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Using Predicted Delivered Defects as A Management Tool

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- The Guns Systems Software Engineering Program at BAE Systems wanted a way to reduce delivered operational defects
  - Stabilize defect removal processes
  - Provide measurable cost reduction
  - Make data driven management decisions
  - Provide early indication of delivered product quality

- CMMI Implementation
- Good historical data set
- Mature Project process set
- Defect removal processes were stable
- Historical defect rate was available

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- Obtained S.W.E.E.P. (Software Error Estimation Program)
- Based initial tests on David Card's Empirical Method
  - See STSC Crosstalk March 2003 "**Managing Software Quality With Defects**"
- Started populating tool with the local data set

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- Use Historical Data to determine t-value and estimated defects
    - T-value is the point where the most defects are discovered

- Insert estimated defect values into tool

- Insert Actual defects discovered in a phase into tool at phase completion (replacing predicted values)

- Determine if defect discoveries are within predicted bounds.

- If not, Perform Causal Analysis
    - Make process changes as needed

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- **Construct Estimated Discovery Curve**
  - 100,000 lines of Code
  - Historically we find 10 defects per KSLOC
  - 1000 defects to be discovered

- **Determine number of phases**
  - 6 Phases (Req, DD, Code/UT, Int, SQT, FQT)

- **Estimated T-value**
  - Default T-value is 2.21
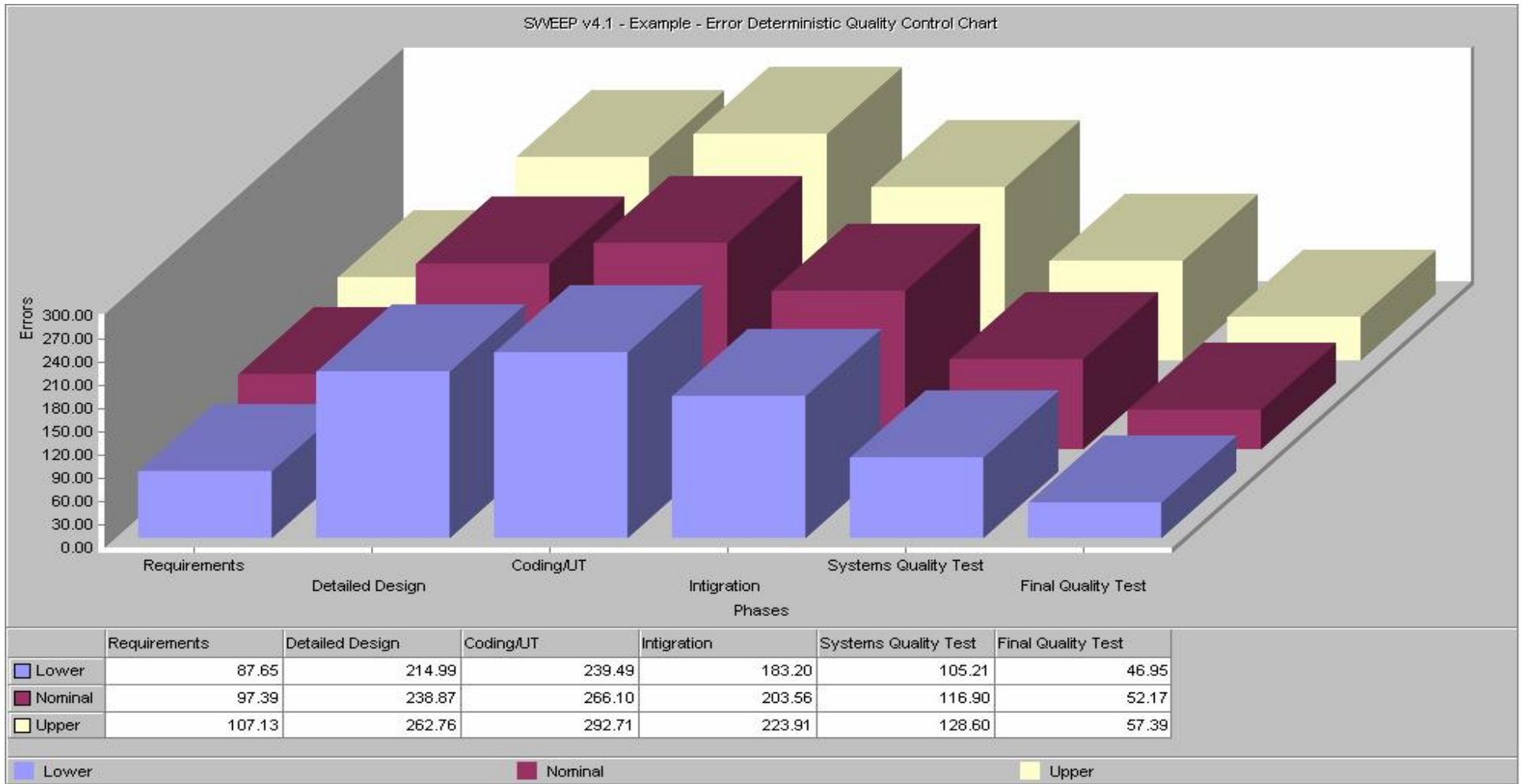
- **Will result in a latent defect count of 52 defects**

