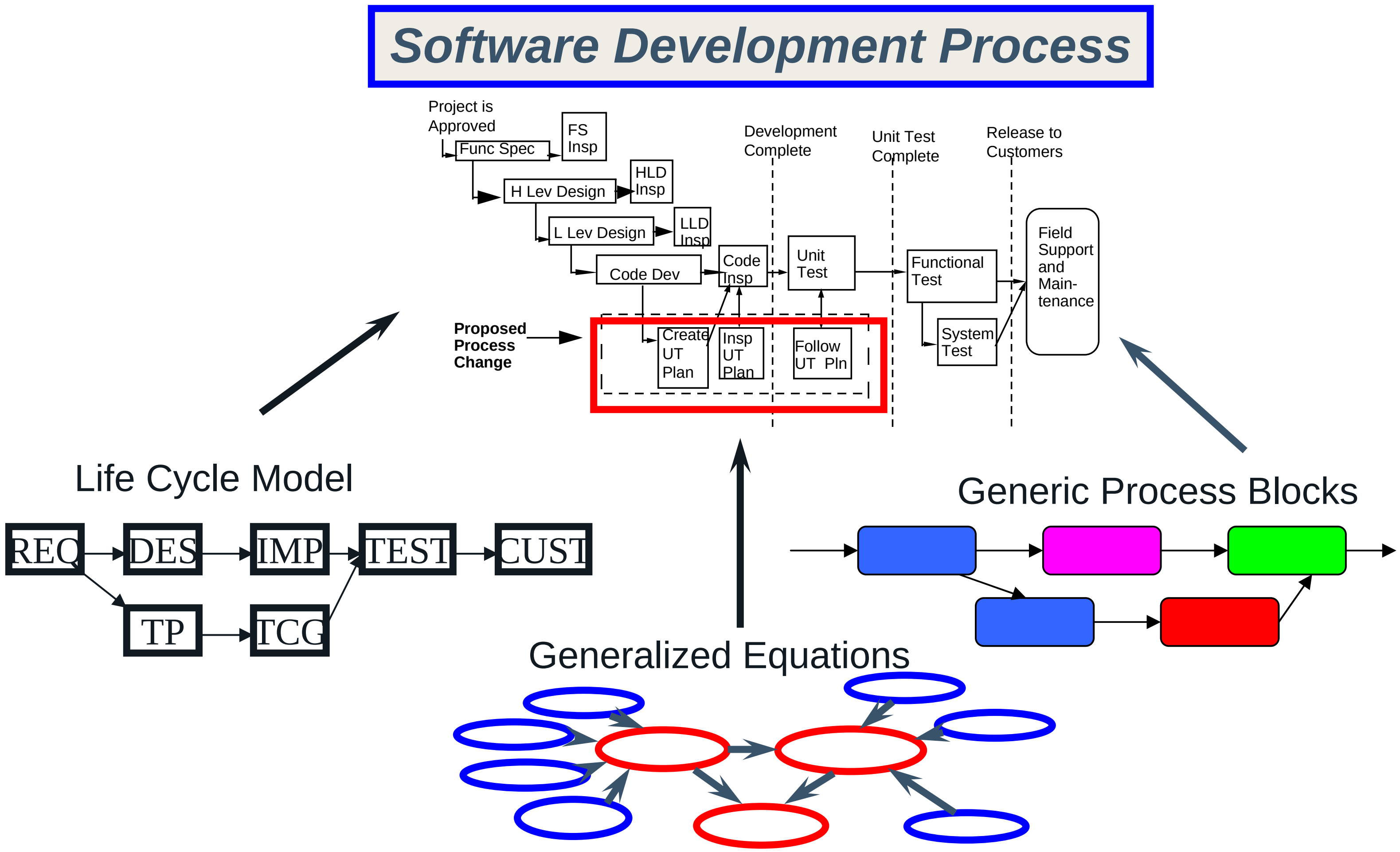
Rapidly Deployable Process Models



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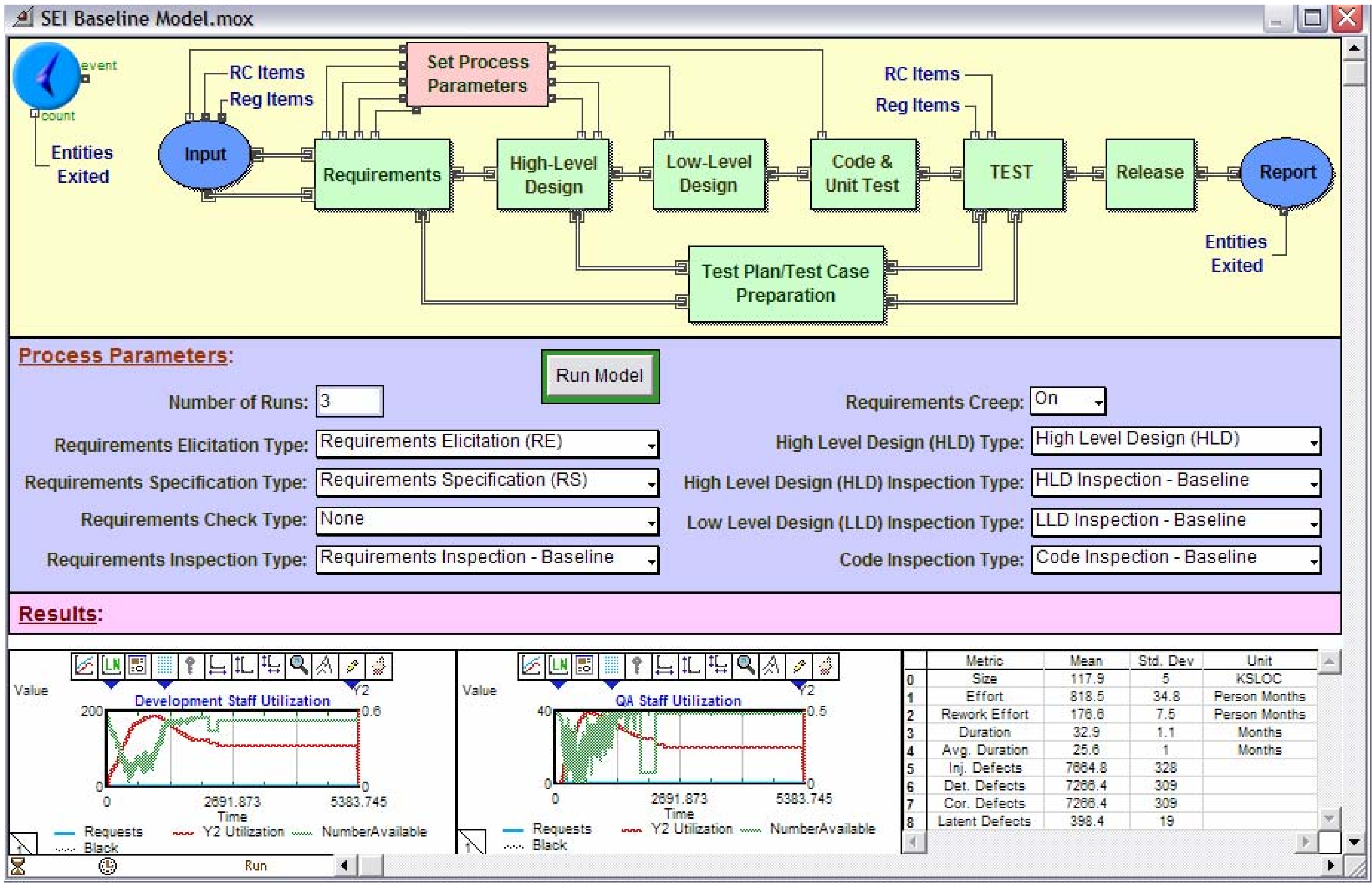
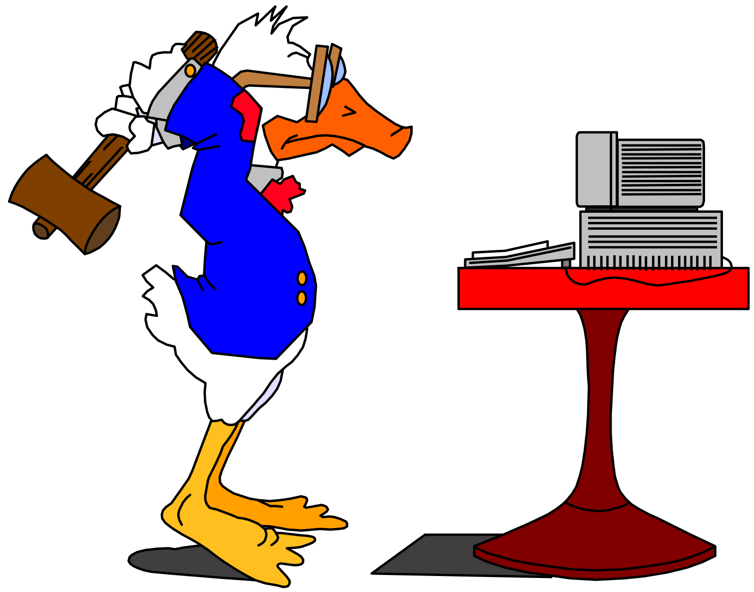
Simulation Dashboard



Demonstration



7 – Wrap up/ Conclusions

Conclusions

Process simulation modeling has been used successfully to quantitatively address a variety of issues from strategic management to process understanding.

Key benefits include:

- Decision Support and Tradeoff Analysis
- Sensitivity Analysis – “What if”
- Supports Industry Certification and process improvement programs including CMMI, Six Sigma, and others
- Supports CMMI at all levels 2 through 5
- Design and Define Processes
- Benchmarking
- Can address project manager concerns
- Supports project management and control

Conclusions

Process Tradeoff Analysis Method (PTAM) provides a tested approach for developing models and utilizing the results

Not a silver bullet

Focus on RAPID DEPLOYMENT

- ***Reducing costs and time to develop models***
- ***Making models easier to use – No simulation expert needed***

The End

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