

Project Estimation Tools

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EECS 811

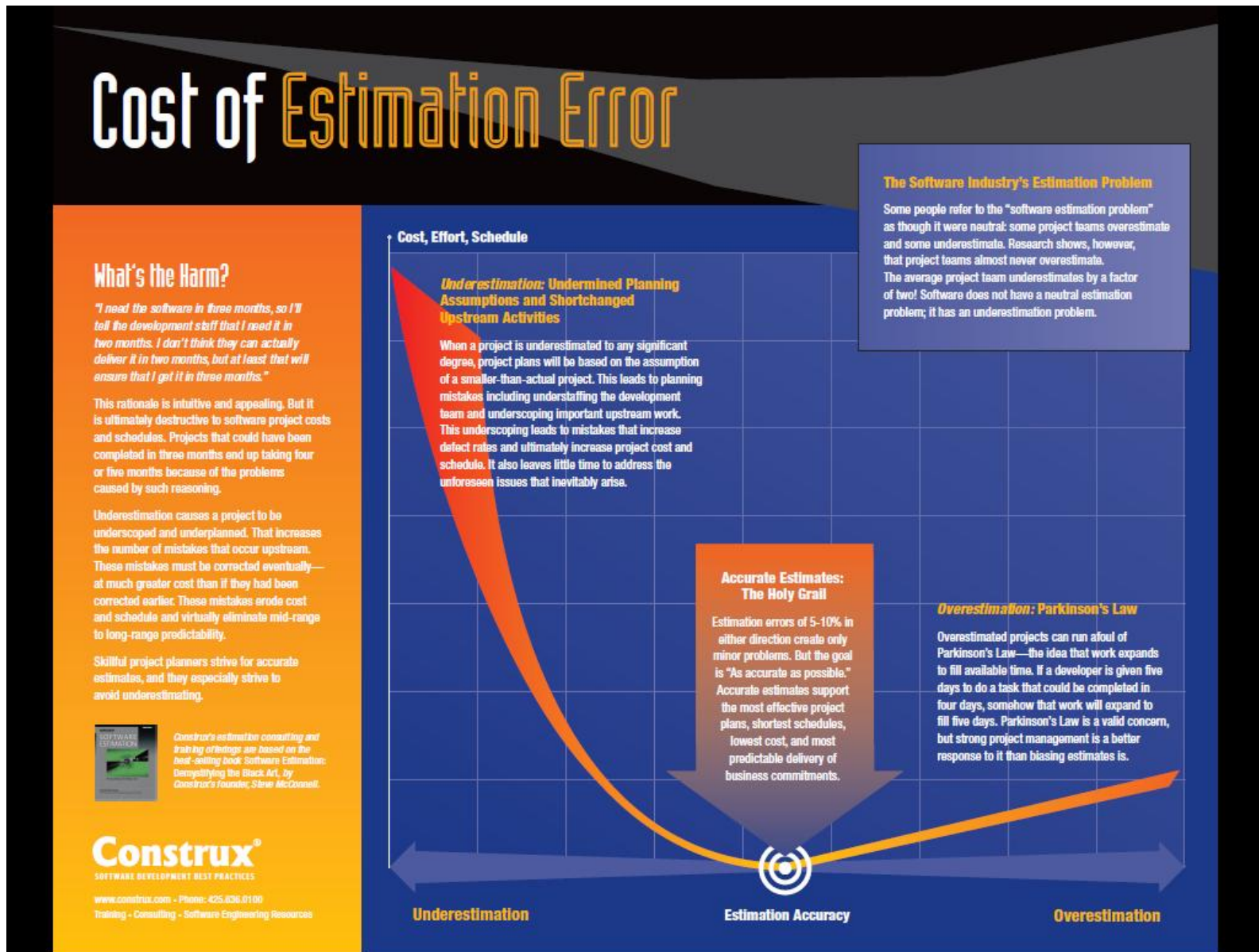
Contents

- COCOMO II
 - estimation and COCOMO II
 - Center for Systems and Software Engineering
- Estimation Tools
 - Construx Estimate
 - Costar 7.0
- Function Point Analysis Tool
 - standard and enterprise edition
- Summary
- Questions

Estimation Goal

- Confidence level
- Parameters
- Constraints
- Acceptable Product

Cost of Estimation Error



COCOMO II

- Constructive Cost Model
- Useful for software development processes
- Quantitative framework
- Allows users to reason about tradeoffs
- 17 cost drivers
- 5 scale factors

Center for Systems and Software Engineering

COCOMO cost and scale drivers

Software Size Sizing Method

Unadjusted Function Points Language

Software Scale Drivers

Precedentedness	<input type="text" value="Nominal"/>	Architecture / Risk Resolution	<input type="text" value="Nominal"/>	Process Maturity	<input type="text" value="Nominal"/>
Development Flexibility	<input type="text" value="Nominal"/>	Team Cohesion	<input type="text" value="Nominal"/>		

Software Cost Drivers

Product		Personnel		Platform	
Required Software Reliability	<input type="text" value="Very High"/>	Analyst Capability	<input type="text" value="Nominal"/>	Time Constraint	<input type="text" value="Nominal"/>
Data Base Size	<input type="text" value="Nominal"/>	Programmer Capability	<input type="text" value="Nominal"/>	Storage Constraint	<input type="text" value="Nominal"/>
Product Complexity	<input type="text" value="Nominal"/>	Personnel Continuity	<input type="text" value="Nominal"/>	Platform Volatility	<input type="text" value="Nominal"/>
Developed for Reusability	<input type="text" value="Nominal"/>	Application Experience	<input type="text" value="Nominal"/>	Project	
Documentation Match to Lifecycle Needs	<input type="text" value="Nominal"/>	Platform Experience	<input type="text" value="Nominal"/>	Use of Software Tools	<input type="text" value="Nominal"/>
		Language and Toolset Experience	<input type="text" value="Nominal"/>	Multisite Development	<input type="text" value="Nominal"/>
				Required Development Schedule	<input type="text" value="Nominal"/>

