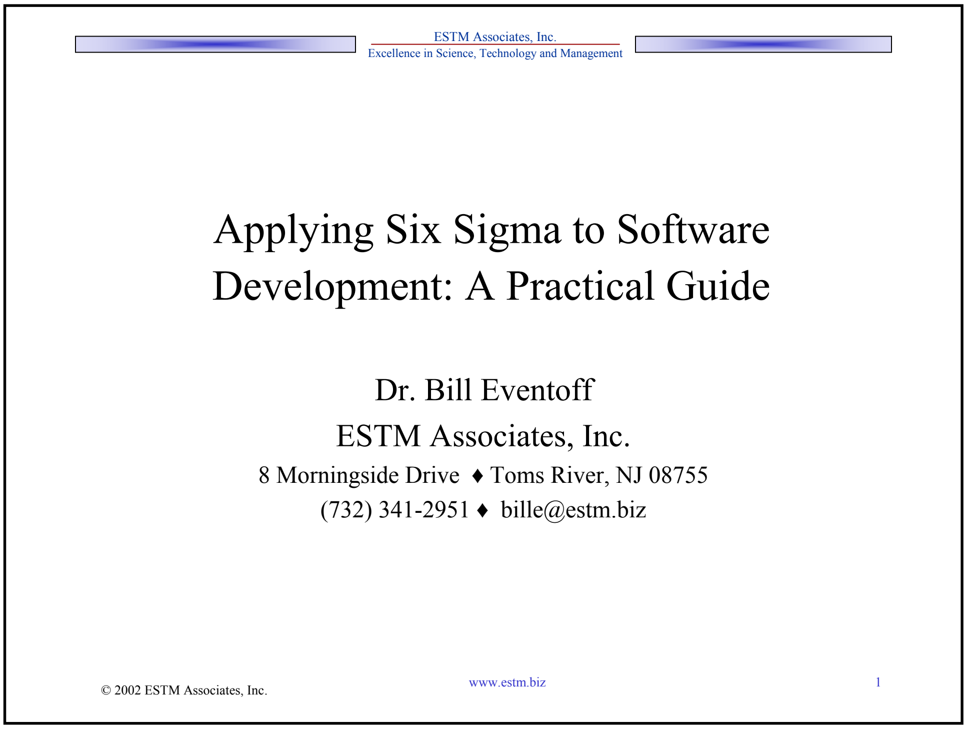

Applying Six Sigma to Software Development: A Practical Guide

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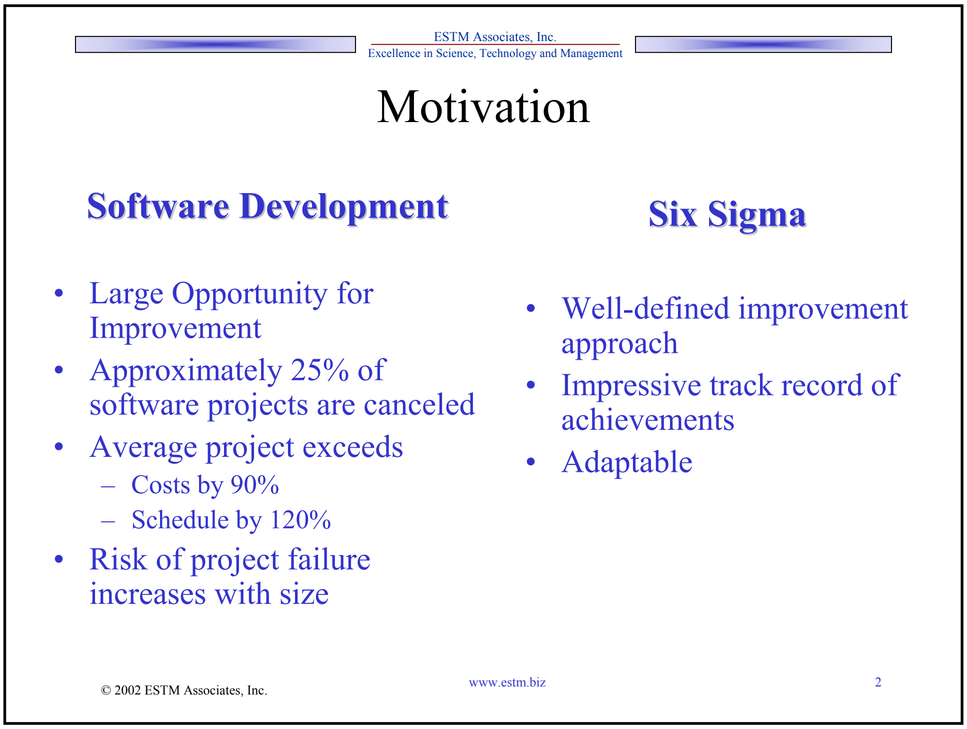


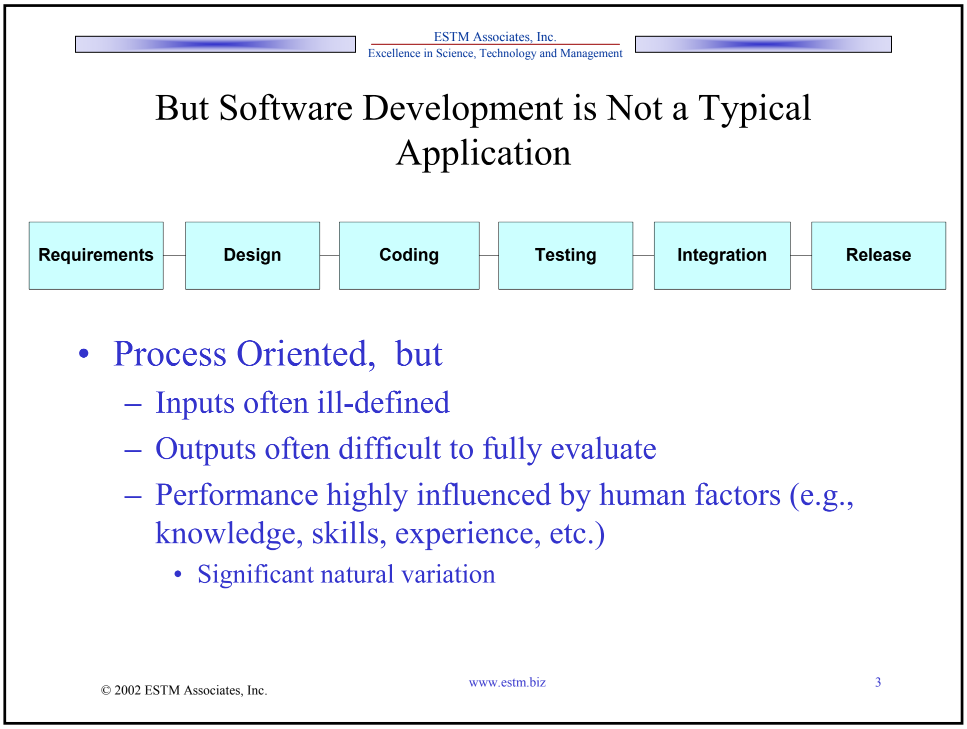
Motivation

Software Development

- Large Opportunity for Improvement
- Approximately 25% of software projects are canceled
- Average project exceeds
  - Costs by 90%
  - Schedule by 120%
- Risk of project failure increases with size

Six Sigma

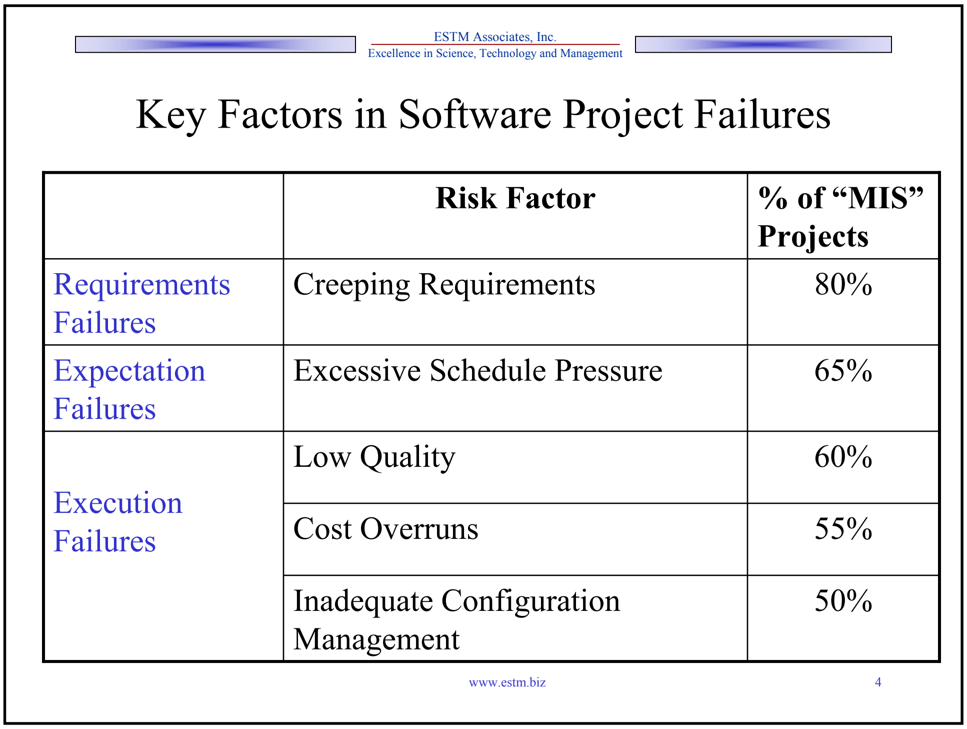
- Well-defined improvement approach
- Impressive track record of achievements
- Adaptable



But Software Development is Not a Typical Application

Requirements	Design	Coding	Testing	Integration	Release

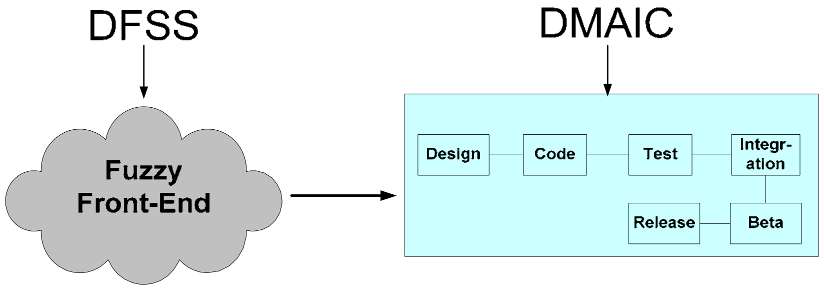
- Process Oriented, but
  - Inputs often ill-defined
  - Outputs often difficult to fully evaluate
  - Performance highly influenced by human factors (e.g., knowledge, skills, experience, etc.)
    - Significant natural variation



