

Optimizing NASA IV&V Benefits Using Simulation



Grant Number: NAG5-12736

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Introduction to PATT

- ◆ There is a critical need for cost effective project management and Independent Verification and Validation (IV&V).
- ◆ The goal of this project is to provide NASA with a flexible tool capability that can quantitatively assess the economic benefit of process decisions and in particular performing IV&V.
- ◆ PATT, or the Process Analysis Tradeoff Tool, is based on extensive research into Software Process Simulation Models (SPSMs) conducted at the Software Engineering Institute (SEI) by Watts Humphrey, Marc Kellner, Bill Curtis and others.



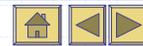
Introduction to PATT

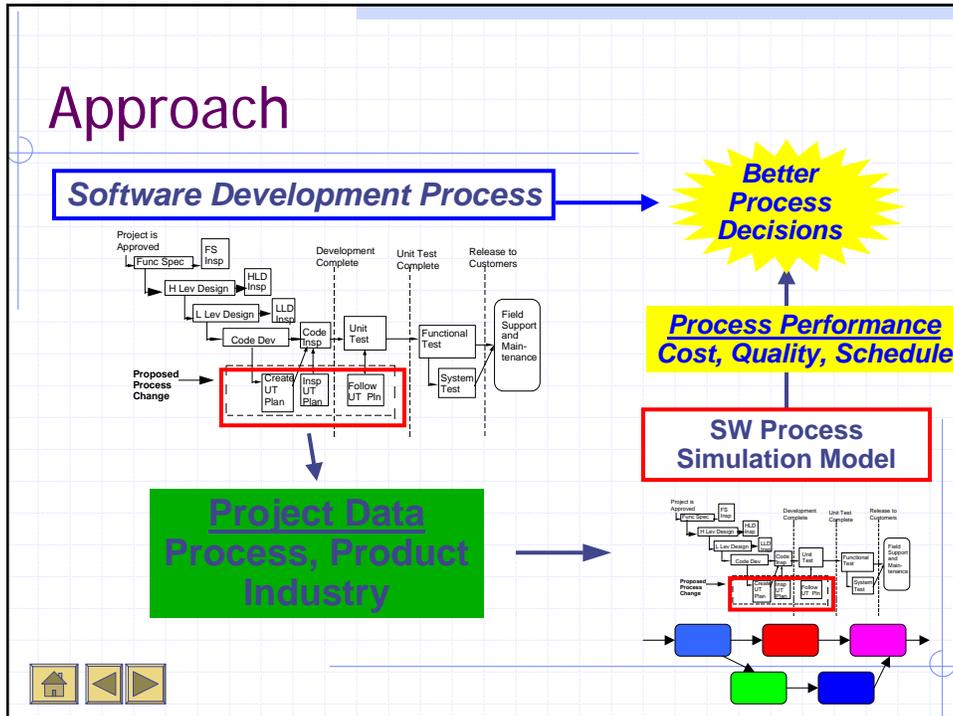
- ◆ PATT can be used to quantify the costs and benefits associated with NASA process decisions and specifically IV&V practices enabling management to effectively allocate scarce resources for IV&V activities (Relevance).
- ◆ PATT facilitates better project management and will provide an assessment of the impact of changes in budget, changes in scope, process changes and many others.
- ◆ NASA's use of models and metrics is a strategic approach to CMMI certification at all levels. PATT's use of process simulation models will help NASA reach its goals of improved process maturity.



Questions that can be addressed

- ◆ How do we predict the benefit associated with implementing a process change, IV&V technique, process technology or tool?
- ◆ How can the economic benefit of process changes or IV&V technologies be optimized?
- ◆ How do we prioritize these process changes?
- ◆ What is the best strategy for applying process changes or IV&V technologies?
- ◆ What is the benefit of applying one combination of IV&V techniques to a given process vs another?
- ◆ What is the level of Risk associated with a change?
- ◆ What is the Return on Investment?
- ◆ How to achieve higher levels of the CMMI?