Software Labor Rates

Center for Systems and Software Engineering

<http://csse.usc.edu/csse/>

- Constraints
 - 500 UFP
 - Java

Results

Software Engineering

Effort = 108 Person-months

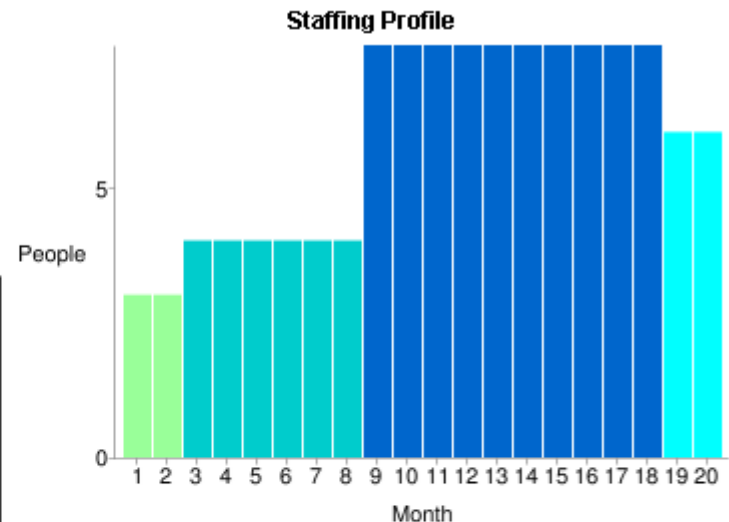
Schedule = 17 Months

Cost = \$0

Total Equivalent Size = 26500

Phase Distribution

Phase	Effort (Person-months)	Schedule (Months)	Average Staff	Cost (Dollars)
Inception	6.5	2.2	3.0	\$0
Elaboration	25.9	6.5	4.0	\$0
Construction	82.1	10.8	7.6	\$0
Transition	13.0	2.2	6.0	\$0



Software Effort Distribution for RUP/MBASE (Person-Months)

Phase/Activity	Inception	Elaboration	Construction	Transition
Management	0.9	3.1	8.2	1.8
Environment/CM	0.6	2.1	4.1	0.6
Requirements	2.5	4.7	6.6	0.5
Design	1.2	9.3	13.1	0.5
Implementation	0.5	3.4	27.9	2.5
Assessment	0.5	2.6	19.7	3.1
Deployment	0.2	0.8	2.5	3.9

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Construx Estimate Tool

- Founded in 1996 by Steve McConnell
- Mission: Advancing the art and science of commercial software engineering.
- Tools – Estimate and Code Surveyor
- Management toolbox – checklists, templates
- White papers, Posters, and Webinars

Construx Estimate Tool – Free

- License Agreement: Use on a single computer, made available “as is”, no warranties
- Size of project must be known
- No phase distribution reports
- Calibrate estimates in three ways
 - project type based on industry data
 - cost factor
 - historical data

Project Type Calibration

- Uses Industry productivity data
- Easiest
- Least accurate
- Project Types Supported
 - Business Systems, Control Systems, Internet Systems, Intranet, Systems, Microcode / Firmware, Real-time Embedded / Avionics, Scientific Engineering / Research, Shrink wrapped Packages Software

Cost Factor Calibration

- COCOMO II
 - product attributes
 - project attributes
 - personnel attributes
- Product type and sub type


Historical Data Calibration

- Most accurate
- Less work required
- Data from 3 or more past organizational projects

Historical Database Wizard

Historical Data Wizard

Click New Project to define a new project. Select a project from the list and click Next to edit an existing project. You can also delete a project by selecting a project and clicking Delete Project.



Project	Start Date	Lines of Code	Staff Months	Schedule (months)
proj2	3/1/2011	50	10	5

Send Historical Data... Delete Project... New Project >

Click Next or New Project to continue.