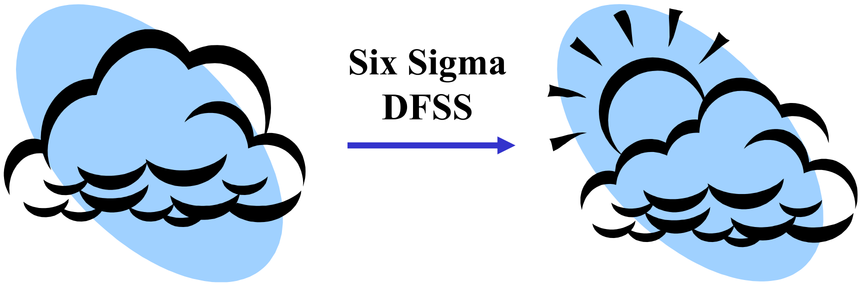
Key Factors in Software Project Failures

	Risk Factor	% of "MIS" Projects
Requirements Failures	Creeping Requirements	80%
Expectation Failures	Excessive Schedule Pressure	65%
Execution Failures	Low Quality	60%
	Cost Overruns	55%
	Inadequate Configuration Management	50%

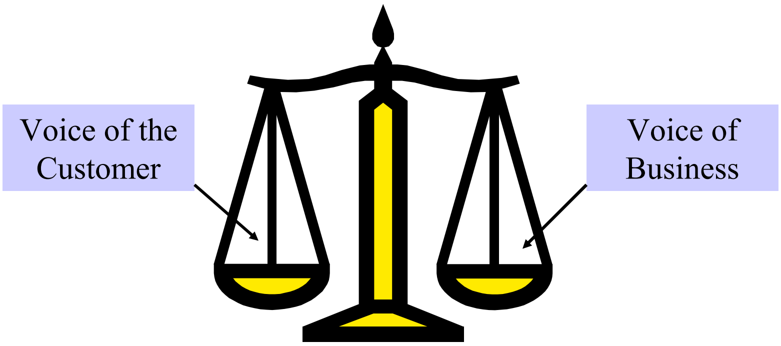
Applying Six Sigma to Software Development



Fuzzy Front End



Balance the VOC and the VOB

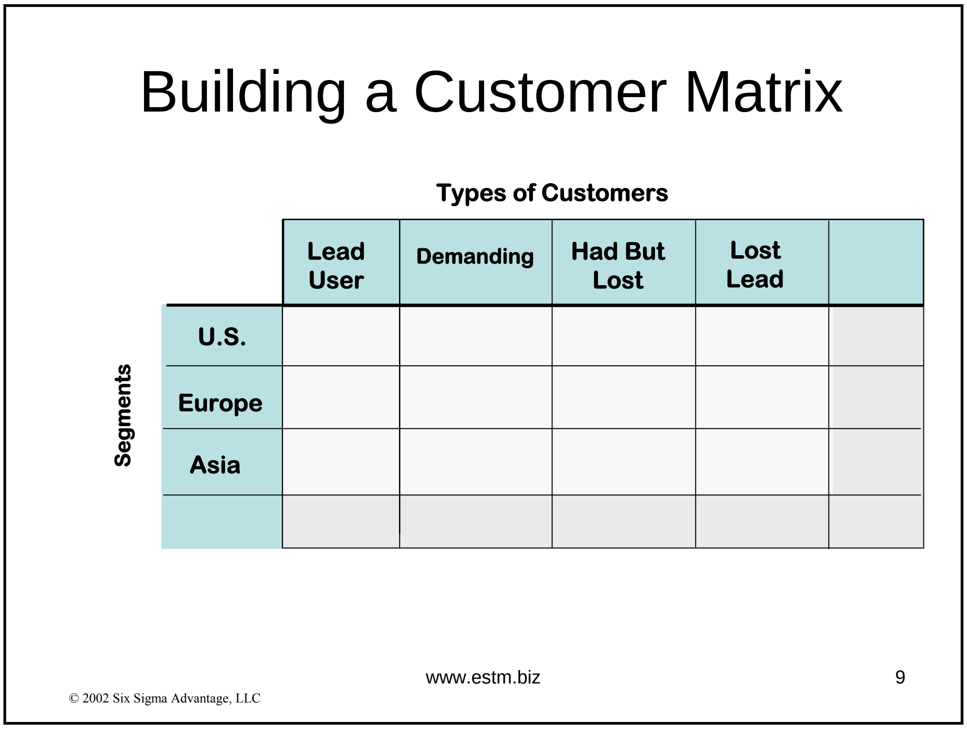


Voice of the Customer

Voice of Business

VOC – Voice of the Customer

- Understand Internal and External Customers and Target Environment



Building a Customer Matrix

Types of Customers

Segments

	Lead User	Demanding	Had But Lost	Lost Lead	
U.S.					
Europe					
Asia					

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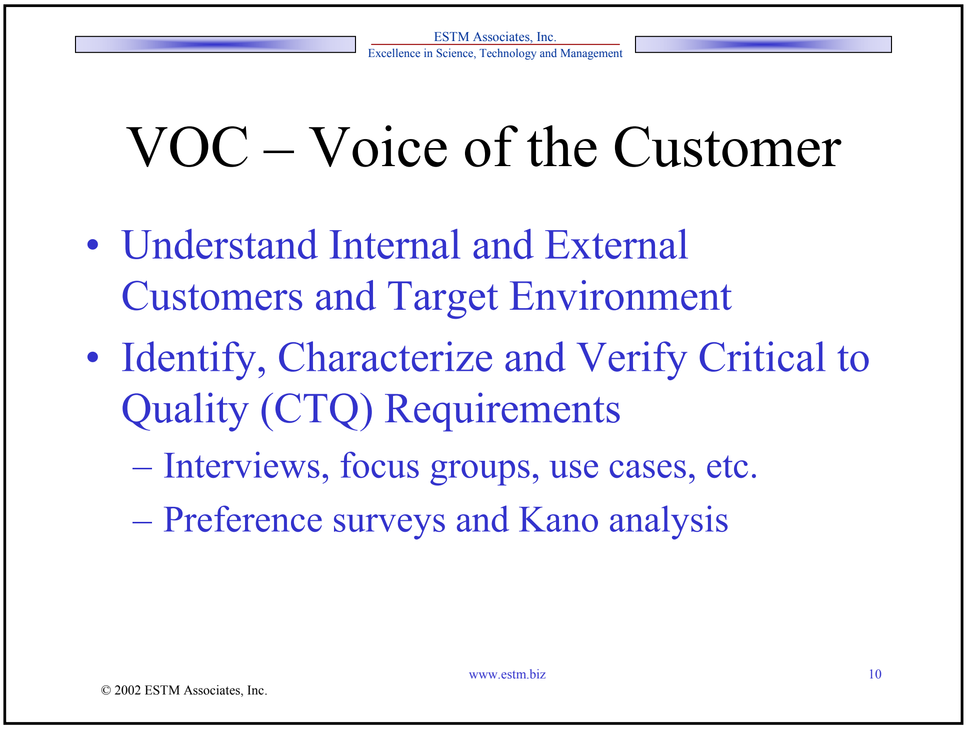

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VOC – Voice of the Customer

- Understand Internal and External Customers and Target Environment
- Identify, Characterize and Verify Critical to Quality (CTQ) Requirements
  - Interviews, focus groups, use cases, etc.
  - Preference surveys and Kano analysis

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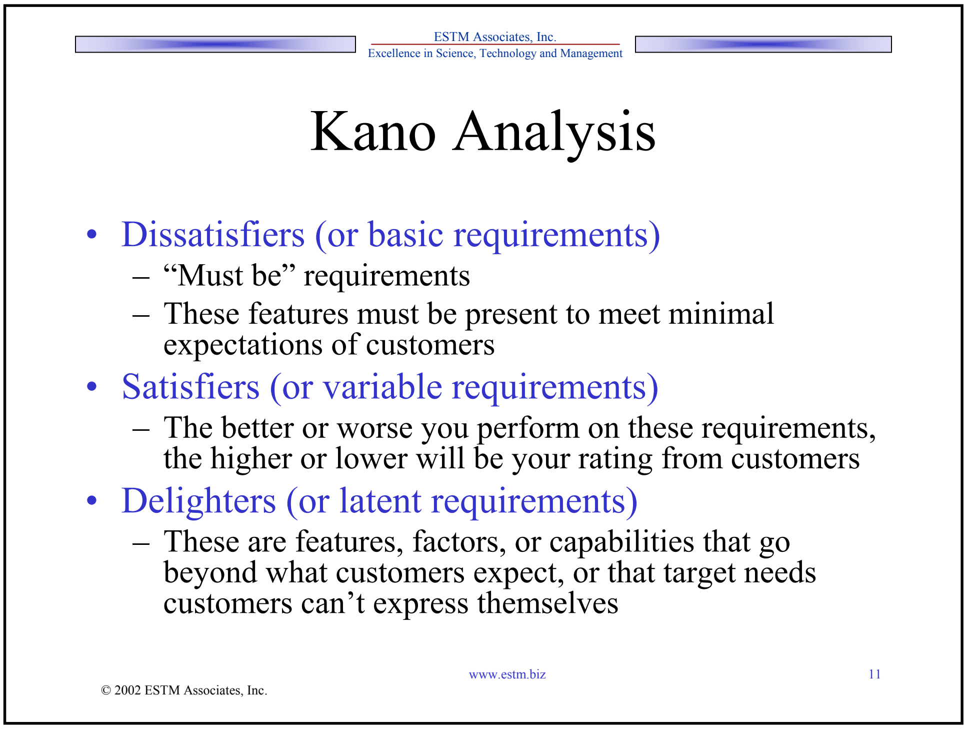