- Number of defects discovered during defect removal reviews

- Change Request type defects

- Customer initiated changes
  - May or may not result in a re-estimate

SWEEP v4.1 - Example - Error Deterministic Quality Control Chart

	Requirements	Detailed Design	Coding/UT	Intigration	Systems Quality Test	Final Quality Test
Lower	87.65	214.99	239.49	183.20	105.21	46.95
Nominal	97.39	238.87	266.10	203.56	116.90	52.17
Upper	107.13	262.76	292.71	223.91	128.60	57.39

Lower   Nominal   Upper

- Nominal estimate would result in 52 defects at FQT

- Set upper and lower bounds at 10% of Nominal

- Will perform Causal Analysis if bounds are exceeded

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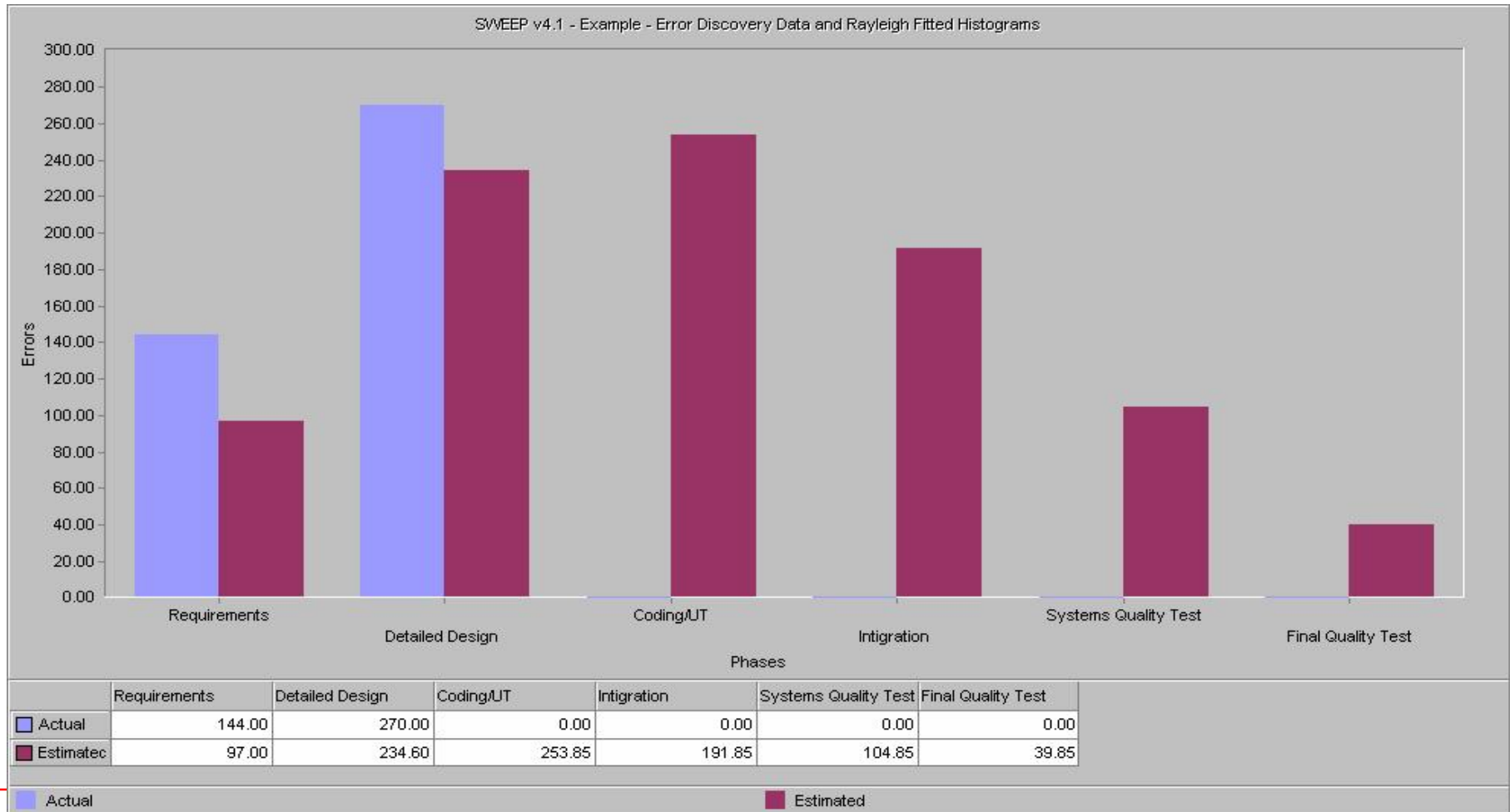SWEEP v4.1 - Example - Error Discovery Data and Rayleigh Fitted Histograms