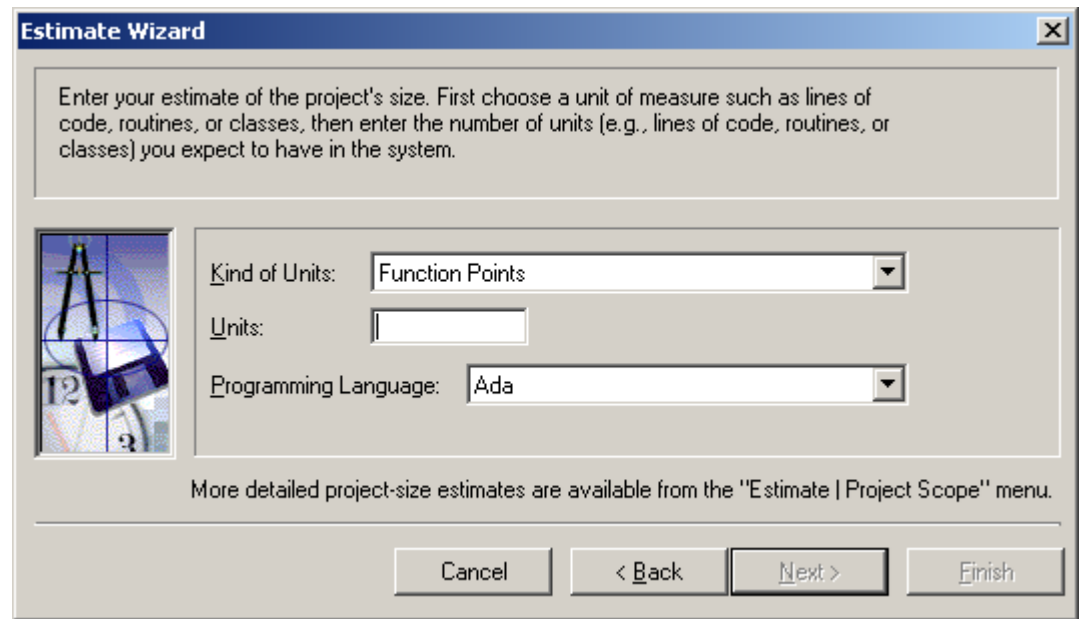
Cancel < Back Next > Close

Estimation Approaches

- SLIM
 - projects follow well defined patterns that can be modeled with a set of exponential equations
 - core of estimations
- COCOMO II
- Monte Carlo Simulation

Kinds of Units

- Function Point
- Lines of Code
- Functions / Subroutines
- Classes / Modules
- Subsystems



The screenshot shows a dialog box titled "Estimate Wizard". It contains a text area with instructions: "Enter your estimate of the project's size. First choose a unit of measure such as lines of code, routines, or classes, then enter the number of units (e.g., lines of code, routines, or classes) you expect to have in the system." Below this, there is a small icon of a compass and a ruler. To the right of the icon, there are three input fields: "Kind of Units:" with a dropdown menu showing "Function Points", "Units:" with a text box, and "Programming Language:" with a dropdown menu showing "Ada". At the bottom, there is a note: "More detailed project-size estimates are available from the 'Estimate | Project Scope' menu." and four buttons: "Cancel", "< Back", "Next >", and "Finish".

Estimate Wizard

Enter your estimate of the project's size. First choose a unit of measure such as lines of code, routines, or classes, then enter the number of units (e.g., lines of code, routines, or classes) you expect to have in the system.

Kind of Units: Function Points

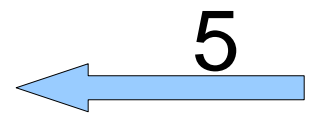
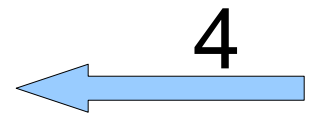
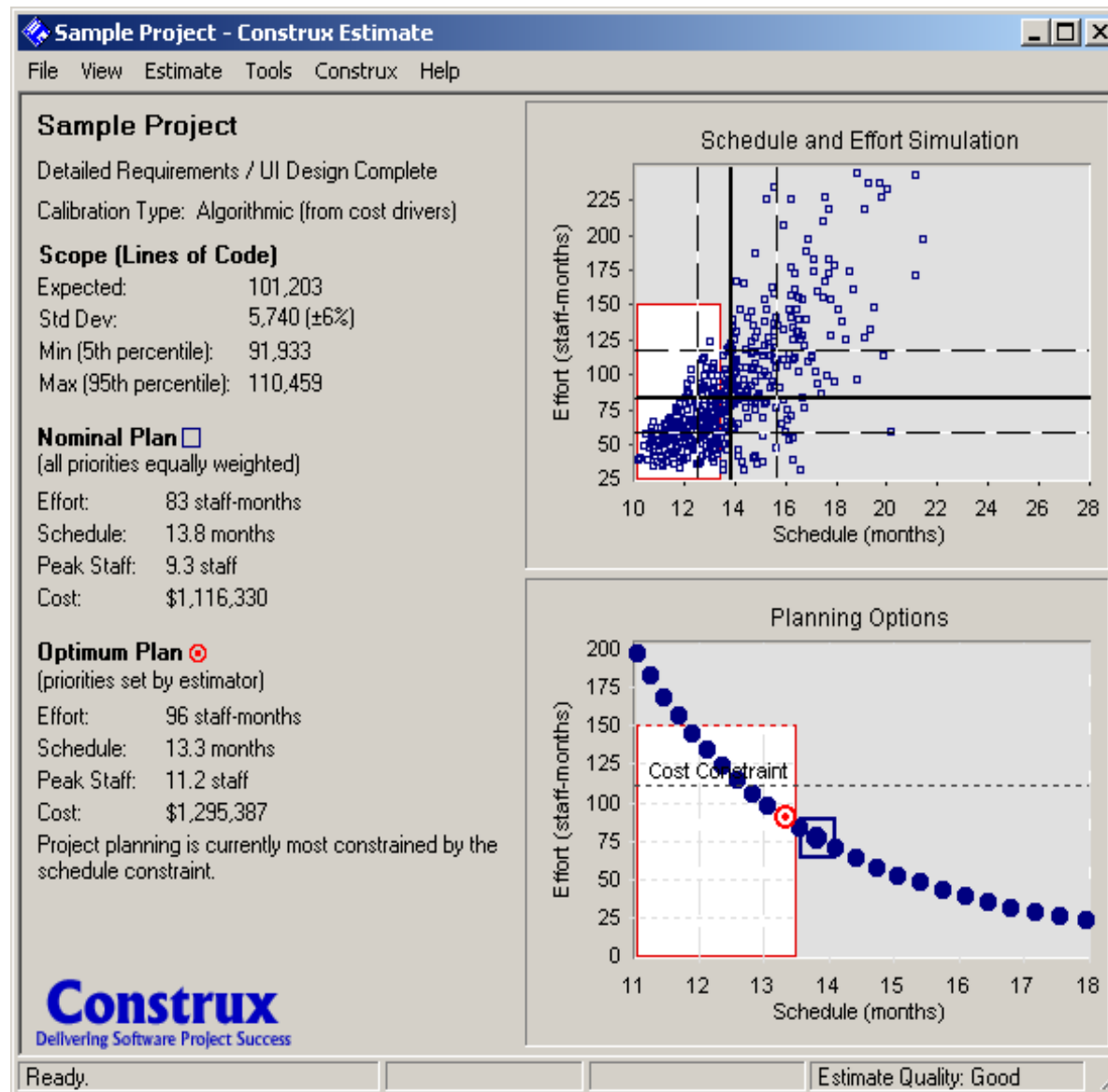
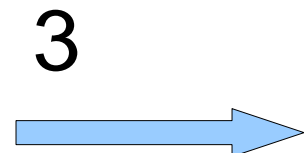
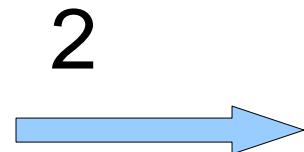
Units:

Programming Language: Ada

More detailed project-size estimates are available from the "Estimate | Project Scope" menu.

Cancel < Back Next > Finish

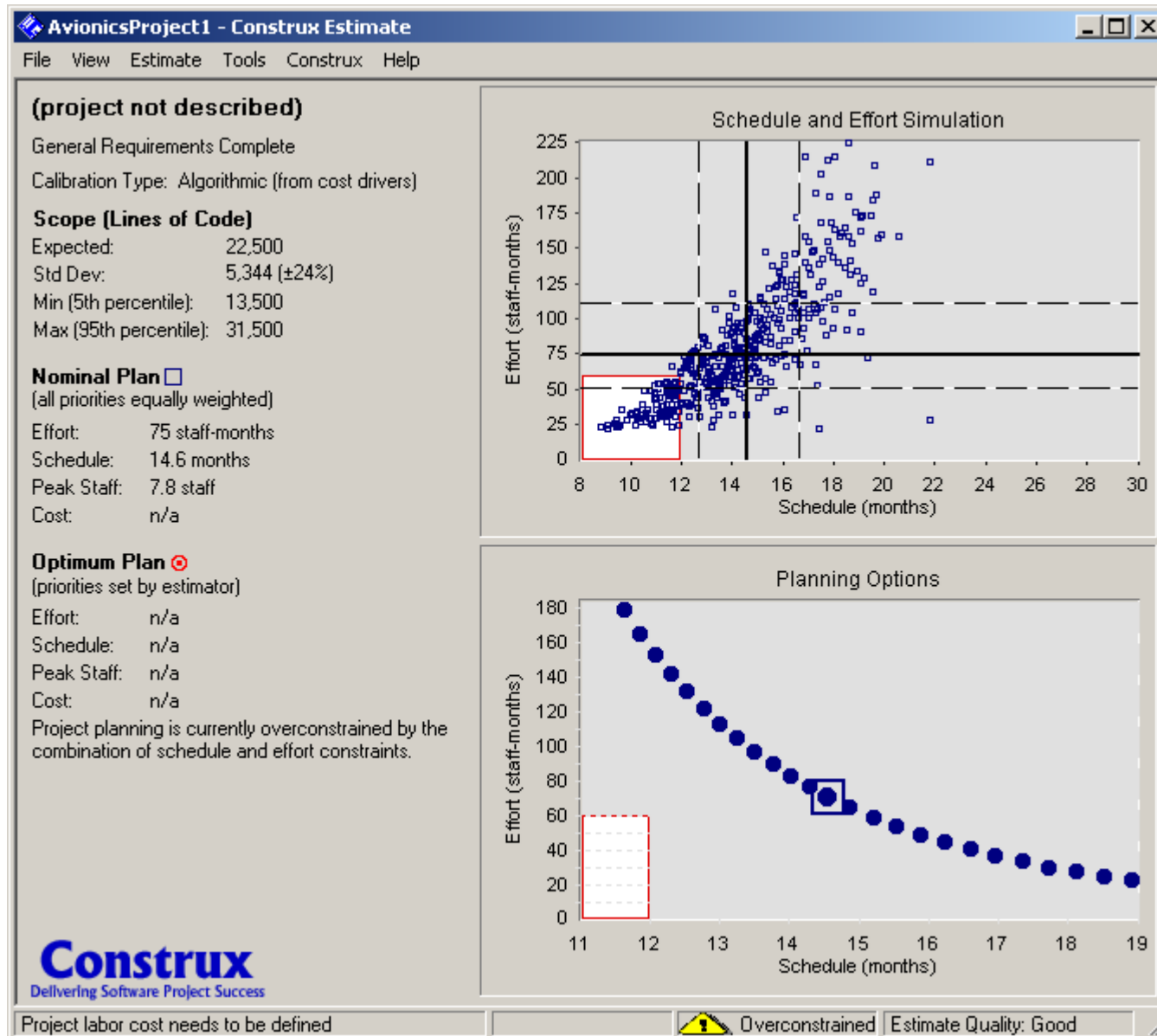
Estimation Window



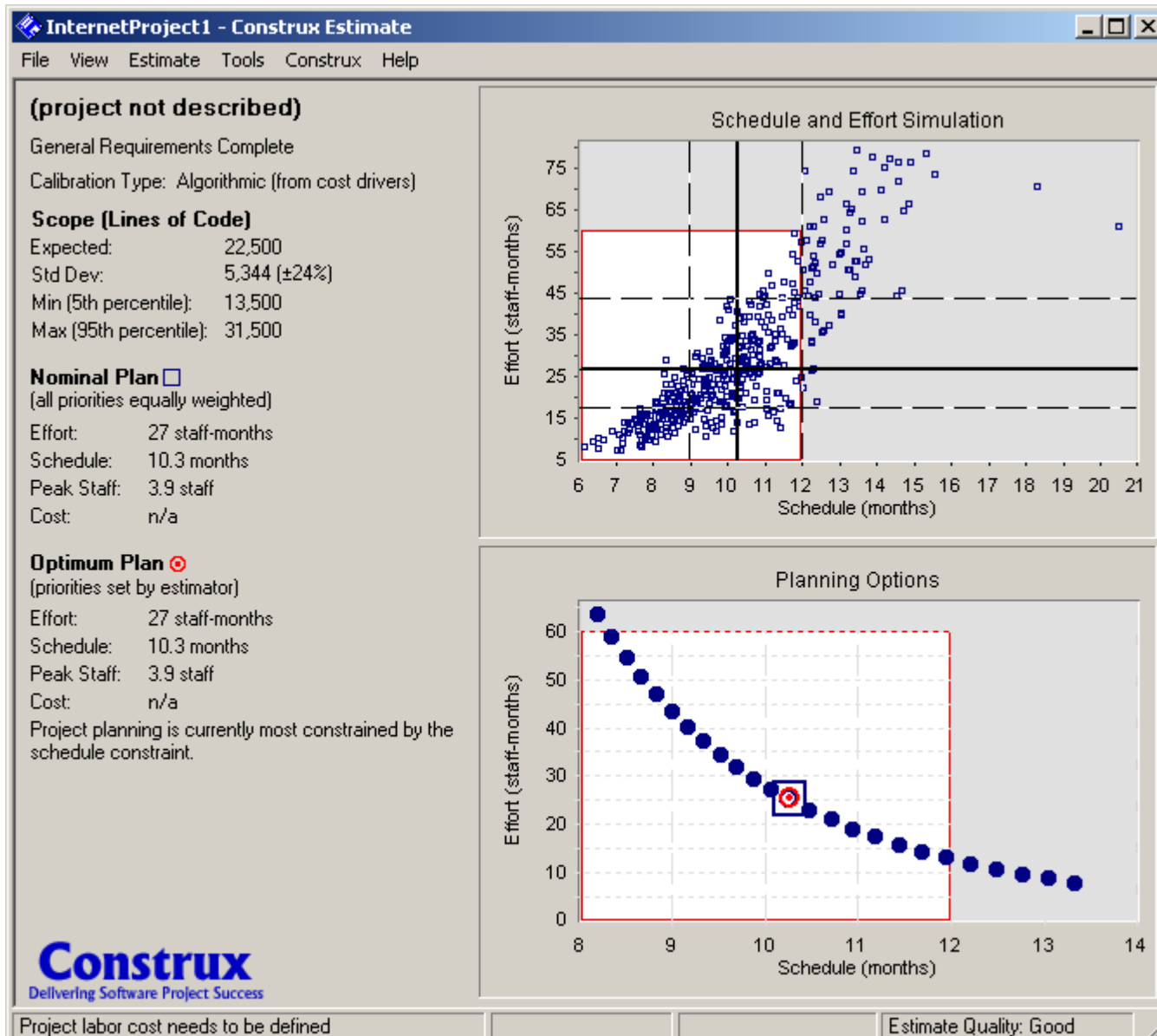
Project Type Comparison

Constraints	Example Project 1	Example Project 2
Project Type	Avionics	Internet
Current Phase	General Requirements Completed	General Requirements Completed
Maximum Schedule	12 months	12 months
Maximum Effort in Staff Month	60 SM	60 SM
Priorities	None	None
Unadjusted Function Points	500	500
Programming Language	Java	Java