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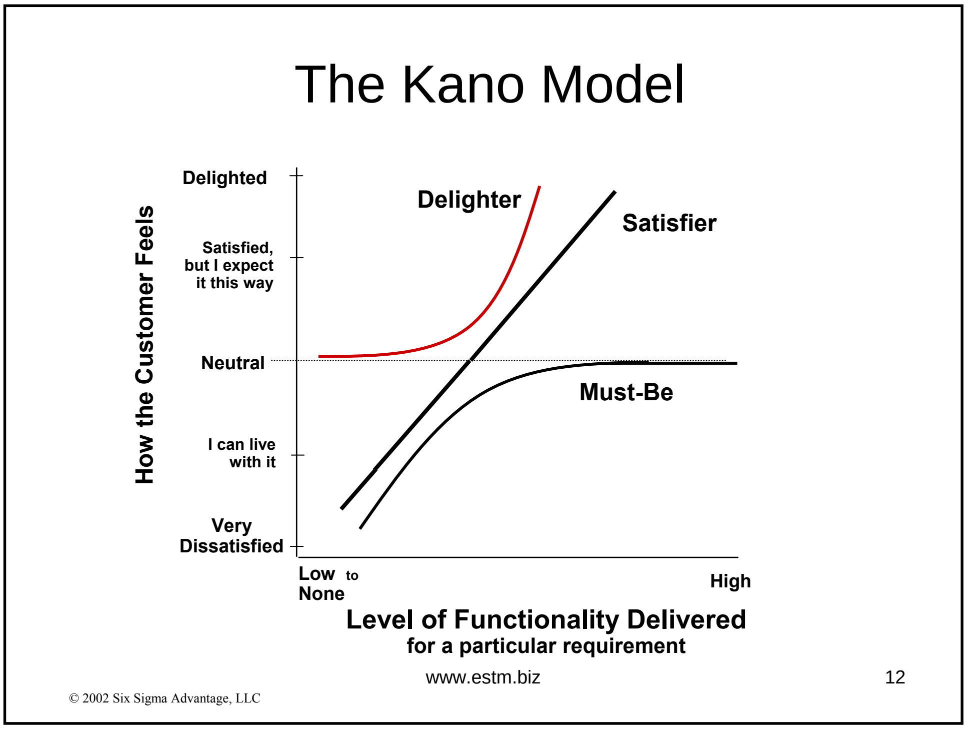
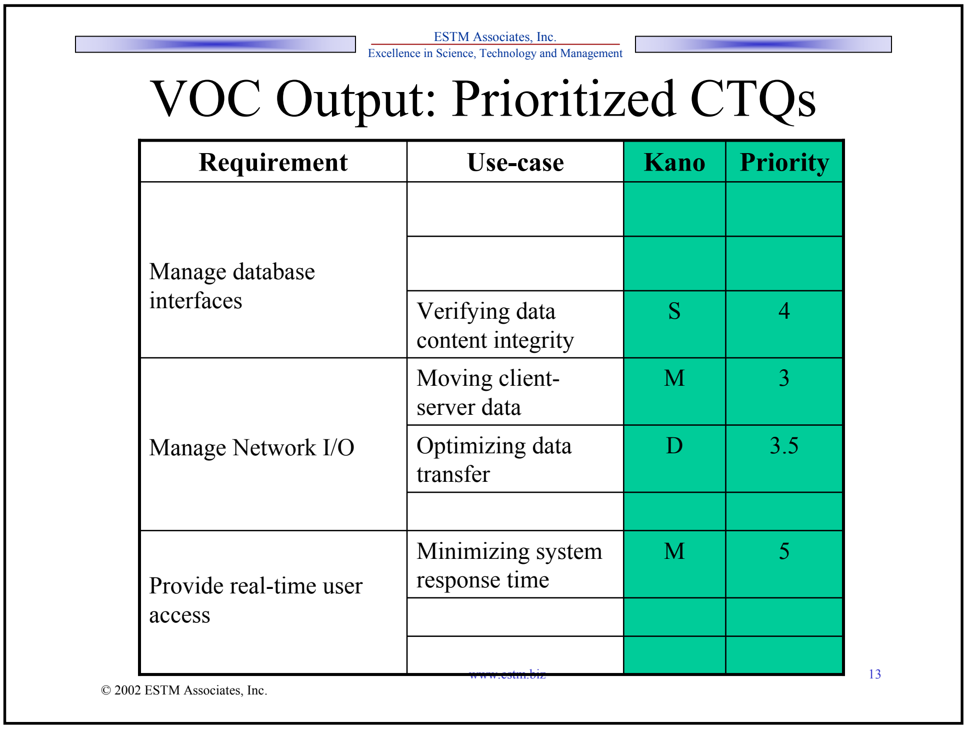
Kano Analysis

- Dissatisfiers (or basic requirements)
  - “Must be” requirements
  - These features must be present to meet minimal expectations of customers
- Satisfiers (or variable requirements)
  - The better or worse you perform on these requirements, the higher or lower will be your rating from customers
- Delighters (or latent requirements)
  - These are features, factors, or capabilities that go beyond what customers expect, or that target needs customers can’t express themselves

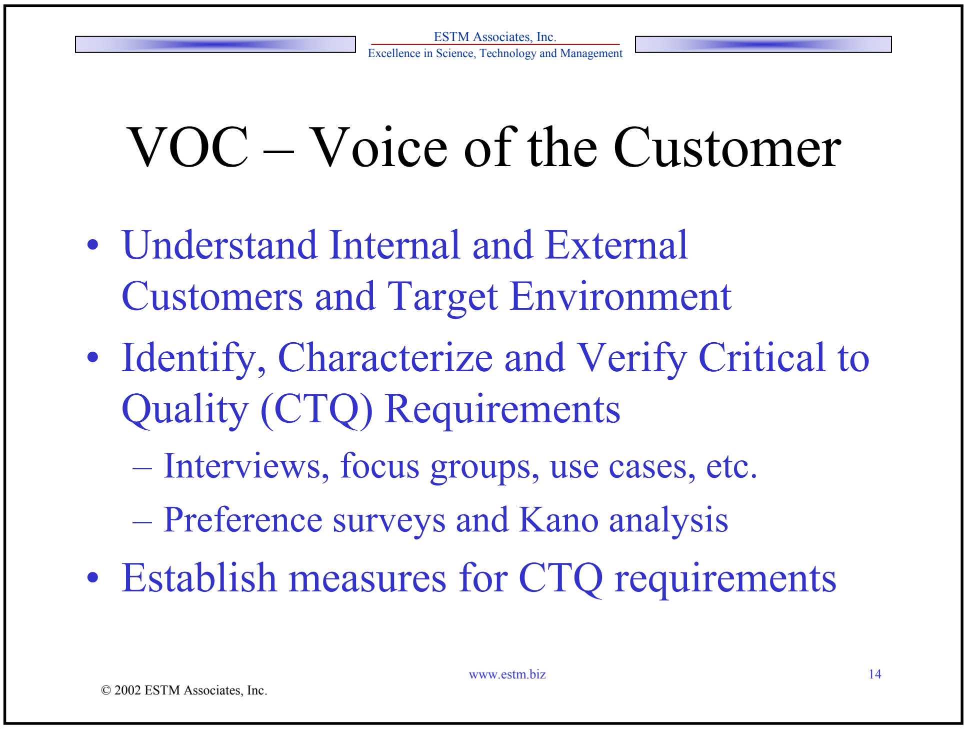
The Kano Model





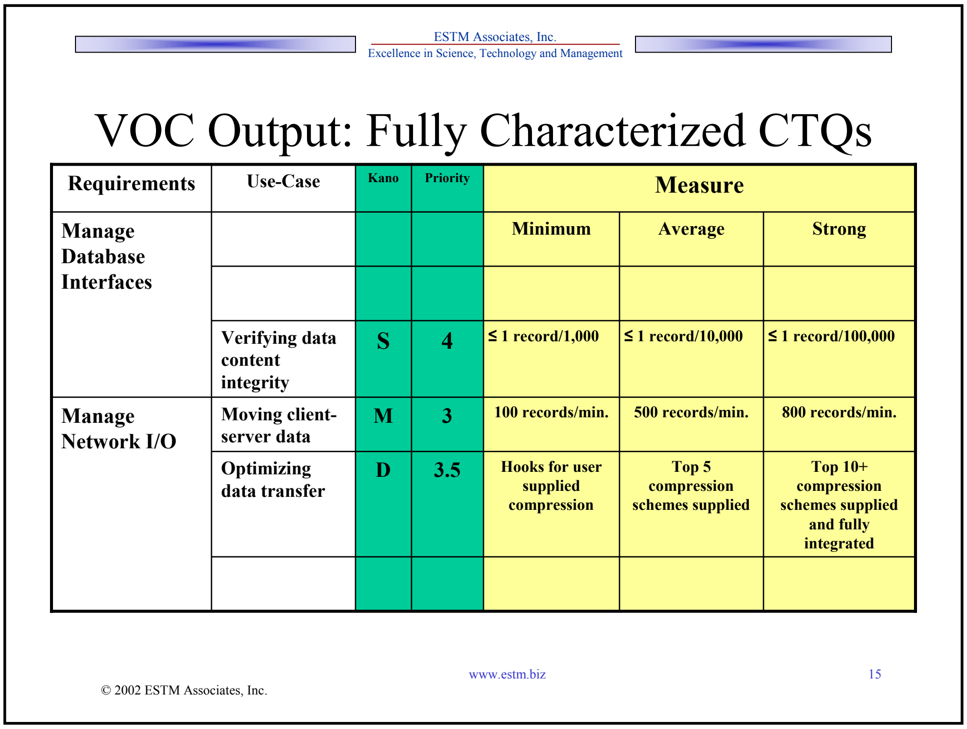
VOC Output: Prioritized CTQs

Requirement	Use-case	Kano	Priority
Manage database interfaces			
	Verifying data content integrity	S	4
Manage Network I/O	Moving client-server data	M	3
	Optimizing data transfer	D	3.5
Provide real-time user access	Minimizing system response time	M	5



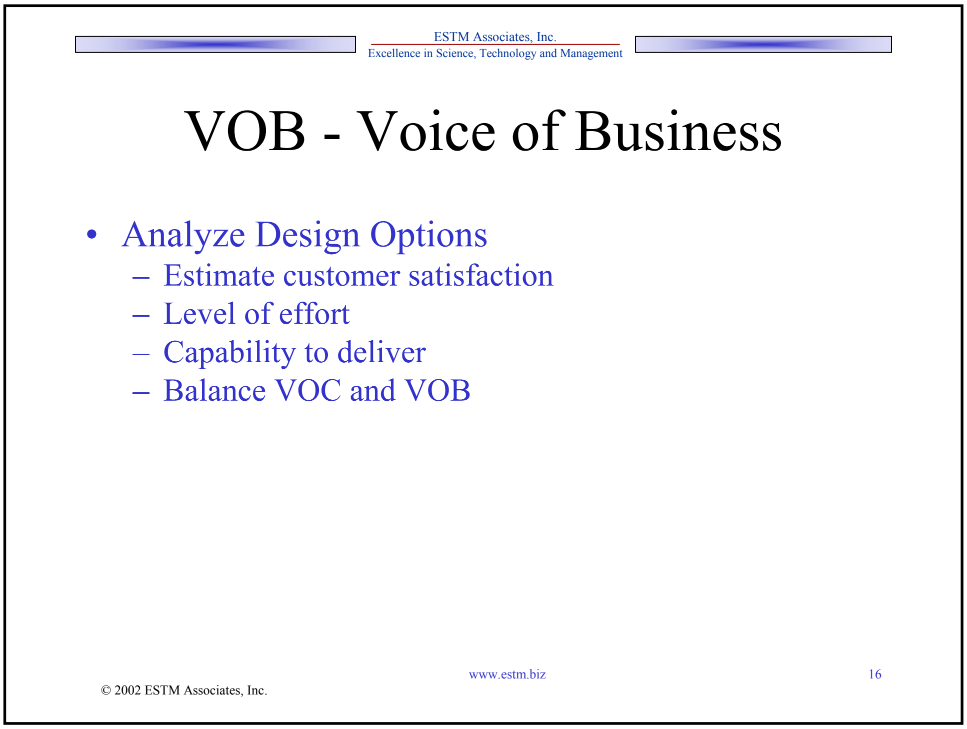
VOC – Voice of the Customer

- Understand Internal and External Customers and Target Environment
- Identify, Characterize and Verify Critical to Quality (CTQ) Requirements
  - Interviews, focus groups, use cases, etc.
  - Preference surveys and Kano analysis
- Establish measures for CTQ requirements