	Requirements	Detailed Design	Coding/UT	Intigration	Systems Quality Test	Final Quality Test
Actual	144.00	0.00	0.00	0.00	0.00	0.00
Estimatec	97.00	230.00	257.00	195.00	108.00	43.00

Actual   Estimated
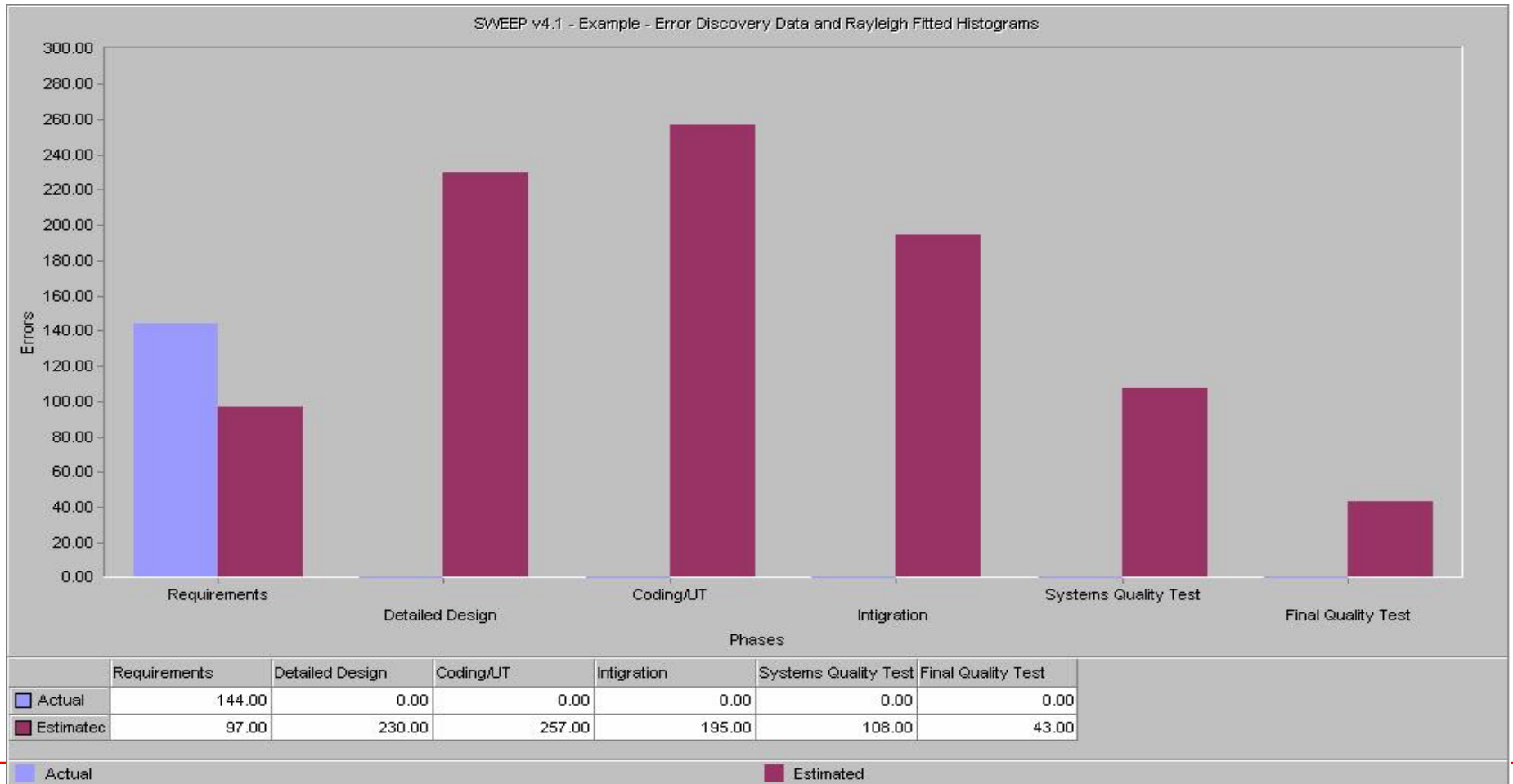
Analysis

- 144 discovered defects
- Exceeded 10% Tolerance
- Perform Causal Analysis to determine why