Avionics Project Estimate



Internet Project Estimate



Internet Project cost factor calibration

Before

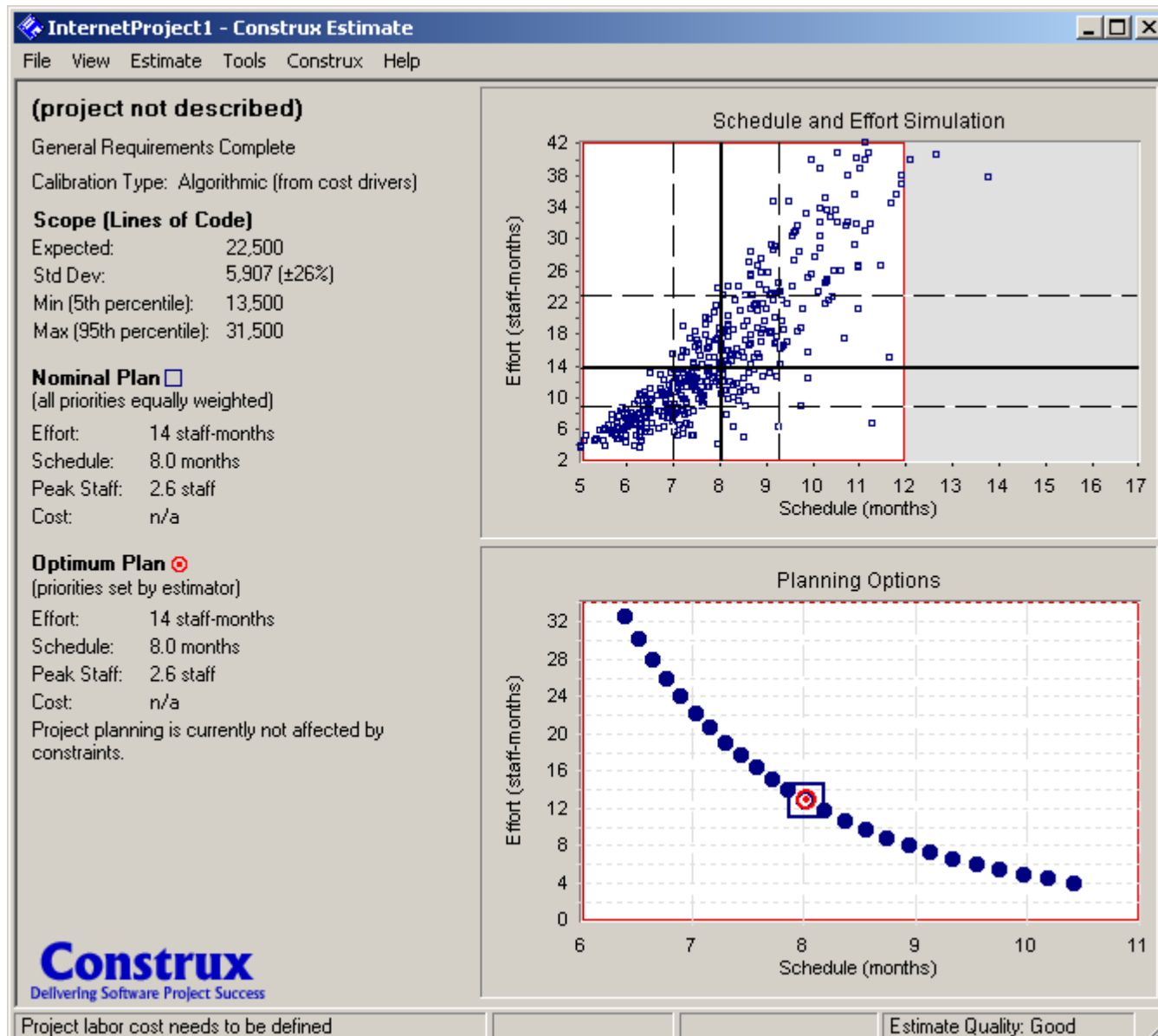
Product Attributes	Project Attributes	Personnel Attributes
Analyst Capability (general): 55th percentile (average)		
Programmer Capability (general): 55th percentile (average)		
Personnel Continuity (turnover): 12%/year (nominal)		
Experience with Applications Area: 1 year of experience (nominal)		
Experience with Platform: 1 year of experience (nominal)		
Language and Tool Experience: 1 year of experience (nominal)		
Team Cohesion: Basically cooperative interactions		