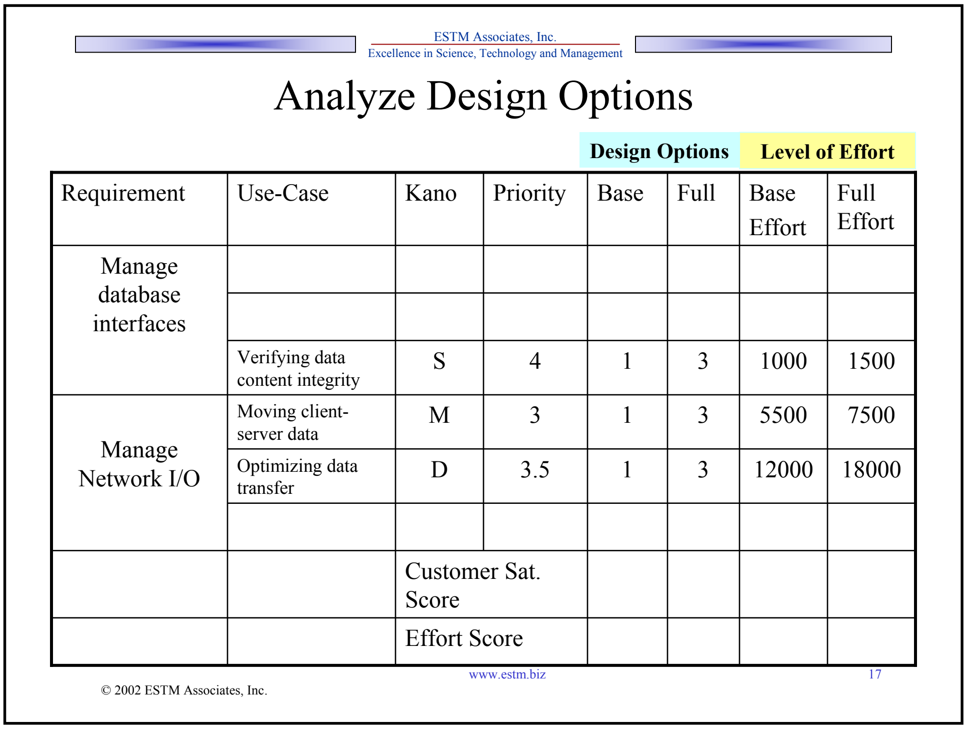
VOC Output: Fully Characterized CTQs

Requirements	Use-Case	Kano	Priority	Measure		
Manage Database Interfaces				Minimum	Average	Strong
	Verifying data content integrity	S	4	≤ 1 record/1,000	≤ 1 record/10,000	≤ 1 record/100,000
Manage Network I/O	Moving client-server data	M	3	100 records/min.	500 records/min.	800 records/min.
	Optimizing data transfer	D	3.5	Hooks for user supplied compression	Top 5 compression schemes supplied	Top 10+ compression schemes supplied and fully integrated



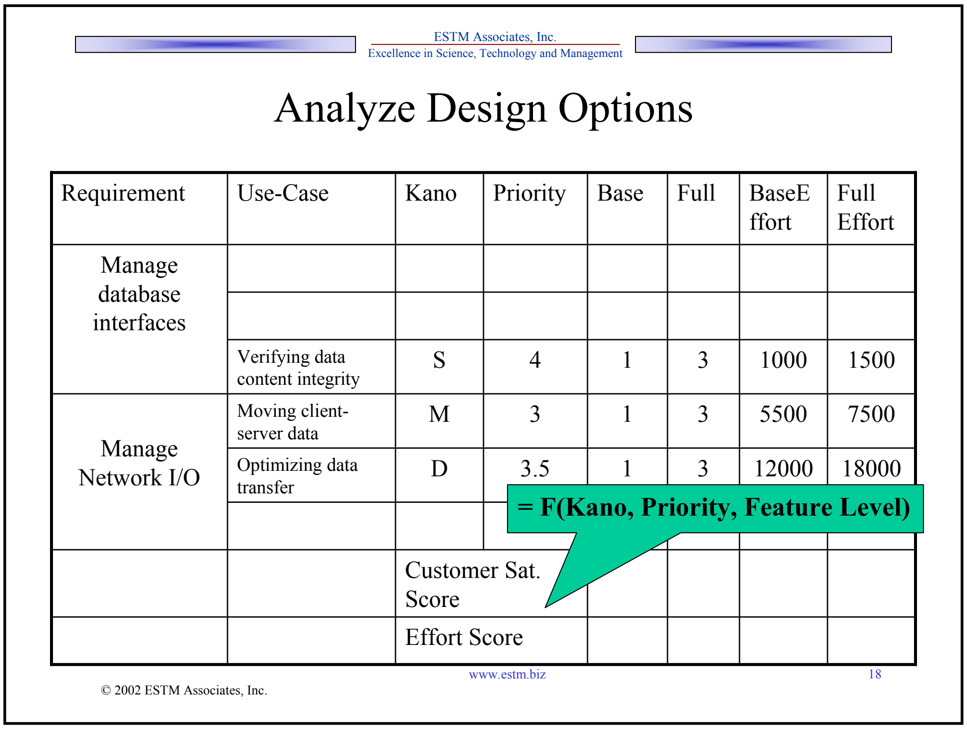
VOB - Voice of Business

- Analyze Design Options
  - Estimate customer satisfaction
  - Level of effort
  - Capability to deliver
  - Balance VOC and VOB



Analyze Design Options

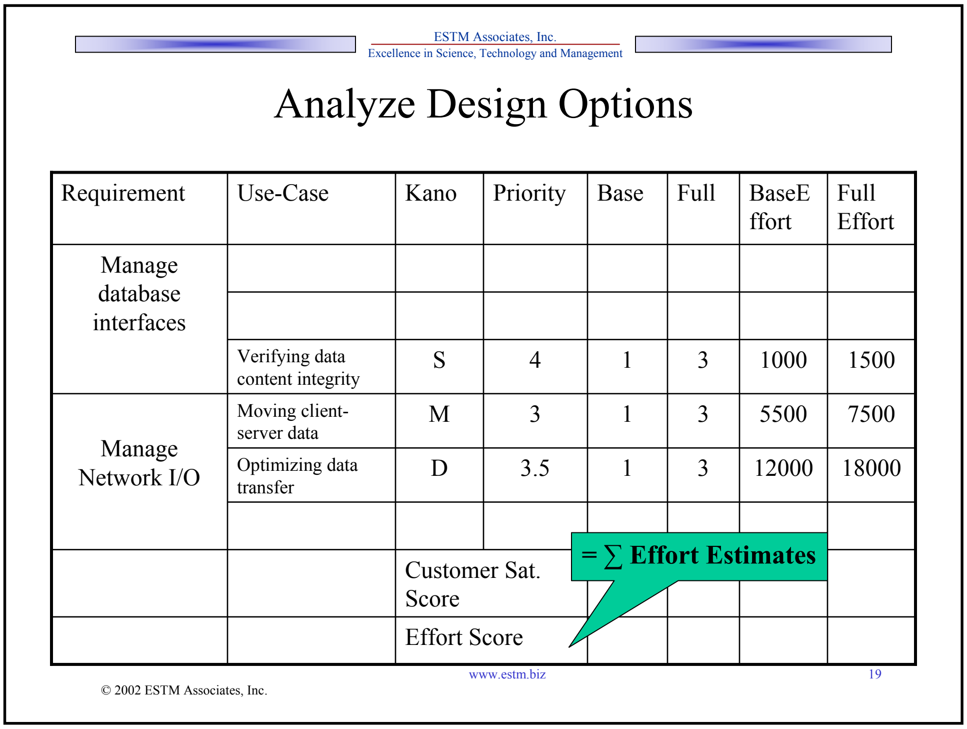
				Design Options		Level of Effort	
Requirement	Use-Case	Kano	Priority	Base	Full	Base Effort	Full Effort
Manage database interfaces							
	Verifying data content integrity	S	4	1	3	1000	1500
Manage Network I/O	Moving client-server data	M	3	1	3	5500	7500
	Optimizing data transfer	D	3.5	1	3	12000	18000
		Customer Sat. Score					
		Effort Score					



Analyze Design Options

Requirement	Use-Case	Kano	Priority	Base	Full	BaseE ffort	Full Effort
Manage database interfaces							
	Verifying data content integrity	S	4	1	3	1000	1500
Manage Network I/O	Moving client-server data	M	3	1	3	5500	7500
	Optimizing data transfer	D	3.5	1	3	12000	18000
		Customer Sat. Score					
		Effort Score					

= F(Kano, Priority, Feature Level)



