
Using Process Simulation to Assess the Test Design Effort Reduction of a Model-Based Testing Approach

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Agenda

- Manual and automated test design
- Adoption of model-based testing
- Effort reduction assessment using process simulation
- Conclusions
- Next steps

Manual x Automated Test Design

- Functional software testing
- Manual Test Design
 - Missing or redundant tests
 - Ambiguity and lack of writing standards
 - High inspection and maintenance effort
- Model-Based Testing (MBT)
 - Specification written in a formal notation
 - Test cases are automatically generated
- TaRGeT: Test and Requirements Generation Tool
 - Specifications written in natural language

Adoption of MBT

- Several costs involved
 - Software acquisition and processes changes
 - Training, learning curve, etc
- In industry, we need empirical evidence to justify the use of any new technologies
 - How to justify this effort to adopt MBT considering the context of the client?

Getting Empirical Evidence: Process Simulation

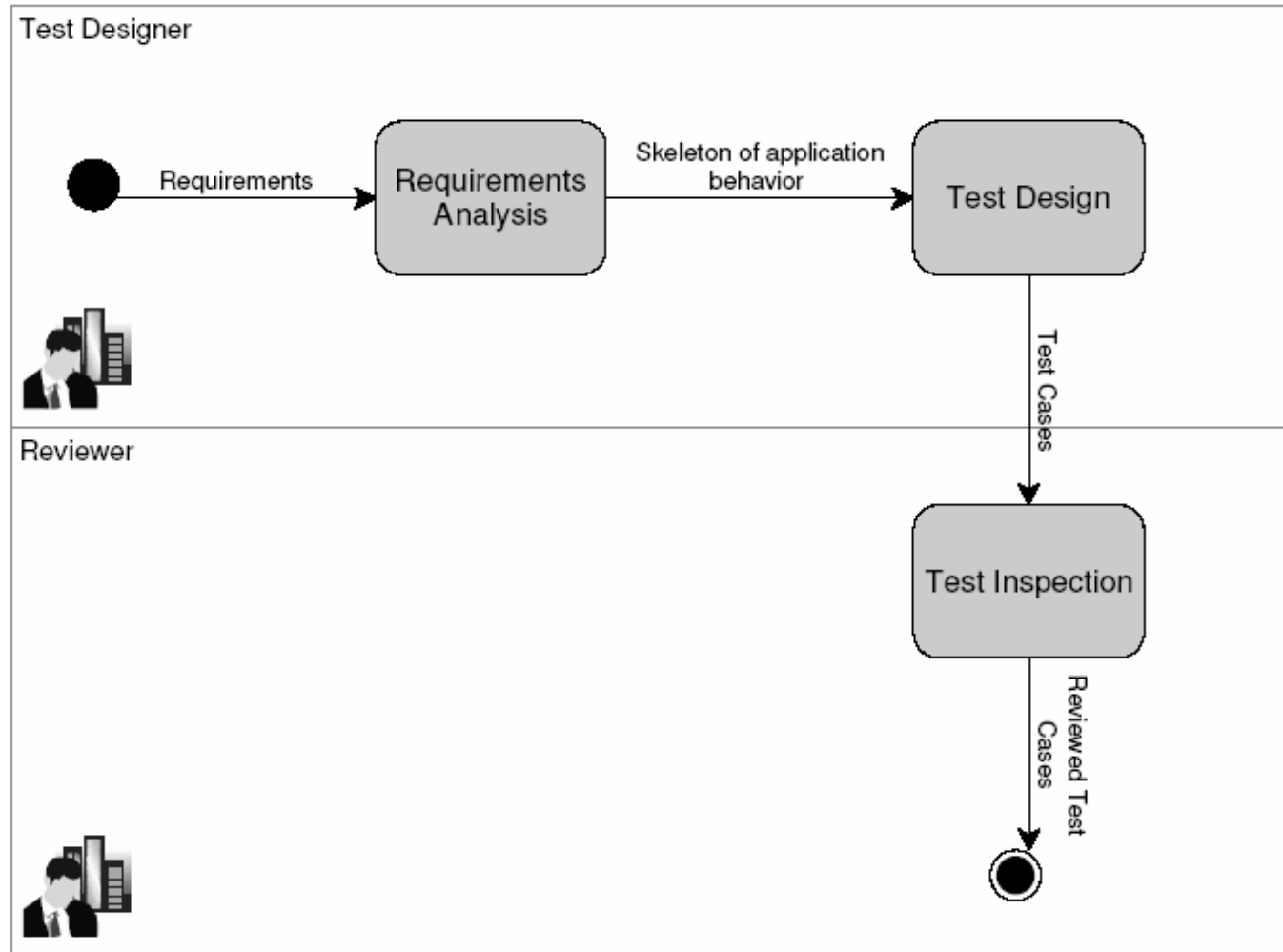
- Modeling of the two test design processes