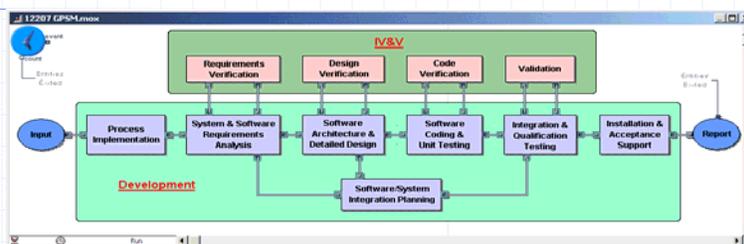
- ## PATT Features
- ◆ PATT graphical process models present an intuitive representation of NASA software development processes.
 - ◆ PATT simulations allow performance prediction in terms of
 - Development Cost
 - ◆ number of man-hours in staff pools
 - Software Quality
 - ◆ number of corrected versus latent defects
 - Project Duration
 - ◆ meeting schedules and project deadlines

PATT Features

- ◆ PATT provides a set of model building blocks enabling models to be quickly tailored to NASA software development processes.
- ◆ PATT implements database connectivity for input parameters, simulation results and analysis.



Process Analysis Tradeoff Tool



- ◆ Large-Scale software project planning support
- ◆ Rapidly deployable models dramatically reduce time to develop and modify
- ◆ Platform for analyzing process tradeoffs and impact of QA, IV&V or other process technologies (tools)
- ◆ NASA Project studying the impact of IV&V
- ◆ IV&V can be applied at one or more phases over the entire software development lifecycle
- ◆ Alternative configurations can be compared (ROI)



Customizing PATT

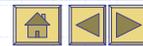
PATT allows total customization to reflect NASA processes

- ◆ Modify Development Workflow
 - Use Extend's visual workflow system and PATT model building blocks to simulate specific workflows
- ◆ Change Resource Sizes
 - Set staff size in 4 resource pools
- ◆ Change Defect Rates
 - Injection, Detection and Correction Rates
- ◆ NASA may define multiple defect types based on project needs and data.
- ◆ NASA may define custom formulas for each step.
- ◆ Many other changes are possible.



NASA PATT Walkthrough

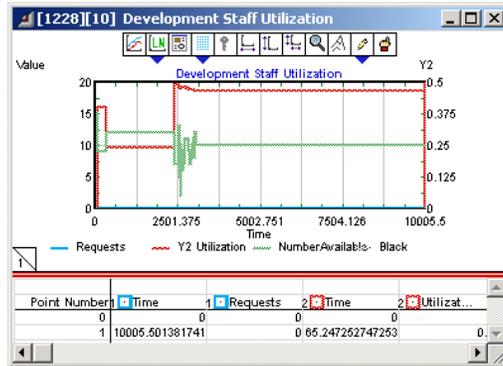
- ◆ The next set of slides will illustrate the steps that a user would go through to run the model and see the results of applying one IV&V technique on a project that originally had none.
- ◆ The goal is to show the ease of use of the PAT tool and to illustrate the types of analyses that can be done.
- ◆ This walkthrough demonstrates
 - Running a process simulation without IV&V
 - Running a process simulation with one IV&V phase
 - Comparison of simulation results



Obtain the Process Baseline (No IV&V)

Starting the simulation and monitoring progress

- ◆ Running PATT with no IV&V
- ◆ Development staff activity appears in plotter window
- ◆ No activity in IV&V Staff plotter



Development Staff Plotter Activity

Enable IV&V

Enable IV&V for Software Criticality Level 2

- ◆ Individual IV&V techniques may be set to run at different criticality levels.
- ◆ In this case, we will enable IV&V for criticality levels 2 and higher.
- ◆ Because the overall project criticality level is 2, this IV&V technique will be applied in the next simulation run.

Activity | Formulas (1) | Formulas (2) | Animate | Results | Comments

Processes an entity based on contract duration or resources used.

Resource Pools: IVV_Staff (Primary) | None (Secondary)

IV&V Phase: 1 | IV&V Process Step: 1

Desired Staff: 4 | Process SW Integrity Levels: (0) - (4) (checked)

Earned Value: 0.02

Schedule/Effort Ratio: 1.00

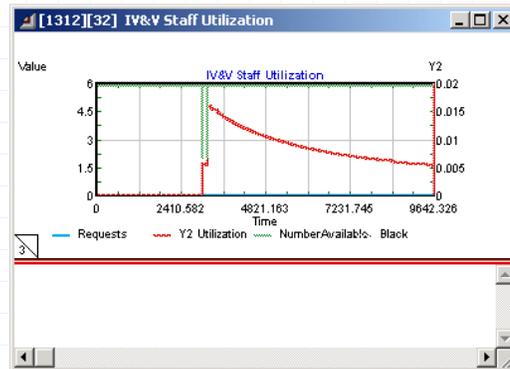
Defect Detection Rates: (1) 0.2, (2) 0, (3) 0, (4) 0.2, (5) 0