Analyze Design Options

Requirement	Use-Case	Kano	Priority	Base	Full	BaseEffort	Full Effort
Manage database interfaces							
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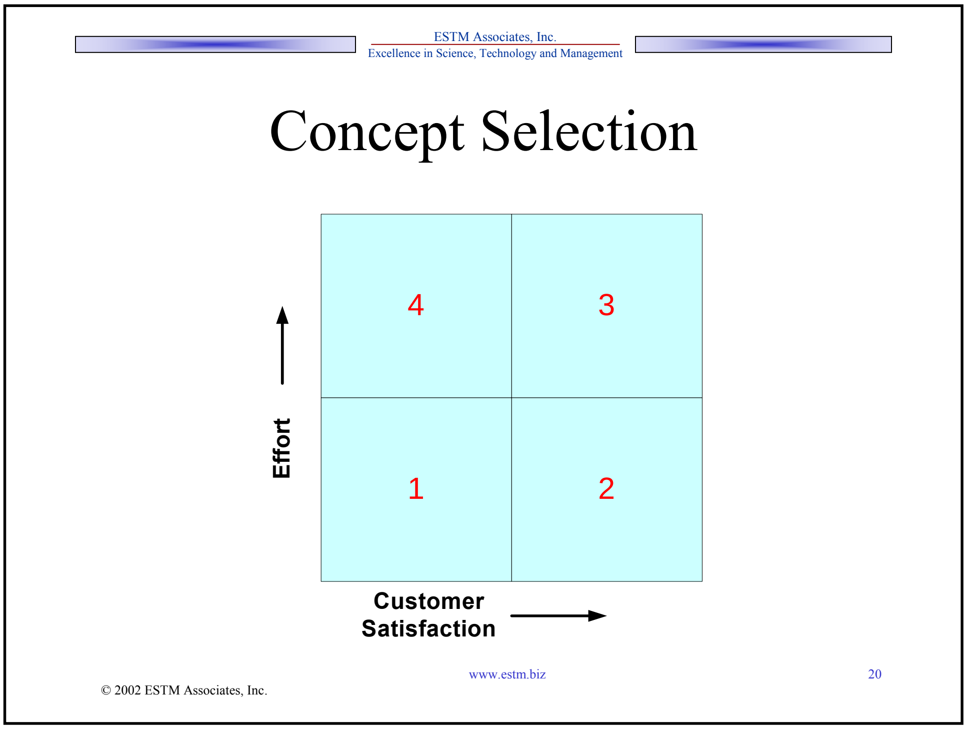
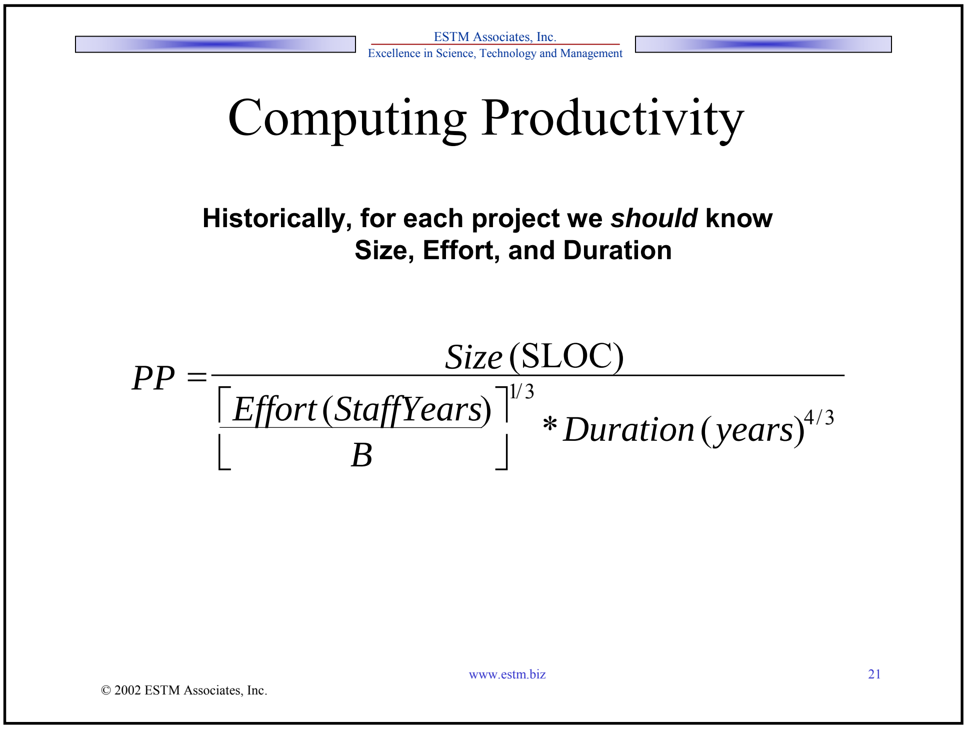
Manage Network I/O	Moving client-server data	M	3	1	3	5500	7500
	Optimizing data transfer	D	3.5	1	3	12000	18000
		Customer Sat. Score					
		Effort Score					

= ∑ Effort Estimates



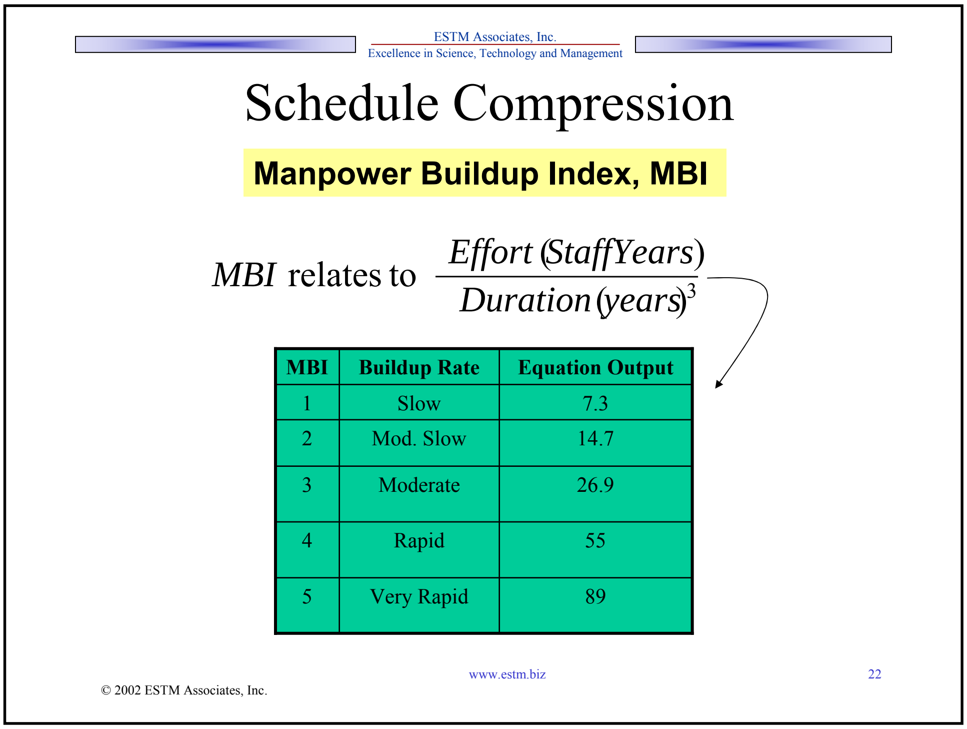
Concept Selection



Computing Productivity

Historically, for each project we *should* know
Size, Effort, and Duration

$$PP = \frac{Size\,(\mathrm{SLOC})}{\left[\frac{Effort\,(StaffYears)}{B}\right]^{1/3} * Duration\,(years)^{4/3}}$$

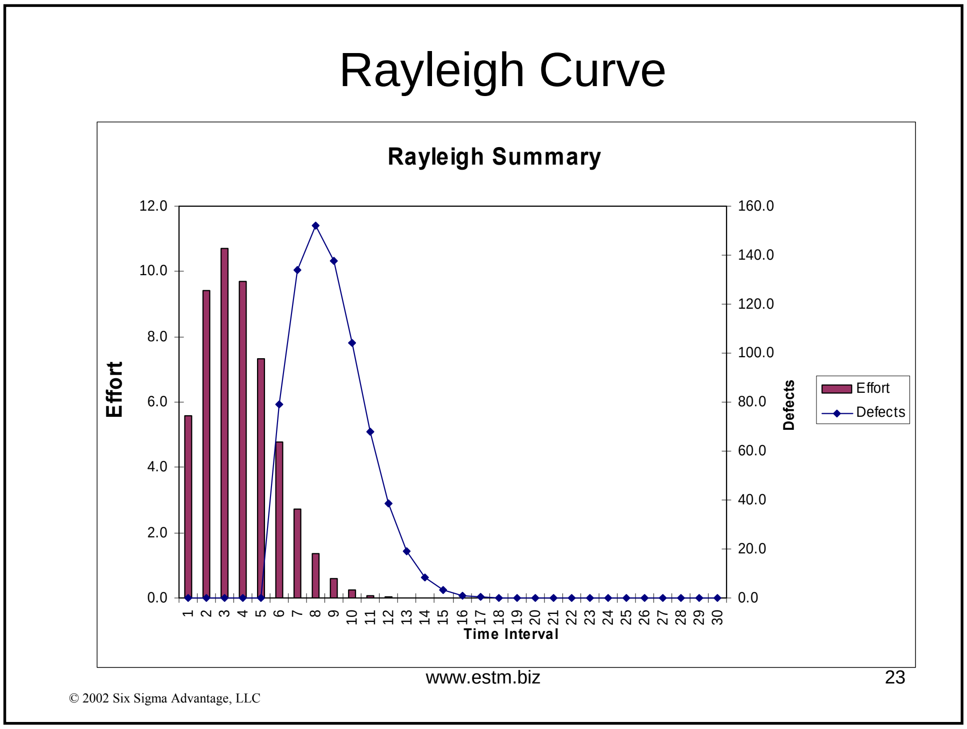


Schedule Compression

Manpower Buildup Index, MBI

$$MBI \text{ relates to } \frac{Effort\,(StaffYears)}{Duration\,(years)^{3}}$$

MBI	Buildup Rate	Equation Output
1	Slow	7.3
2	Mod. Slow	14.7
3	Moderate	26.9
4	Rapid	55
5	Very Rapid	89



Rayleigh Curve

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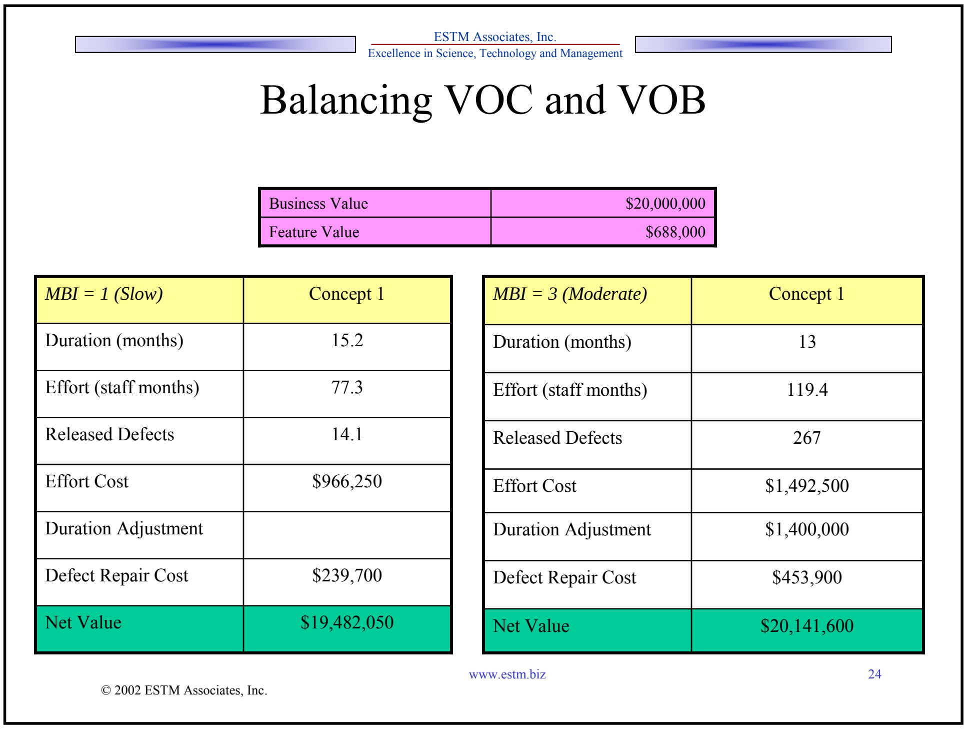