  - Incomplete Requirements?
  - Better Discovery Rate?
  - Poorly written work product?
- Finding more defects earlier results in a drop in delivered defects to FQT (43 defects instead of 52)
- Management makes decision to continue with development but with more time spent on defect removal reviews
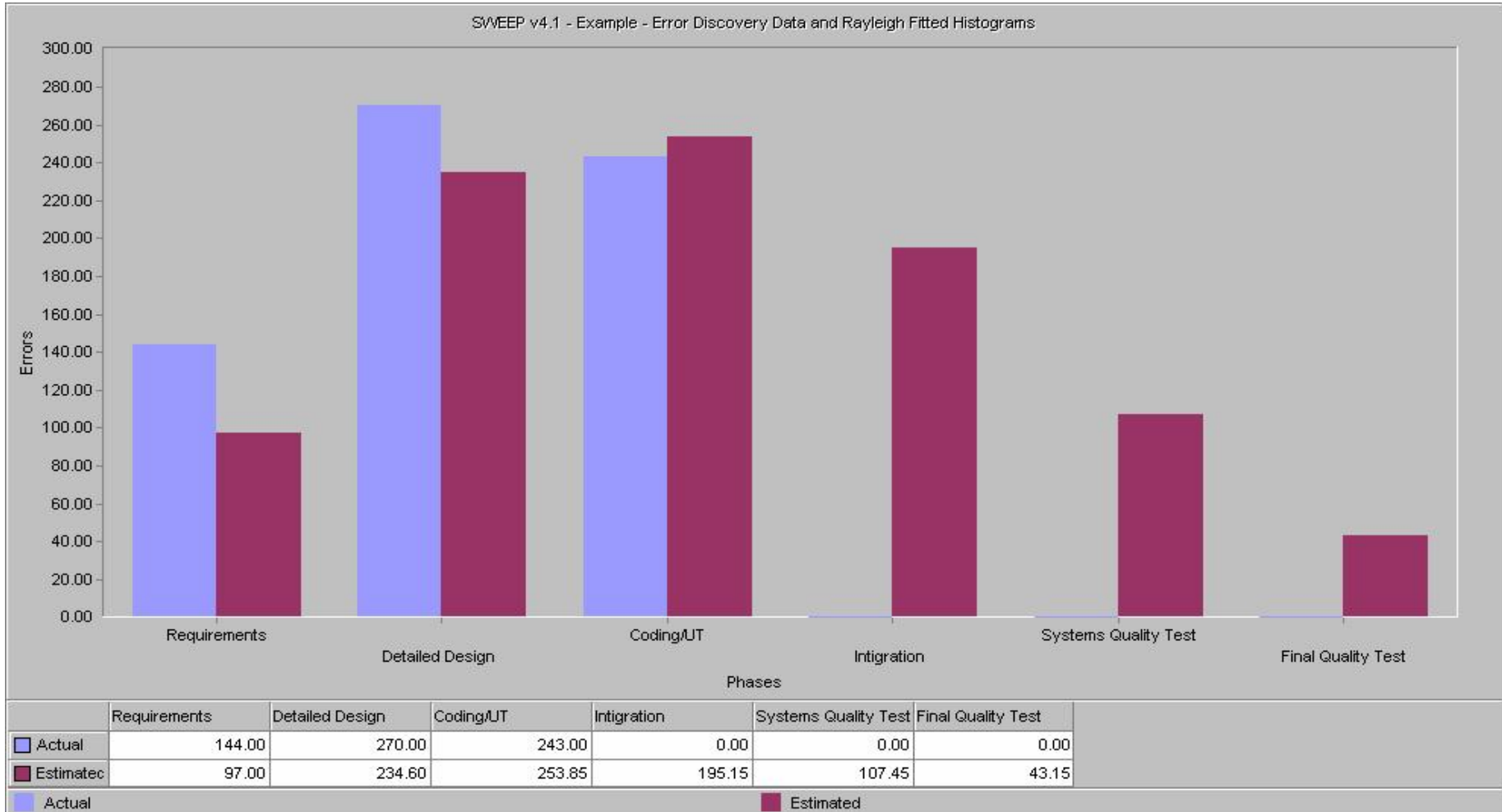
Phase