After

Product Attributes	Project Attributes	Personnel Attributes
Analyst Capability (general): 90th percentile (exceptional)		
Programmer Capability (general): 90th percentile (exceptional)		
Personnel Continuity (turnover): 3%/year		
Experience with Applications Area: 6 years of experience		
Experience with Platform: 6 years of experience		
Language and Tool Experience: 6 years of experience		
Team Cohesion: Seamless interactions		

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Internet Project Updated Estimate



Internet Project comparison

Personnel cost factors adjusted

	Original Results	Adjusted Results	Difference
Effort	27 SM	14 SM	52% decrease
Schedule	10.3 Months	8 Months	29% decrease
Staff	3.9 peak staff	2.6 peak staff	1 less staff

Internet Project comparison

Product cost factors adjusted

Original Cost Factors

- average complexity
- average size database
- errors cause small and easily recoverable losses

Adjusted Cost Factors

- extremely complex
- extremely large database
- errors pose risk to life

	Original	Adjusted	Difference
Effort	27 SM	33 SM	22% increase
Schedule	10.3 months	11.3 months	1% increase
Staffing	3.9 peak staff	4.5 peak staff	1 more staff

Estimate Report Manager

The screenshot displays the 'SampleProject2 - Construx Estimate' application window. The interface includes a menu bar (File, View, Estimate, Tools, Construx, Help), a toolbar with zoom and print controls, and a left-hand navigation pane listing various report sections. The main content area shows the 'Estimate Summary Report' for a project not described. It features a table of management metrics under the 'Nominal Plan' section, followed by a descriptive paragraph and an 'Optimum Plan' section.

Estimate Report Manager

SampleProject2 - Construx Estimate

File View Estimate Tools Construx Help

Zoom: + - 100% Fit

Print Selected Reports

Title Page
Estimate Summary Report
Estimate Summary View Screen
Estimate Quality
Planning Options Overview
Planning Options Graph
Planning Options Report
Constraints and Priorities
Milestones
Staffing Profile
Cash Flow
Simulation Scatter Plot
Project Scope Probabilities
Project Effort Probabilities
Project Cost Probabilities
Project Schedule Probabilities
Calibration Summary
Estimation Technical Notes
Estimation Software Background

Estimate Summary Report

Estimate Summary

(project not described)

Nominal Plan

Current Project Phase: Detailed Requirements / UI Design Complete

Management Metric	Expected Value (50% Probability)	Standard Deviation	Standard Deviation as Percentage
System Size (lines of code)	23,625	4,879	±21%
Effort (staff months)	16	34	±215%
Schedule (calendar months)	11.9	5.3	±44%
Completion Date	3/10/2012	5.3 months	±44%
Cost	n/a	n/a	n/a
Peak Staff (people)	2.0	2.2	±107%
Average Staff (people)	1.3	2.9	±215%
Overall Estimate Quality	Fair		

This estimate is the 50/50 estimate--the estimate for which there is both a 50 percent chance of overrunning and a 50 percent chance of underrunning the estimate. This is also known as the "nominal" estimate. This estimate is for the "main build" phase of a project, the time from detailed requirements specification complete to software acceptance. Earlier phases of a project are not estimated here.