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Balancing VOC and VOB

Business Value	$20,000,000
Feature Value	$688,000

MBI = 1 (Slow)	Concept 1
Duration (months)	15.2
Effort (staff months)	77.3
Released Defects	14.1
Effort Cost	$966,250
Duration Adjustment	
Defect Repair Cost	$239,700
Net Value	$19,482,050

MBI = 3 (Moderate)	Concept 1
Duration (months)	13
Effort (staff months)	119.4
Released Defects	267
Effort Cost	$1,492,500
Duration Adjustment	$1,400,000
Defect Repair Cost	$453,900
Net Value	$20,141,600

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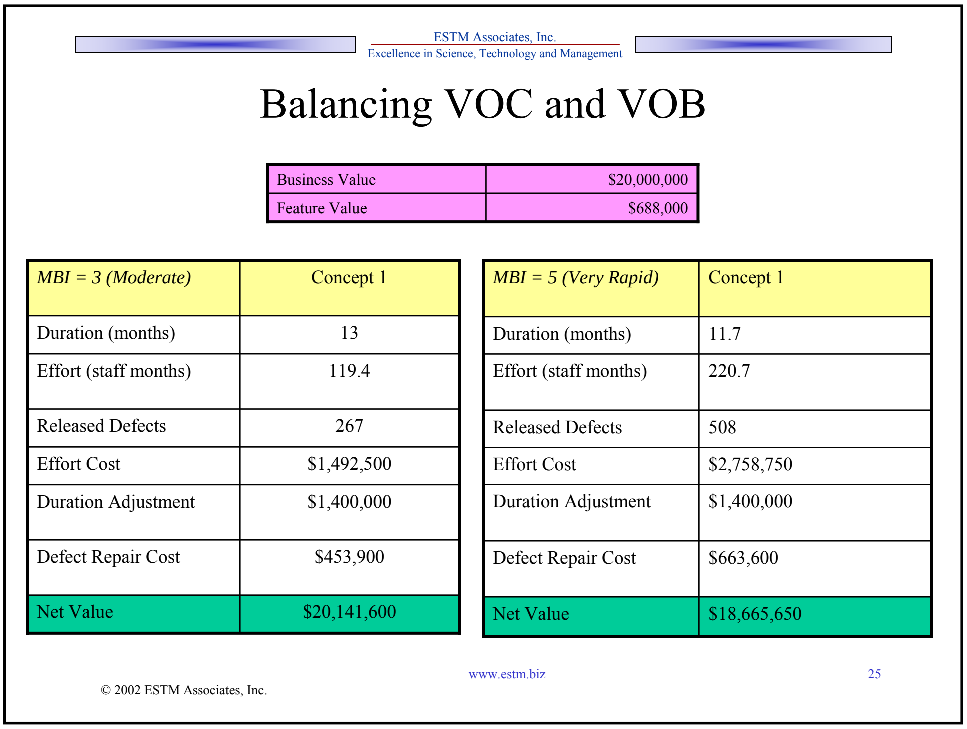
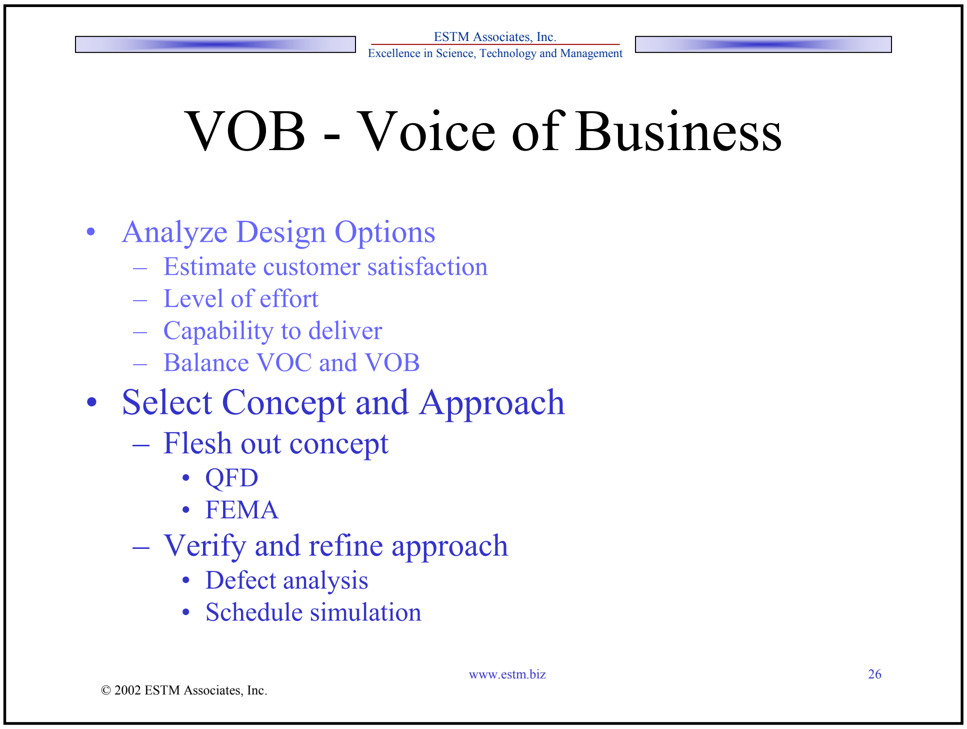


Balancing VOC and VOB

Business Value	$20,000,000
Feature Value	$688,000

MBI = 3 (Moderate)	Concept 1
Duration (months)	13
Effort (staff months)	119.4
Released Defects	267
Effort Cost	$1,492,500
Duration Adjustment	$1,400,000
Defect Repair Cost	$453,900
Net Value	$20,141,600

MBI = 5 (Very Rapid)	Concept 1
Duration (months)	11.7
Effort (staff months)	220.7
Released Defects	508
Effort Cost	$2,758,750
Duration Adjustment	$1,400,000
Defect Repair Cost	$663,600
Net Value	$18,665,650



VOB - Voice of Business

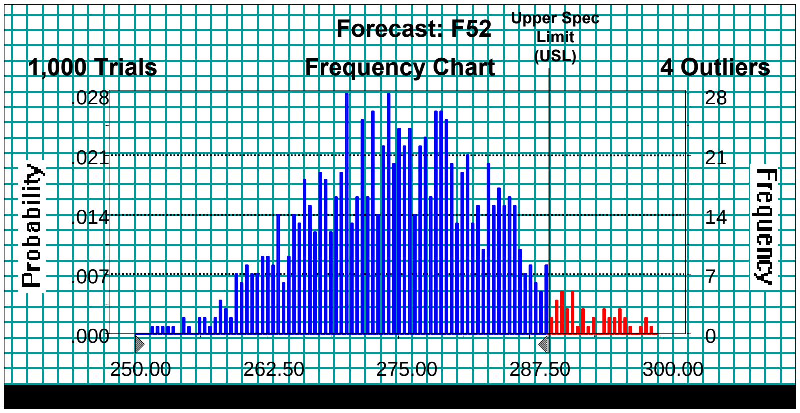
- Analyze Design Options
  - Estimate customer satisfaction
  - Level of effort
  - Capability to deliver
  - Balance VOC and VOB
- Select Concept and Approach
  - Flesh out concept
    - QFD
    - FEMA
  - Verify and refine approach
    - Defect analysis
    - Schedule simulation

Capability to Deliver on Time

Probabilistic Scheduling

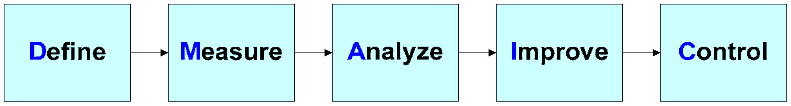
How much confidence should we have in the schedule?
… At a 95% confidence level

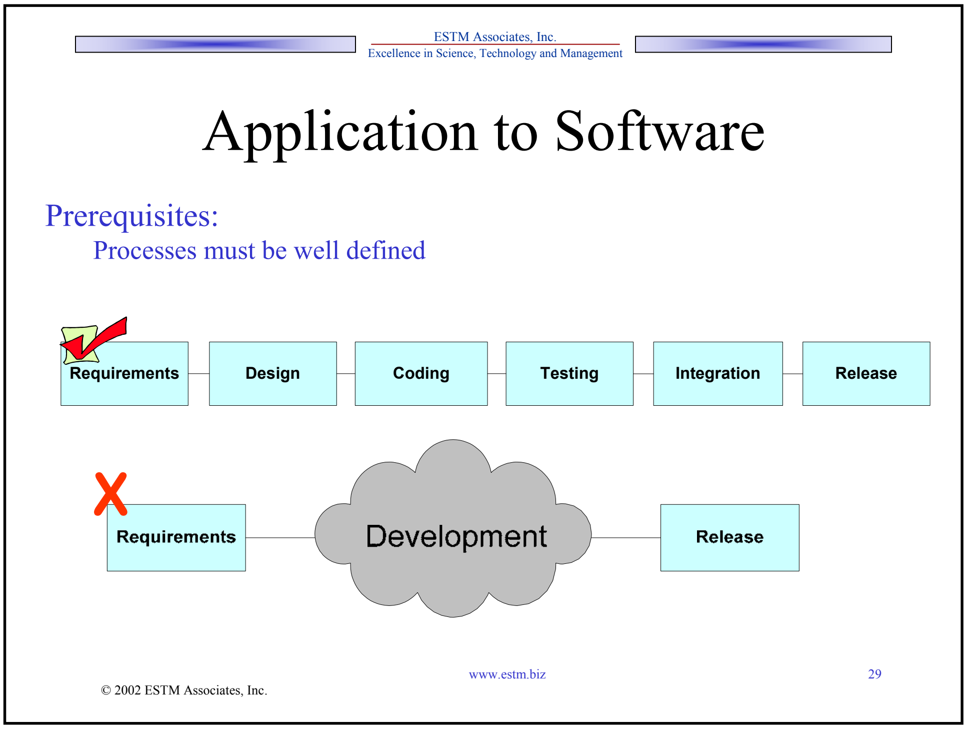
- latest mid March, 2003 (+ 43 days)
- earliest mid January, 2003 (- 15 days)