SWEEP v4.1 - Example - Error Discovery Data and Rayleigh Fitted Histograms

	Requirements	Detailed Design	Coding/UT	Intigration	Systems Quality Test	Final Quality Test
Actual	144.00	270.00	0.00	0.00	0.00	0.00
Estimatec	97.00	234.60	253.85	191.85	104.85	39.85

Actual   Estimated

Analysis

- Discovered 270 defects
- Perform Analysis to determine:
  - Cause of defects
  - Quality of work product
  - Impact to defect latency
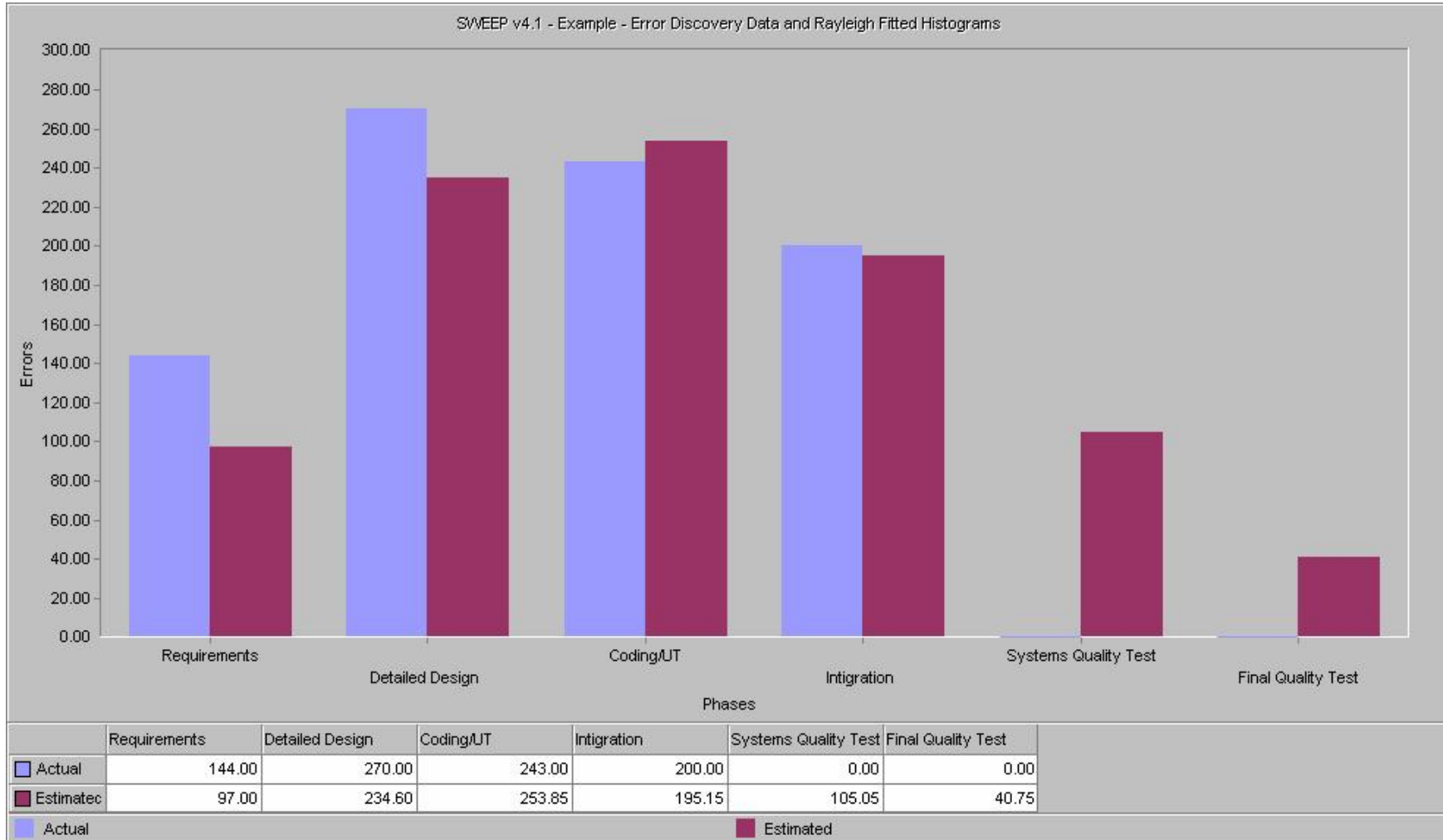 - Impact of more review time
- Latency Rate is now 39 defects

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SWEEP v4.1 - Example - Error Discovery Data and Rayleigh Fitted Histograms

	Requirements	Detailed Design	Coding/UT	Intigration	Systems Quality Test	Final Quality Test
Actual	144.00	270.00	243.00	0.00	0.00	0.00
Estimated	97.00	234.60	253.85	195.15	107.45	43.15