Average IV&V Efforts: (1) 0.2, (2) 0, (3) 0, (4) 0.2, (5) 0

Second Simulation (With IV&V)

Starting the Model and Monitoring Progress

- ◆ With IV&V on, IV&V staff usage is displayed in plotter window

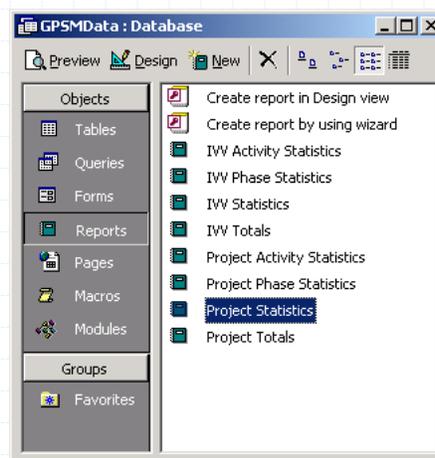


Activity in IV&V Staff Plotter

PATT Results Database

PATT results are stored in a Microsoft Access database

- ◆ Detailed results from each run set are stored in a variety of tables
- ◆ Results of simulation runs are combined into Run Sets with mean and standard deviation data.
- ◆ Results of multiple IV&V applications may be easily compared in Access reports .



Review Results - Project Statistics Report

Project Statistics Report shows overview of Run Sets

Project Statistics

Project Name: *IEEE12207 SW Development Process Model*

Run Set	Total Effort Mean Total Effort SD	Rework Effort Mean Rework Effort SD	Duration Mean Duration SD	Corrected Defects Mean Corrected Defects SD	Latent Defects Mean Latent Defects SD
1	46,008.97 676.91	23,356.92 534.00	10,293.42 202.00	6,189.57 144.00	475.63 10.00
<i>No IV&V</i>					
2	43,947.90 936.61	21,389.61 761.00	9,989.03 231.00	6,200.78 210.00	458.71 16.00
<i>With IV&V</i>					

- ◆ Each new Run Set is appended to report
- ◆ Each Run Set contains mean and standard deviation data for all of the runs in that set.



Review Results - Project Statistics Report

Total Effort Mean and Standard Deviation

Project Statistics

Project Name: *IEEE12207 SW Development Process Model*

Run Set	Total Effort Mean Total Effort SD	Rework Effort Mean Rework Effort SD	Duration Mean Duration SD	Corrected Defects Mean Corrected Defects SD	Latent Defects Mean Latent Defects SD
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<i>No IV&V</i>					
2	43,947.90 936.61	21,389.61 761.00	9,989.03 231.00	6,200.78 210.00	458.71 16.00
<i>With IV&V</i>					

- ◆ Notice that IV&V reduces total project effort, which includes rework effort.
- ◆ Effort reduction is due to savings in rework effort.



Review Results - Project Statistics Report

Rework Effort Mean and Standard Deviation

Project Statistics

Project Name: *IEEE12207 SW Development Process Model*

Run Set	Total Effort Mean Total Effort SD	Rework Effort Mean Rework Effort SD	Duration Mean Duration SD	Corrected Defects Mean Corrected Defects SD	Latent Defects Mean Latent Defects SD
1	46,008.97 676.91	23,356.92 534.00	10,293.42 202.00	6,189.57 144.00	475.63 10.00
<i>No IV&V</i>					
2	43,947.90 936.61	21,389.61 761.00	9,989.03 231.00	6,200.78 210.00	458.71 16.00
<i>With IV&V</i>					

- ◆ Notice that rework effort (total man-hours) decreased significantly as IV&V was added.
- ◆ This is due to a reduction of rework efforts by applying IV&V early in the development life cycle



Review Results - Project Statistics Report

Duration Mean and Standard Deviation

Project Statistics

Project Name: *IEEE12207 SW Development Process Model*

Run Set	Total Effort Mean Total Effort SD	Rework Effort Mean Rework Effort SD	Duration Mean Duration SD	Corrected Defects Mean Corrected Defects SD	Latent Defects Mean Latent Defects SD
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<i>With IV&V</i>					

- ◆ IV&V application decreases project duration.
- ◆ In this prototype, IV&V is applied in series at the end of the requirements phase.