Process Improvement

Standard Six Sigma DMAIC Process





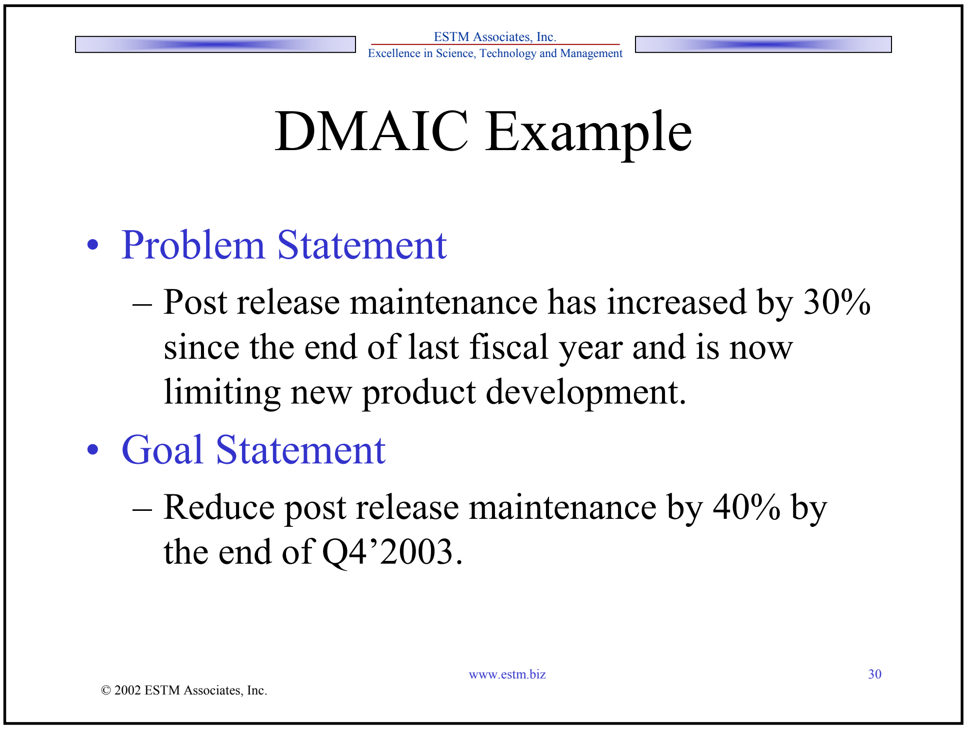
Application to Software

Prerequisites:

Processes must be well defined

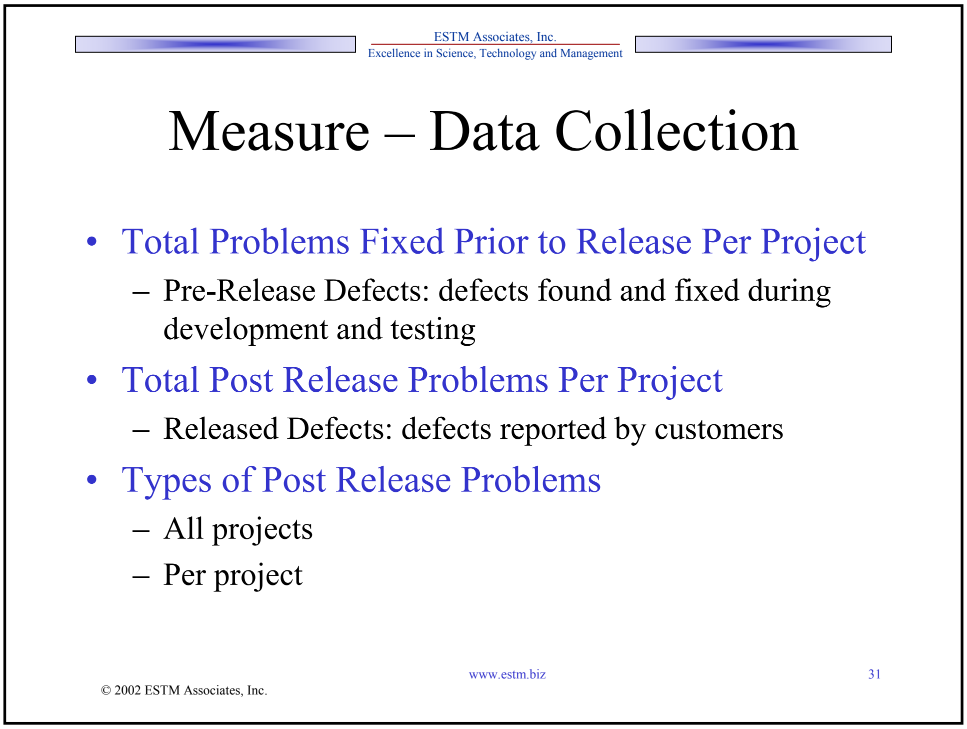
Requirements — Design — Coding — Testing — Integration — Release

Requirements — Development — Release



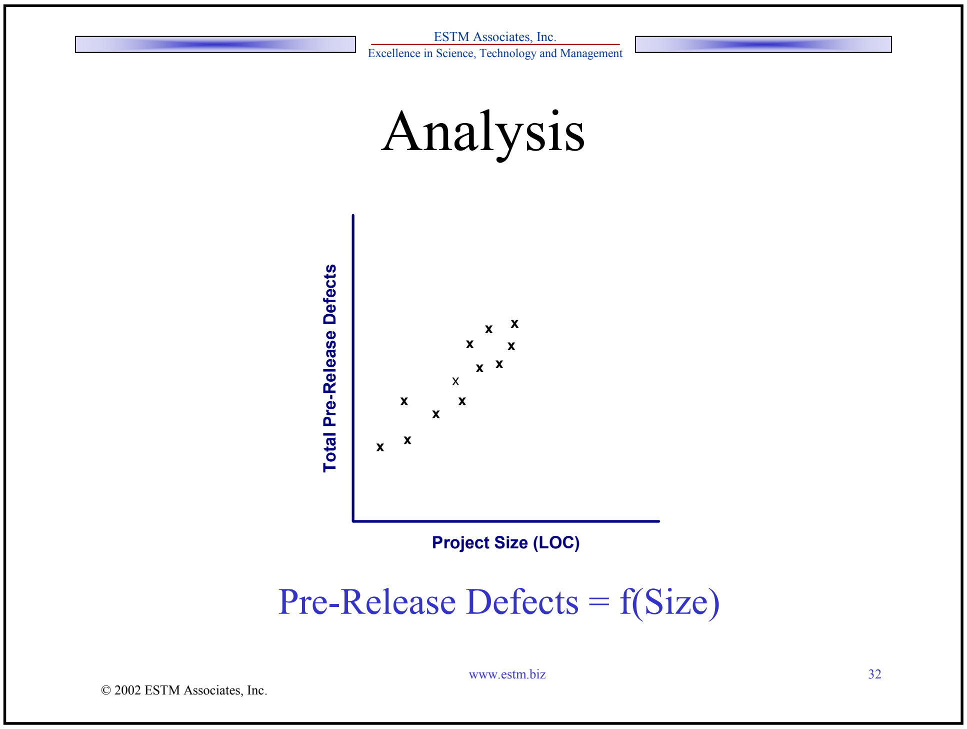
DMAIC Example

- Problem Statement
  - Post release maintenance has increased by 30% since the end of last fiscal year and is now limiting new product development.
- Goal Statement
  - Reduce post release maintenance by 40% by the end of Q4’2003.



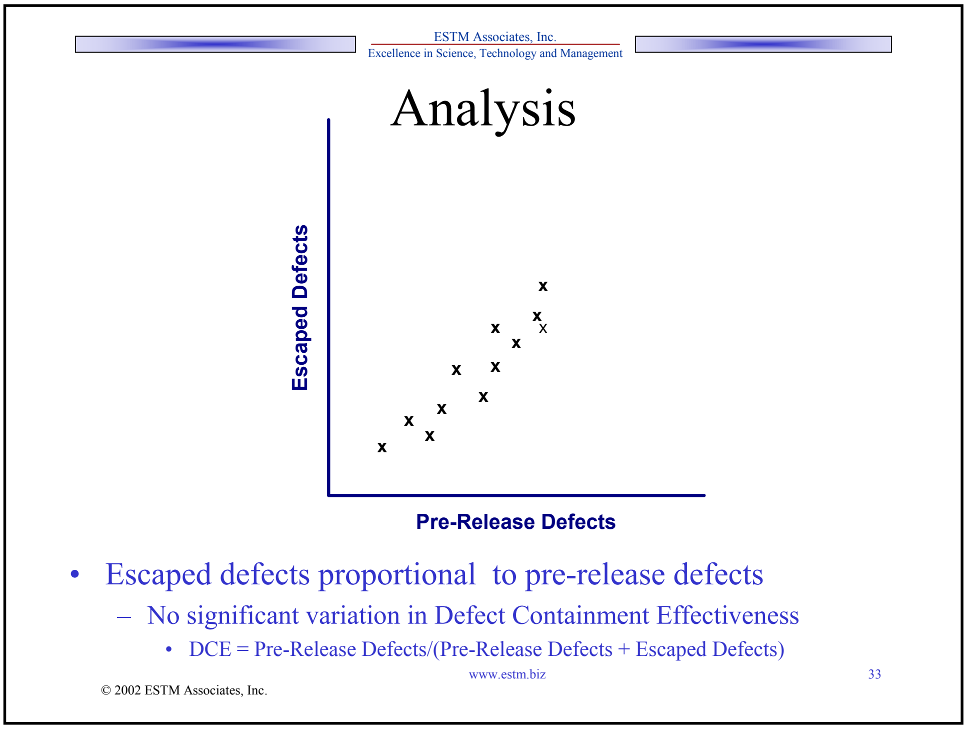
Measure – Data Collection

- Total Problems Fixed Prior to Release Per Project
  - Pre-Release Defects: defects found and fixed during development and testing
- Total Post Release Problems Per Project
  - Released Defects: defects reported by customers
- Types of Post Release Problems
  - All projects
  - Per project



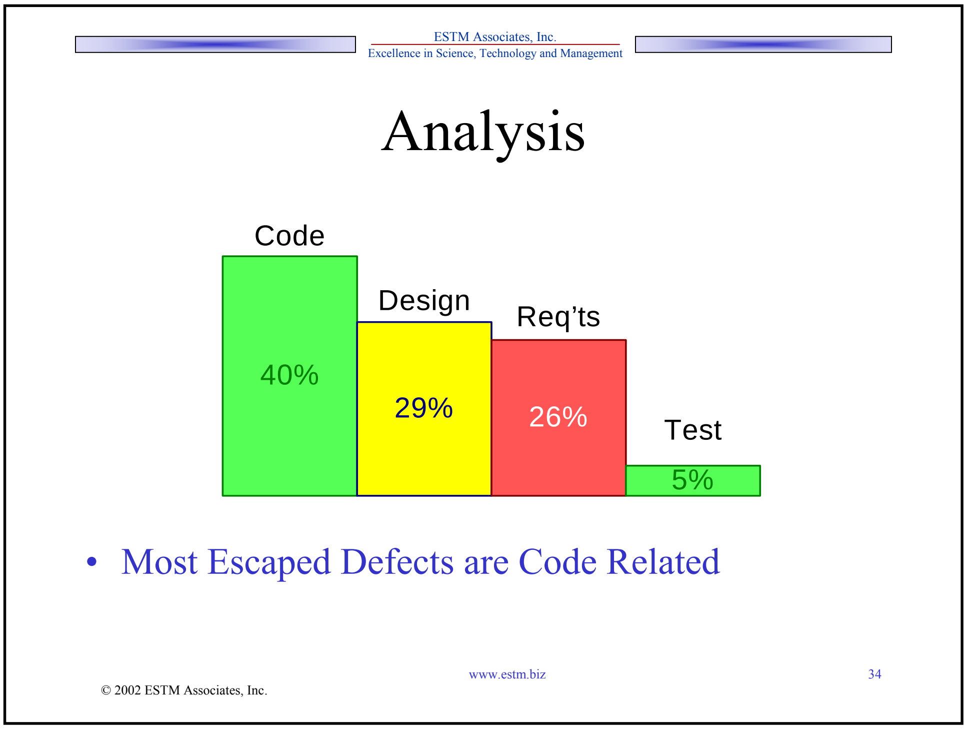
Analysis

Pre-Release Defects = f(Size)