Actual   Estimated

nalysis

- Discovered 243 defects

- Within Bounds of Estimate

- Latency rate is 43 defects
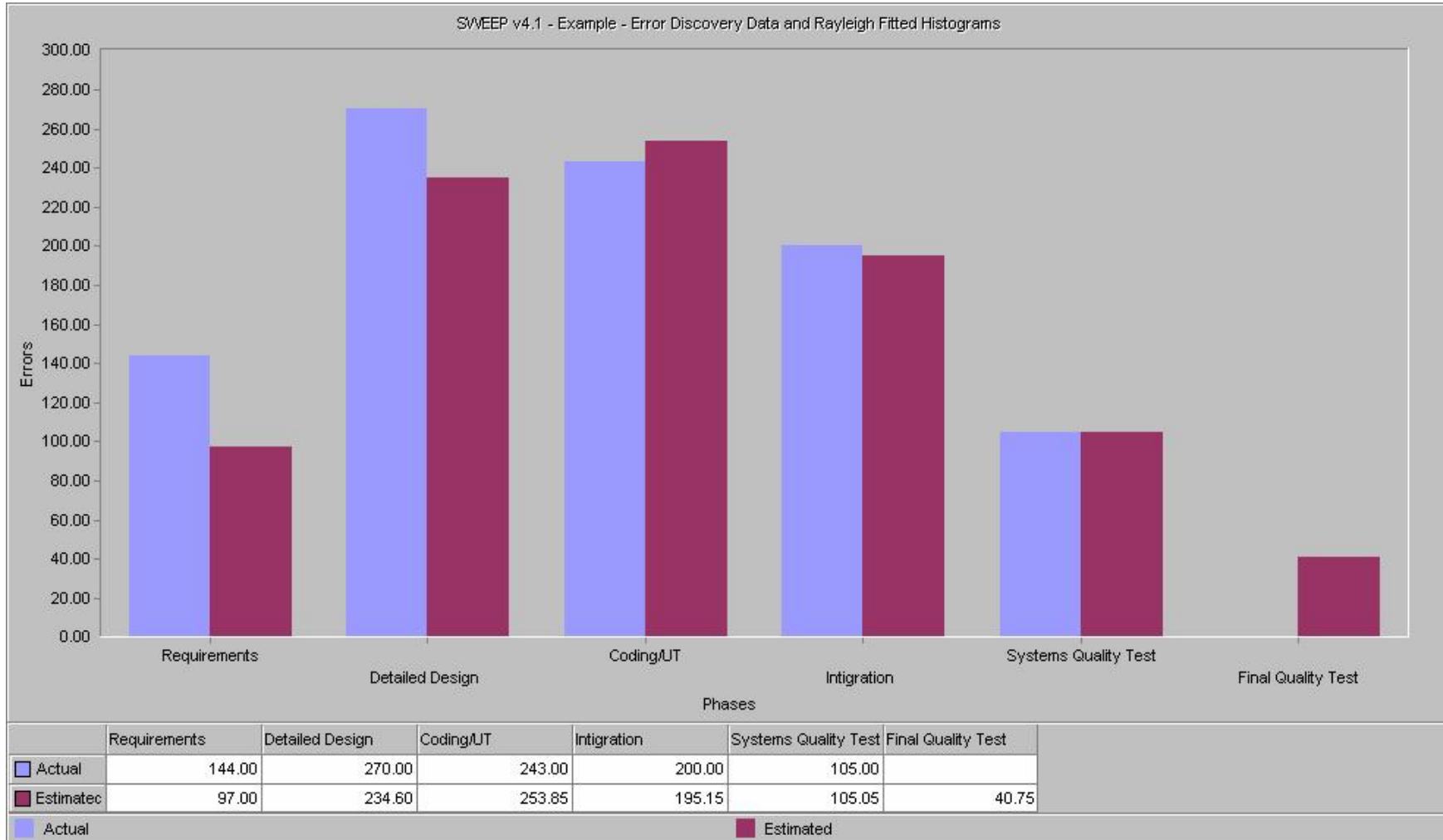
- Management decides to continue with no change to process

SWEEP v4.1 - Example - Error Discovery Data and Rayleigh Fitted Histograms

	Requirements	Detailed Design	Coding/UT	Intigration	Systems Quality Test	Final Quality Test
Actual	144.00	270.00	243.00	200.00	0.00	0.00
Estimatec	97.00	234.60	253.85	195.15	105.05	40.75