Manual Test Design

Automated Test Design with TaRGeT

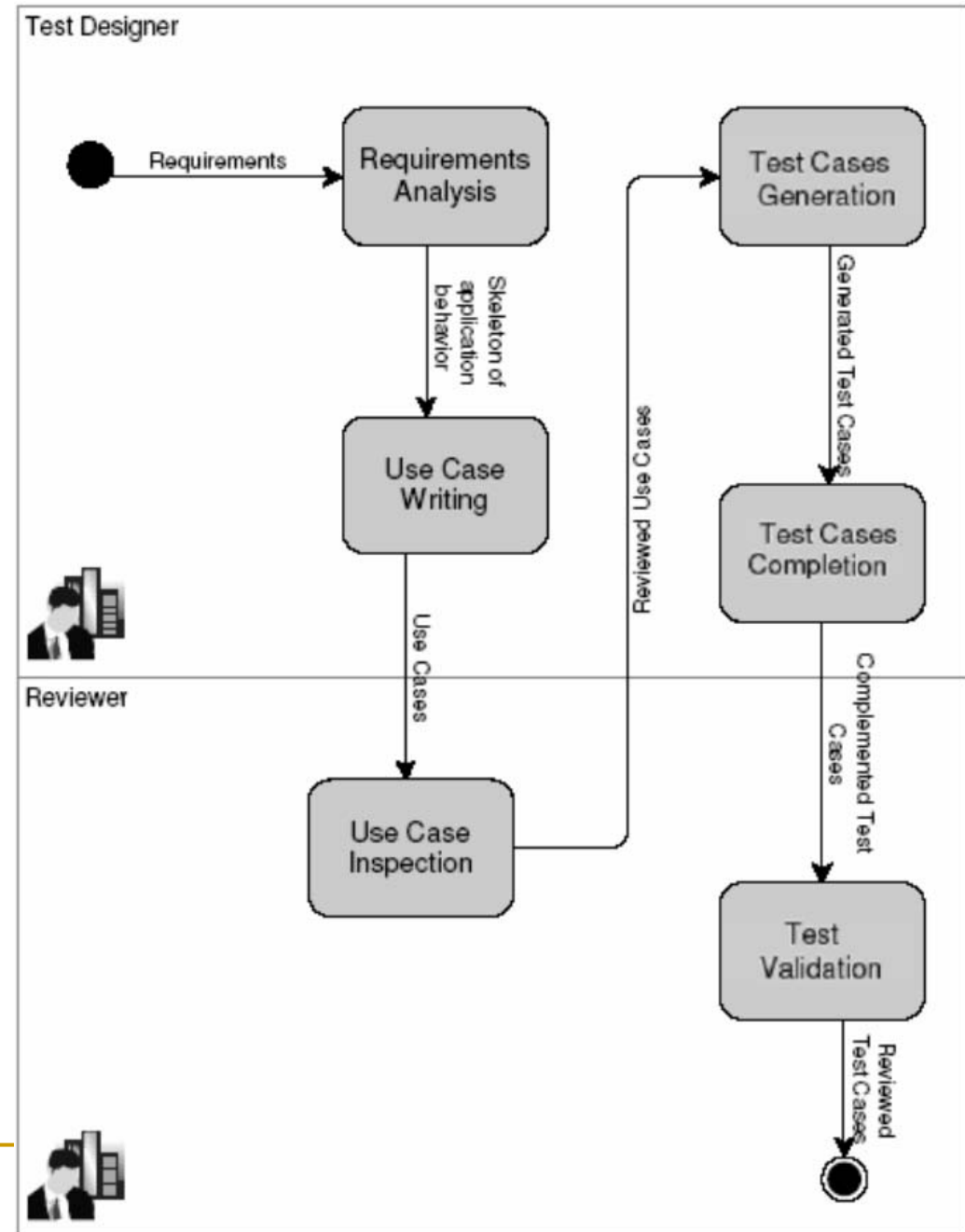
- Simulation of the execution of the processes
 - Analysis of multiple scenarios
 - Effort analysis with paired comparison
 - Statistical hypothesis tests
- Reduced cost