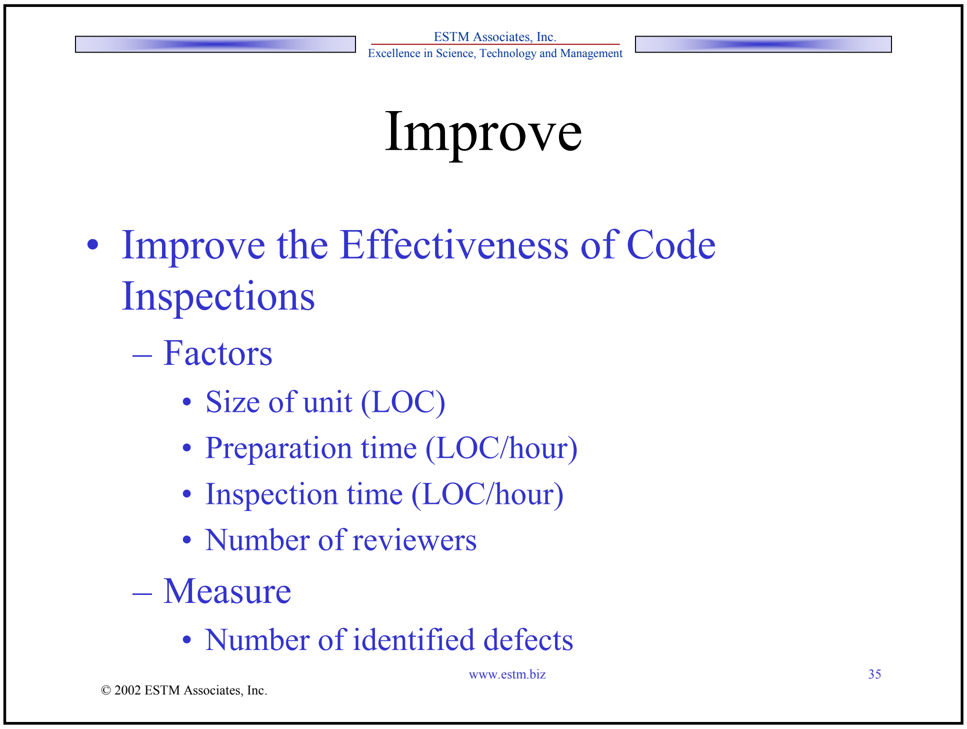
Analysis

- Escaped defects proportional to pre-release defects
  - No significant variation in Defect Containment Effectiveness
    - DCE = Pre-Release Defects/(Pre-Release Defects + Escaped Defects)



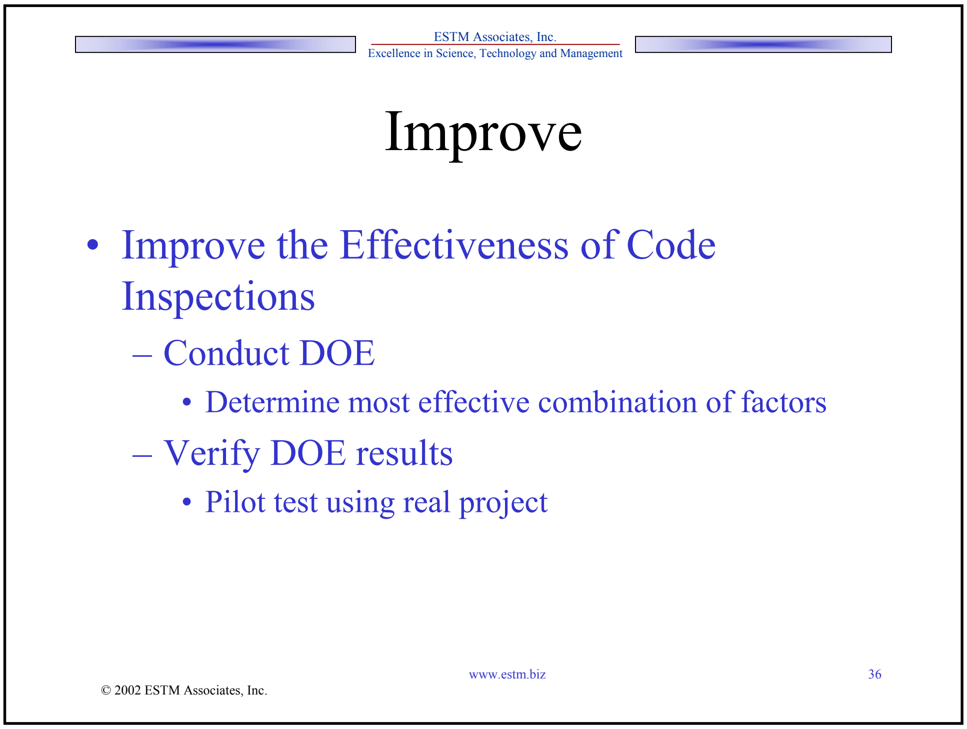
Analysis

- Most Escaped Defects are Code Related



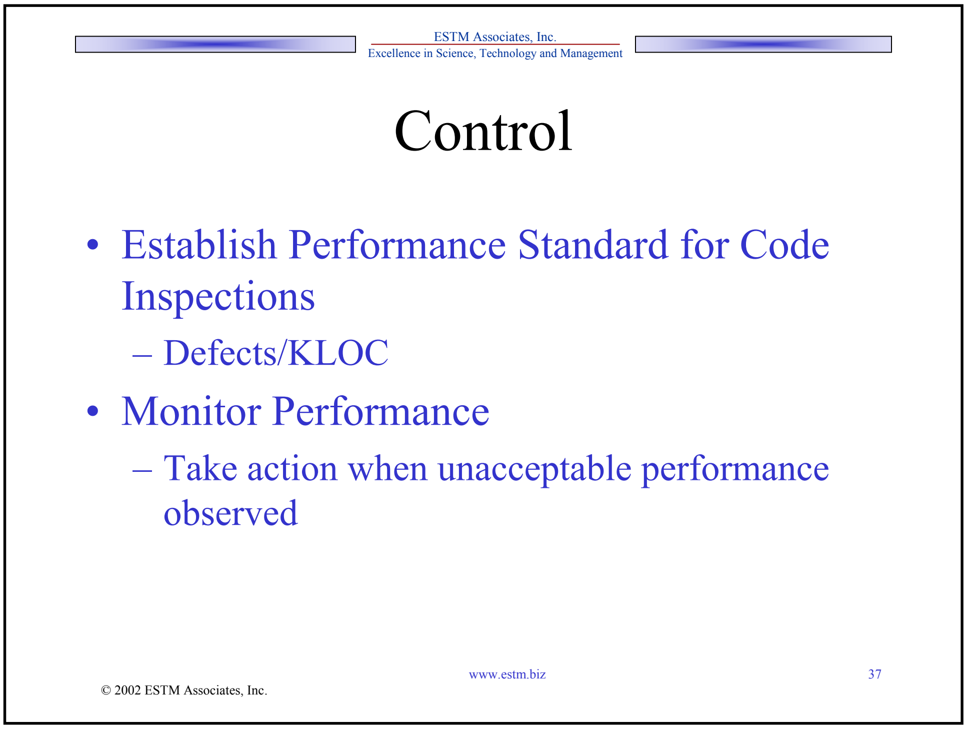
Improve

- Improve the Effectiveness of Code Inspections
  - Factors
    - Size of unit (LOC)
    - Preparation time (LOC/hour)
    - Inspection time (LOC/hour)
    - Number of reviewers
  - Measure
    - Number of identified defects



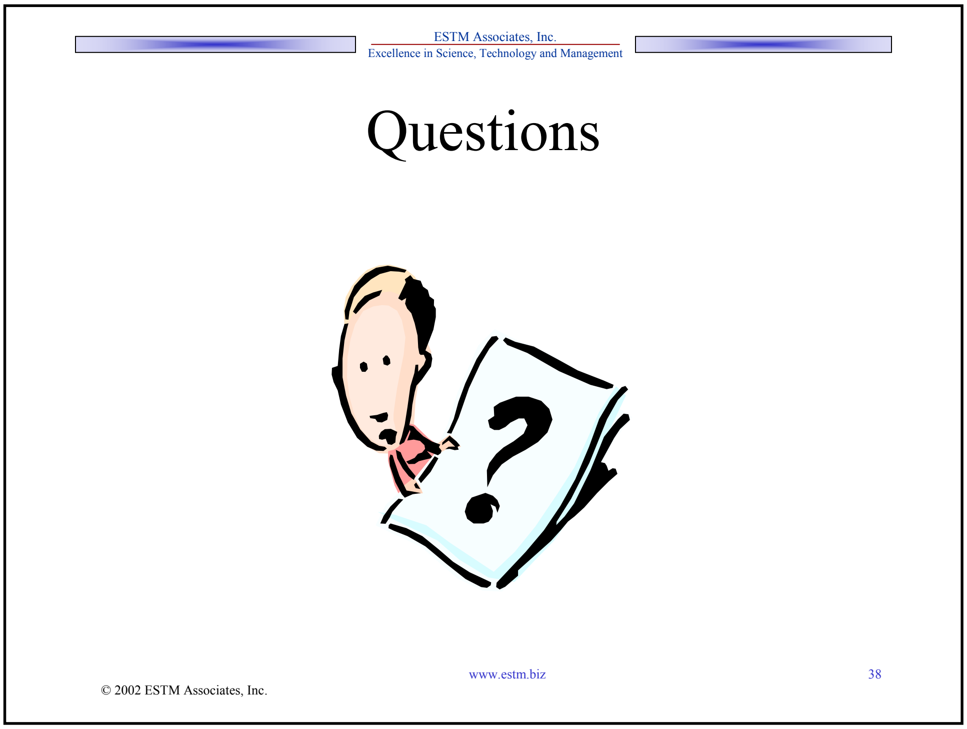
Improve

- Improve the Effectiveness of Code Inspections
  - Conduct DOE
    - Determine most effective combination of factors
  - Verify DOE results
    - Pilot test using real project



Control

- Establish Performance Standard for Code Inspections
  - Defects/KLOC
- Monitor Performance
  - Take action when unacceptable performance observed



Questions