☐ Actual   ☐ Estimated

- Discovered 200 defects

- Within estimated bounds

- Latency rate is 40.75 defects

- Management decides Work Product development is performing the way they want it to.
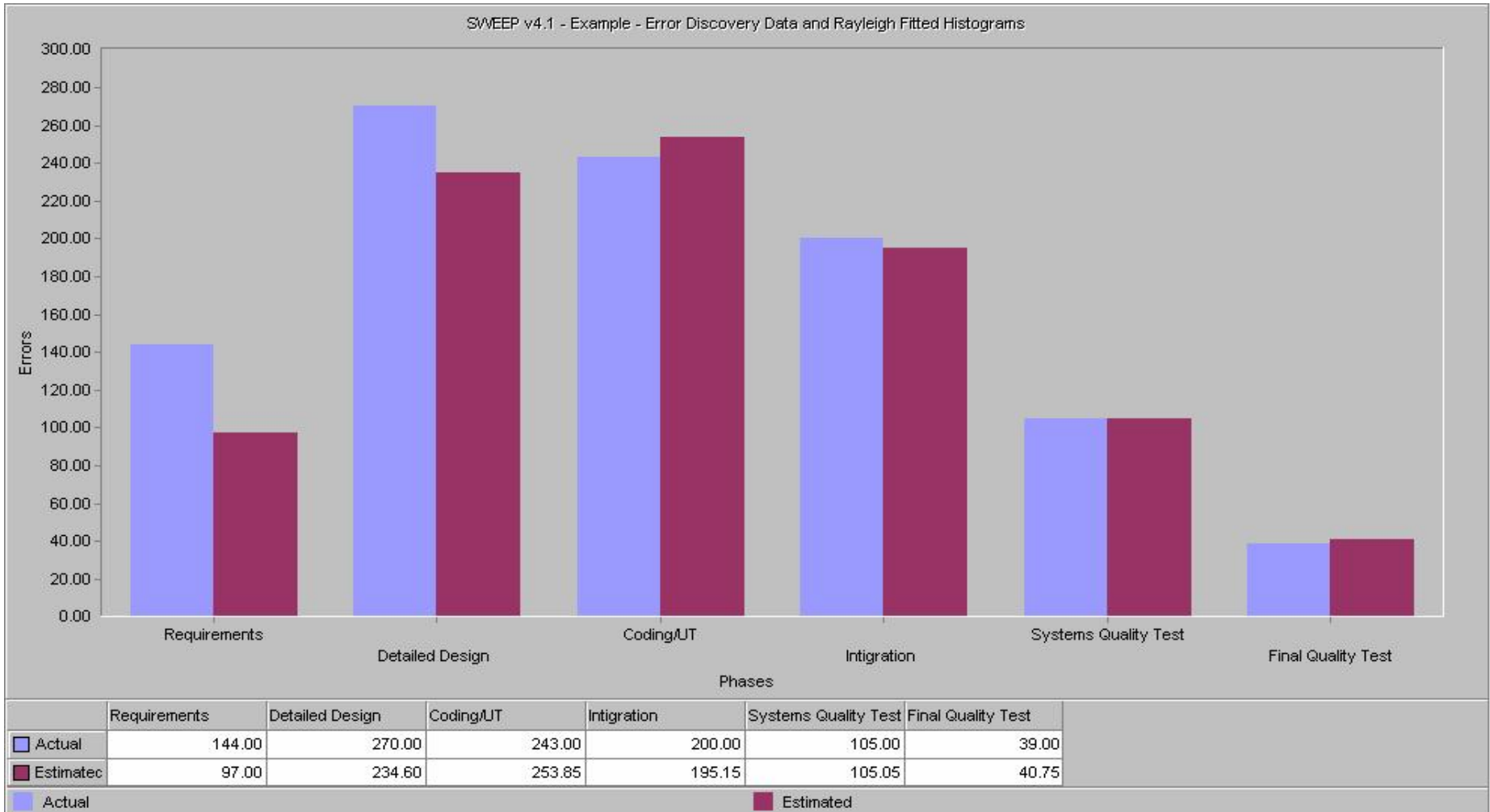
- No Changes to Development Process

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SWEEP v4.1 - Example - Error Discovery Data and Rayleigh Fitted Histograms

	Requirements	Detailed Design	Coding/UT	Intigration	Systems Quality Test	Final Quality Test
Actual	144.00	270.00	243.00	200.00	105.00	
Estimated	97.00	234.60	253.85	195.15	105.05	40.75

Actual   Estimated

- 105 Discovered Defects

- Within estimated bounds

- Latency rate is 40.75 defects

- Management decides Work Product development is performing the way they want it to.

SWEEP v4.1 - Example - Error Discovery Data and Rayleigh Fitted Histograms

	Requirements	Detailed Design	Coding/UT	Intigration	Systems Quality Test	Final Quality Test
Actual	144.00	270.00	243.00	200.00	105.00	39.00
Estimated	97.00	234.60	253.85	195.15	105.05	40.75

Actual   Estimated

- 39 Defects discovered

- Project delivers under its goal of 52.

- Product Quality Objectives have been met and Work Product can be passed to customer

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- By performing more intensive reviews at the start of the development cycle, better work product quality was obtained.

- The chance to perform Defect Profile Analysis will provide information on which processes injected the most defects
  - OID activity
  - Causal Analysis cycle

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- By performing analysis on discovered defects during development, one can impact the number of delivered defects to FQT.

- This analysis works quite well for waterfall type projects

- Have witnessed zero delivered defects for several delivery cycles

- Provides value added measurement data

- Covers a whole host of CMMI evidentiary requirements

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Questions

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