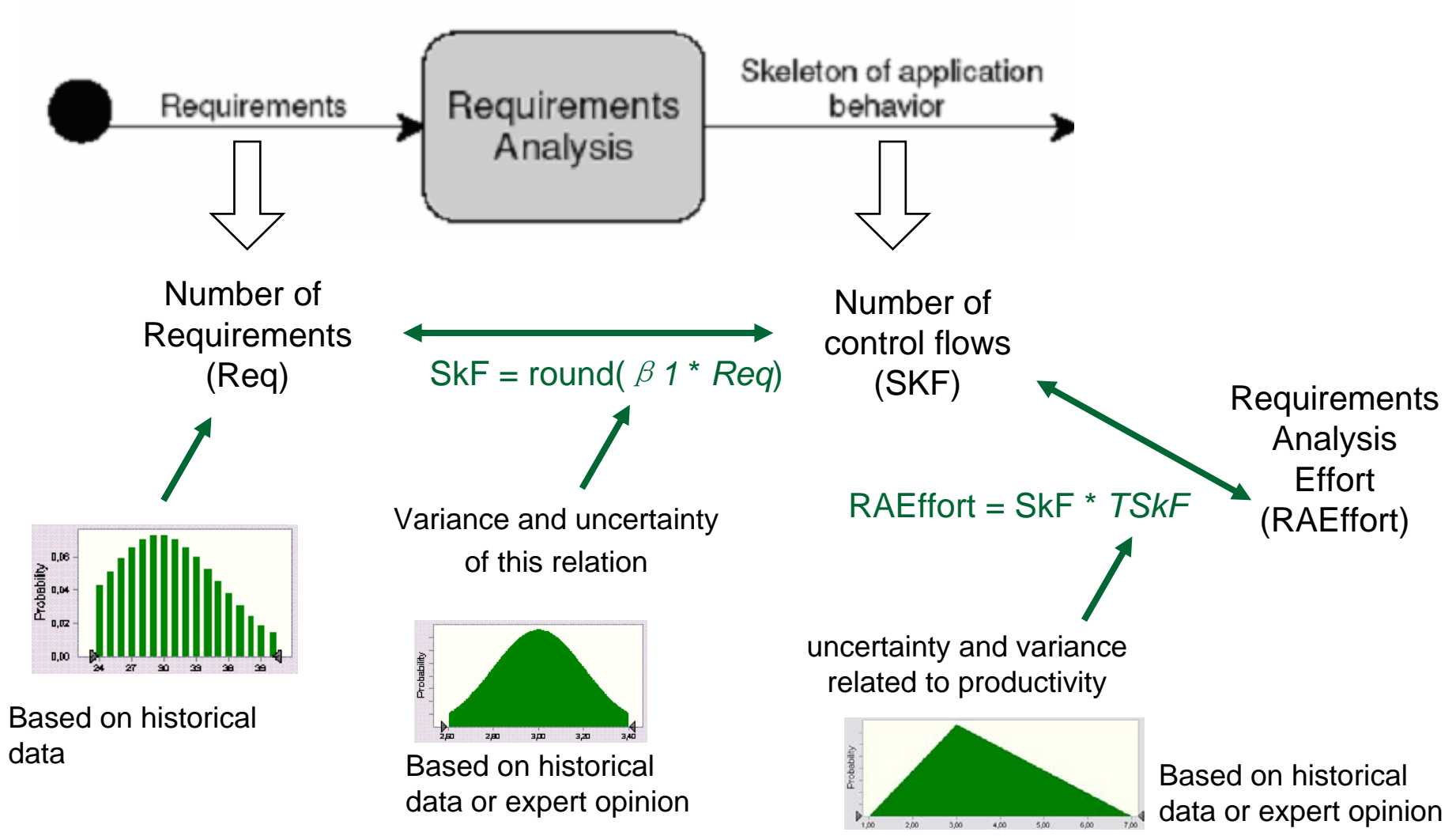
Manual Test Design: General Process



Automated Test Design Process

- TaRGeT Approach





Assumptions:

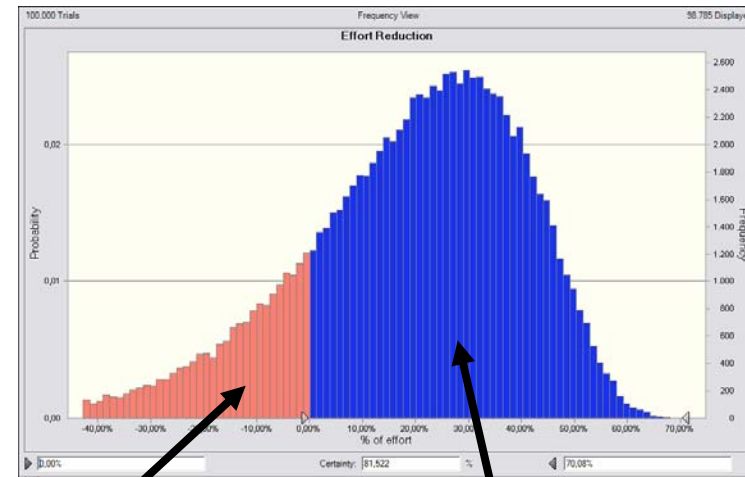
- ❑ The output of each activity can be deduced based on the inputs
- ❑ Effort can be deduced based on the output of each activity
- ❑ Linear relationships