Review Results - Project Statistics Report

Corrected Defects Mean and Standard Deviation

Project Statistics

Project Name: IEEE12207 SW Development Process Model

Run Set	Total Effort Mean Total Effort SD	Rework Effort Mean Rework Effort SD	Duration Mean Duration SD	Corrected Defects Mean Corrected Defects SD	Latent Defects Mean Latent Defects SD
1	46,008.97 676.91	23,356.92 534.00	10,293.42 202.00	6,189.57 144.00	475.63 10.00
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2	43,947.90 936.61	21,389.61 761.00	9,989.03 231.00	6,200.78 210.00	458.71 16.00
<i>With IV&V</i>					

◆ Application of IV&V techniques increases number of Corrected Defects.



Review Results - Project Statistics Report

Latent Defects Mean and Standard Deviation

Project Statistics

Project Name: IEEE12207 SW Development Process Model

Run Set	Total Effort Mean Total Effort SD	Rework Effort Mean Rework Effort SD	Duration Mean Duration SD	Corrected Defects Mean Corrected Defects SD	Latent Defects Mean Latent Defects SD
1	46,008.97 676.91	23,356.92 534.00	10,293.42 202.00	6,189.57 144.00	475.63 10.00
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2	43,947.90 936.61	21,389.61 761.00	9,989.03 231.00	6,200.78 210.00	458.71 16.00
<i>With IV&V</i>					

◆ Latent (shipped) defects are decreased with IV&V



Interpret Results

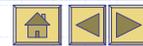
Review effectiveness of IV&V application

- ◆ From these values, a Direct ROI for IV&V can be computed and a business case for IV&V can be developed.
- ◆ The current model also supports applying Requirements Traceability and a number of other IV&V techniques at various points in the process for comparison
- ◆ Future versions of PATT will support exploration of other IV&V scenarios using different IV&V techniques and lifecycle development processes.



Technology Readiness Level

- ◆ Delivered prototype version of simulation tool to NASA. This prototype contains:
 - IEEE 12207 Software Development Process Lifecycle Model that can be adapted to a variety of NASA projects
 - Nine potential IV&V techniques (using new IV&V WBS)
- ◆ Increased PF to 7 - Researchers using NASA data (2 projects)
- ◆ Reported work at ProSim'04



Next Steps

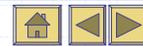
- ◆ Creating new software process life cycle models
- ◆ Adding more IV&V Techniques
- ◆ Continuing NASA data analysis with goal of developing business case scenarios
- ◆ Continuing tool development
- ◆ Joint research with KSC
- ◆ Continuing research in Optimization Theory
 - Assessing variety of techniques including:
Treatment Learning, DEA, and Financial Measures



PATT Conclusion

PATT models process change

- ◆ Competitive pressures drive process change
- ◆ Process change is expensive and can introduce risk
- ◆ Software Process Simulation Models (SPSMs) *uniquely capture* the structure of the development process. As a result, they are better able to capture process variations and better able to assess the costs and benefits of alternative processes.
- ◆ This presentation has shown how NASA can use PATT to assess the costs and benefits of process decisions and IV&V. PATT supports making a business case for alternative IV&V implementations and alternative process changes.



PATT Conclusion

PATT is Versatile and Cost Effective

- ◆ The PATT model will address:
 - Single or Multiple IV&V insertion points
 - Appropriate IV&V techniques for various development phases
 - Optimization of IV&V costs and benefits
- ◆ PATT is not a silver bullet
- ◆ The PAT tool reduces the cost of Software Process Simulation
- ◆ The Result is:
 - Less training and effort required
 - Goal to be able to tailor a model in a day; build a model in two days



PATT Conclusion

PATT helps achieve certification goals

- ◆ PATT supports higher software development maturity
 - Training, Process Definition, and Metrics Definition (Levels 2 and 3)
 - Organizational Process Performance, Quantitative Project Management (CMMI Level 4 PAs)
 - Organizational Innovation and Deployment, Causal Analysis and Resolution (CMMI Level 5 PAs)