Optimum Plan

Management Metric	Optimum Planning Value
Effort (staff months)	16

Project labor cost needs to be defined

Estimate Quality: Fair

Schedule Probabilities Report

Avionics Project Report

Probability (%)	Schedule Will Be Less Than	Difference From Nominal
1.0	9.4	-35%
5.0	10.5	-28%
10.0	11.2	-23%
20.0	12.3	-16%
30.0	13.1	-10%
40.0	13.9	-4%
50.0	14.6	0%
60.0	15.2	4%
70.0	16.1	10%
80.0	17.3	19%
90.0	19.1	31%
95.0	22.4	54%
99.0	33.6	130%

Internet Project Report

Probability (%)	Schedule Will Be Less Than	Difference From Nominal
1.0	5.1	-36%
5.0	5.8	-28%
10.0	6.2	-23%
20.0	6.8	-16%
30.0	7.2	-11%
40.0	7.5	-6%
50.0	8.0	0%
60.0	8.4	5%
70.0	8.9	12%
80.0	9.8	22%
90.0	11.5	43%
95.0	14.2	77%
99.0	33.7	320%

Costar

- Supported estimation models
 - COCOMO II with traditional phases
 - COCOMO II with MBASE.RUP phases
 - Ada COCOMO
 - COCOMO 81
 - Custom model
- Component Tree
- Very Descriptive
- Cost
 - Single license \$1900
 - Site license \$5000
 - Corporate License \$25,000

Costar Estimate Window

★ Costar - Example (Component1)

File View Reports Components Tools Preferences Help

Estimate: Example ID: Model: COCOMO II 2000

Component: Component1 ID: Increment: 1

ACT ARC CBR CDR CMP CST DET EBR EFF EGS GCS GMI GST IDT ISM MSZ NAM SCH SIZ SSM STR

Totals for entire Project		Effort (PM)	Duration (Mo)	Cost (K\$)	Productivity	Equivalent Size
Requirements	RQ:	0.5	1.1	0.0		Total Size: 3,000
Development	PD+DD+CT+IT:	7.0	6.8	0.0	429.4	
Total	RQ+PD+DD+CT+IT:	7.5	7.9	0.0	401.3	

COCOMO II Cost Drivers for Component: Component1

Personnel

ACAP... Very High

APEX... Nominal

PCAP... Nominal

PLEX... Nominal

LTEX... Nominal

PCON... Nominal

Platform

TIME... Nominal

STOR... Nominal

PVOL... Nominal

Product

RELY... Nominal

DATA... Nominal

CPLX... Nominal

RUSE... Nominal

DOCU... Nominal

Project

TOOL... Nominal

SITE... Nominal

SCED... Nominal

Size Summary

Size: 3000

Method: SLOC

User Defined

USR1... Undefined

USR2... Undefined

USR3... Undefined

USR4... Undefined

Drivers & Size Model REVL Reuse Function Points Increments Breakage Costs Rates Maint Filter Descr.

Click on a tab to display another notebook page

Example: 7.5 PM, 7.9 Months Component1: 7.5 PM EAF: 0.7100 Level: 1

Costar Detailed Report

★ Example - Detail Report
Print
Export...
Save as Graphic
☒ Headers
<< Back
Next >>

Example - Detail Report

Costar 7.02 01/24/2005 11:34:57 Page: 1

Estimate Name:	Example	Estimate ID:	
Model Name:	COCOMO II 2000	Model ID:	2000
Process Model:	COCOMO II Model	Phases:	Waterfall

Component Name:	Component1	Component ID:	
Increment:	1	Level:	1
Developed Size:	3,000	EAF:	0.7100

Phase	Effort (Person-Months)	Cost (K\$)	Duration (Months)	Staffing
RQ -- Requirements	0.5	0.0	1.1	0.4
PD -- Product Design	1.2	0.0	1.6	0.7
DD -- Detailed Design	1.9	0.0	1.6	1.2
CT -- Code & Unit Test	2.6	0.0	2.2	1.2
IT -- Integration & Test	1.4	0.0	1.4	1.0
Development (PD+DD+CT+IT)	7.0	0.0	6.8	
Totals (RQ+PD+DD+CT+IT)	7.5	0.0	7.9	
MN -- Maintenance (per year)	0.0	0.0		0.0

Model tab

★ Costar - Estimate1 (Component1)

File View Reports Components Tools Preferences Help

Estimate: Estimate1 ID: Model: COCOMO II 2000

Component: Component1 ID: Increment: 1

ACT ARC CBR CDR CMP CST DET EBR EFF EGS GCS GMI GST IDT ISM MSZ NAM SCH SIZ SSM STR

Totals for entire Project		Effort (PM)	Duration (Mo)	Cost (K\$)	Productivity	Equivalent Size
Requirements	RQ:	0.6	1.2	0.0		Total Size: 3,000
Development	PD+DD+CT+IT:	8.4	7.3	0.0	356.6	
Total	RQ+PD+DD+CT+IT:	9.0	8.5	0.0	333.3	

COCOMO II Scale Factors for Estimate: Estimate1

COCOMO Model: COCOMO II 2000

Model ID: 2000

Phases: Waterfall

Model Type: COCOMO II

Select COCOMO Model...

Precedentedness: Somewhat Unprecedented

Development Flexibility: Rigorous

Architecture / Risk Resolution: Often (60%)

Team Cohesion: Basically Cooperative

Process Maturity: SEI CMM Level 2

Show Equations

APM Settings...

Drivers & Size Model REVL Reuse Function Points Increments Breakage Costs Rates Maint. Filter Descr.