Calculating the Effort Reduction

- **ManualProcessEffort** =
RAEffort + TDEffort + TIEffort
- **AutomatedProcessEffort** =
RAEffort + UCEffort + UCInspEffort
+ *TCGEffort* + CompGTCEffort + TVEffort
- **EffortReduction** = ManualProcessEffort –
AutomatedProcessEffort

Simulation Results

- Graphical outputs



Scenarios with negative results

Scenarios with positive results

- Descriptive statistics about the effort reduction
- Simulation log
 - Can be filtered to identify the best and worst scenarios
 - Enough data to support statistical hypothesis test

Conclusions: Advantages of Using Process Simulation

- Analysis of multiple scenarios
- Can be used to investigate specific scenarios
 - Learning curve, etc.
- Requires less effort than pilot projects
- Relations and assumptions of the simulation model are explicit

Conclusions: Advantages of Using Process Simulation

- Useful insights, predictions and empirical evidences
- Analysis per activity
 - Highlight points in the process to improve

Conclusions: Drawbacks of Using Process Simulation

- Difficulty to create models close to reality
 - Relations based on expert opinion
 - Characterization of artifacts
 - Inputs -> Outputs, Output -> Effort, ...
 - Linear vs. non-linear relationships
- Lack of data for the model calibration
 - In general, non-biased historical data for new technologies are not available

Next Steps

- Identify model parameters that TaRGeT should provide to ensure best performance
- Run case studies to collect more data (in progress)
 - Analyze results and compare with simulation results
- Recalibrate simulation model and analyze results again
 - Compare to the first simulation model
 - Determine root causes of the variations
- Try new process modeling and simulation tools
- Effort reduction x Quality improvement

Using Process Simulation to Assess the Test Design Effort Reduction of a MBT Approach

Thank you!

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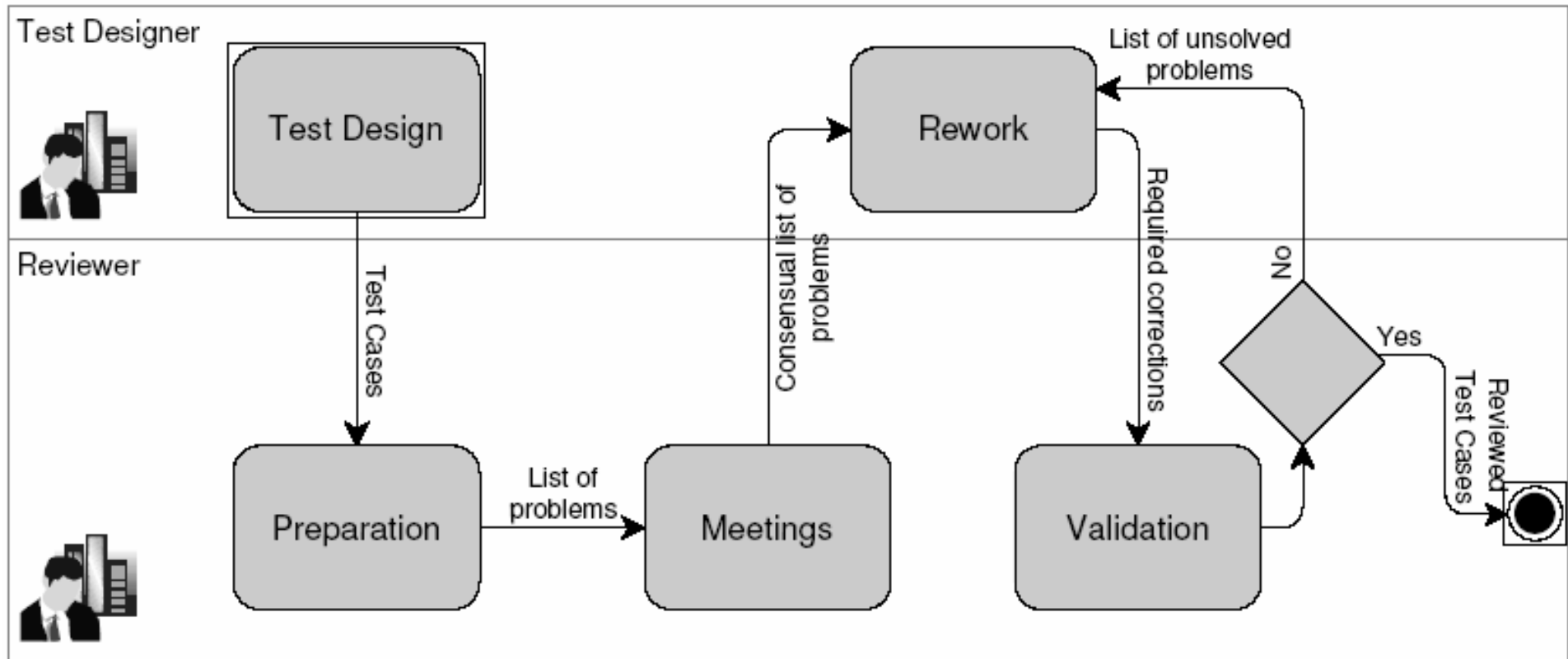
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BACKUP SLIDES

Getting Empirical Evidence: Pilot Studies

- Try the solution in the client environment
- Limited conclusions
 - Small projects and simple scenarios
 - How to compare with current solutions?
- Significant cost to run
 - Changes in the process
 - Availability of additional resources
 - Training

Manual Test Design: Test Inspection



Artifact	Variable	Description	Determined by
Requirements	Req	Number of requirements.	
Skeleton of application behavior	SkF	Number of control flows identified in the skeleton.	Req
Use cases	UCF	Number of control flows written in the UCs.	SkF
	RwUCF	Number of reworked control flows.	UCF
Test cases	MTC	Number of TCs created manually.	SkF
	RwMTC	Number of MTCs cases that required rework.	MTC
	GTC	Number of test cases generated automatically.	UCF
	CompGTC	# of GTCs that required a manual completion.	GTC
	RwGTC	Number of GTCs that required rework after validation.	CompGTC

$$\text{RAEffort} = \text{SkF} * \text{TSkF}$$

$$\text{TDEffort} = \text{MTC} * \text{TMTC}$$

$$\text{TIEffort} = \text{PrepEffort} + \text{MeetEffort} + \text{RwEffort} + \text{ValidEffort}$$

$$\text{PrepEffort} = \text{MTC} * \text{TPrepTC} * \text{Reviewers}$$

$$\text{MeetEffort} = \text{RwMTC} * \text{TMeetTC} * \text{Reviewers}$$

$$\text{RwEffort} = \text{RwMTC} * \text{TRwTC}$$

$$\text{ValidEffort} = \text{RwMTC} * \text{TValidTC}$$

$$\text{UCEffort} = \text{UCF} * \text{TUCF}$$

$$\text{CompGTCEffort} = \text{GTC} * \text{TAnalyzeGTC} + \text{CompGTC} * \text{TCompGTC}$$

$$\text{ManualProcessEffort} = \text{RAEffort} + \text{TDEffort} + \text{TIEffort}$$

$$\begin{aligned} \text{AutomatedProcessEffort} = & \text{RAEffort} + \text{UCEffort} + \text{UCInspEffort} \\ & + \text{TCGEffort} + \text{CompGTCEffort} + \text{TVEffort} \end{aligned}$$

$$\text{EffortReduction} = (\text{ManualProcessEffort} - \text{AutomatedProcessEffort}) / \text{ManualProcessEffort}$$

Analyzing Specific Scenarios

- Simulation can consider all possible scenarios or be restricted to specific scenarios

Scenario	Size of Requirements	Productivity	
		Manual Process	Automated Process
1	Low	High	Low
2	Low	High	Average
3	Low	High	High
4	Average	High	Low
5	Average	High	Average
6	Average	High	High
7	High	High	Low
8	High	High	Average
9	High	High	High

Simulation of the Test Design Process

- Modeling of the two test design processes

Manual Test Design

Automated Test Design with TaRGeT

- Addition of behavioral information
 - Productivity
 - Characteristics of the generated artifacts
 - Focus on the effort reduction analysis
- Simulation and result analysis

Conclusions: Drawbacks of Using Process Simulation

- Complex tools, lot of resources, sometimes difficult to understand and use
- Lack of modeling support for simulation
 - Output determined based on activity inputs
 - Process comparison