Click on a tab to display another notebook page

Estimate1: 9.0 PM, 8.5 Months Component1: 9.0 PM EAF: 0.8360 Level: 1

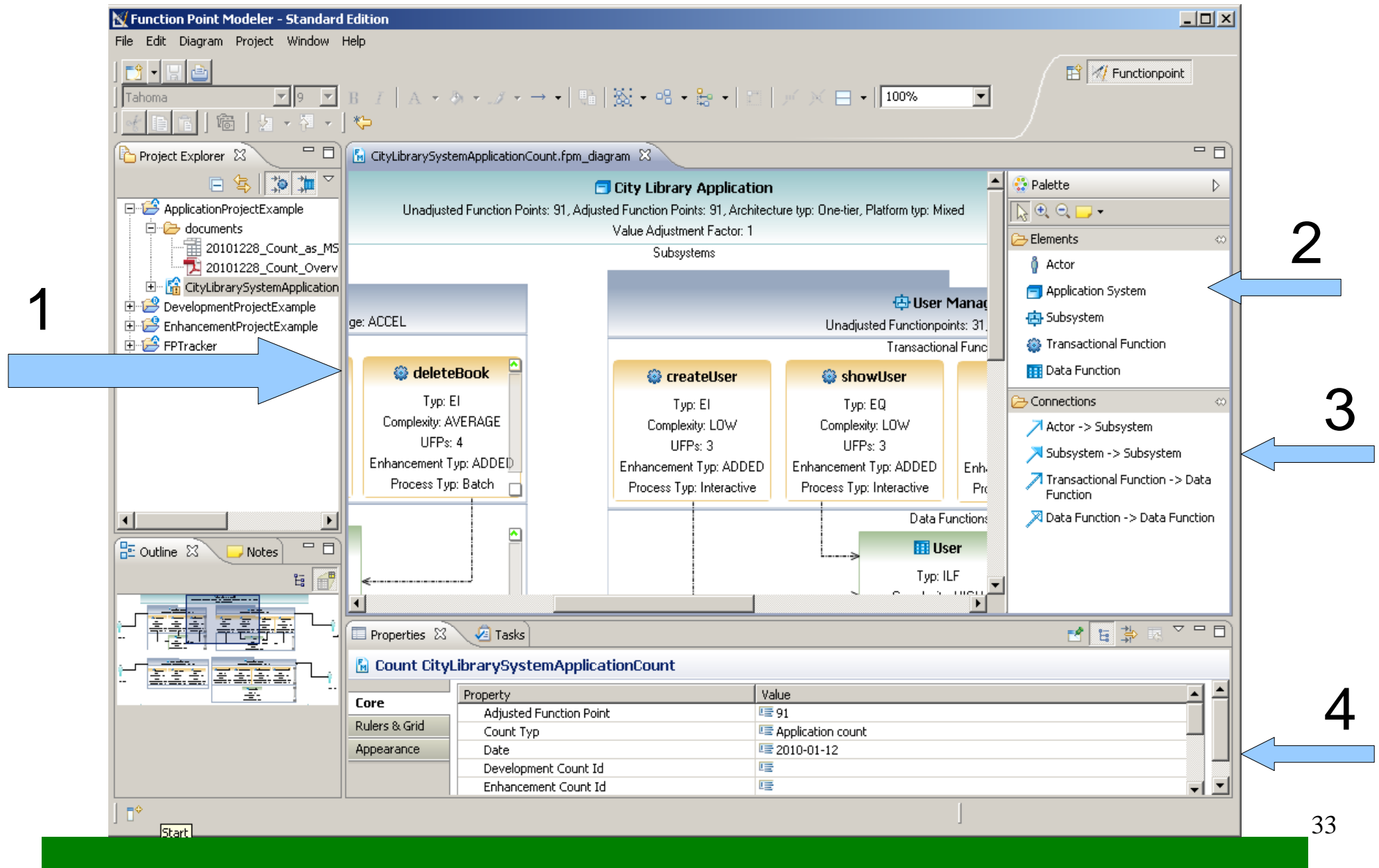
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Function Point Modeler

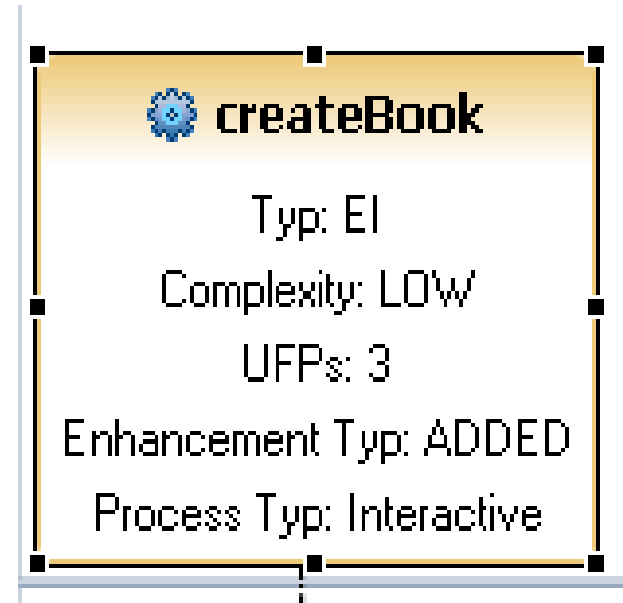
- Eclipse Graphical Modeling framework (GMF)
- Standard version – free
- Enterprise version - \$10,500
- International Function Point User group (IFPUG)
CPM 4.2 and 4.x
 - development project counts
 - enhancement project counts
 - application project counts
- Model Driven Architecture (MDA)

Standard Function Point Modeler



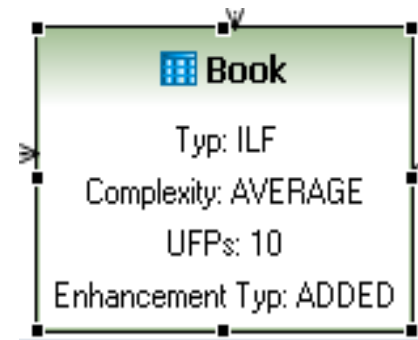
Transactional Function

- Type EI, EO or EQ
- Complexity
- UFP automatically calculated
- Enhancement Type
- Process Type

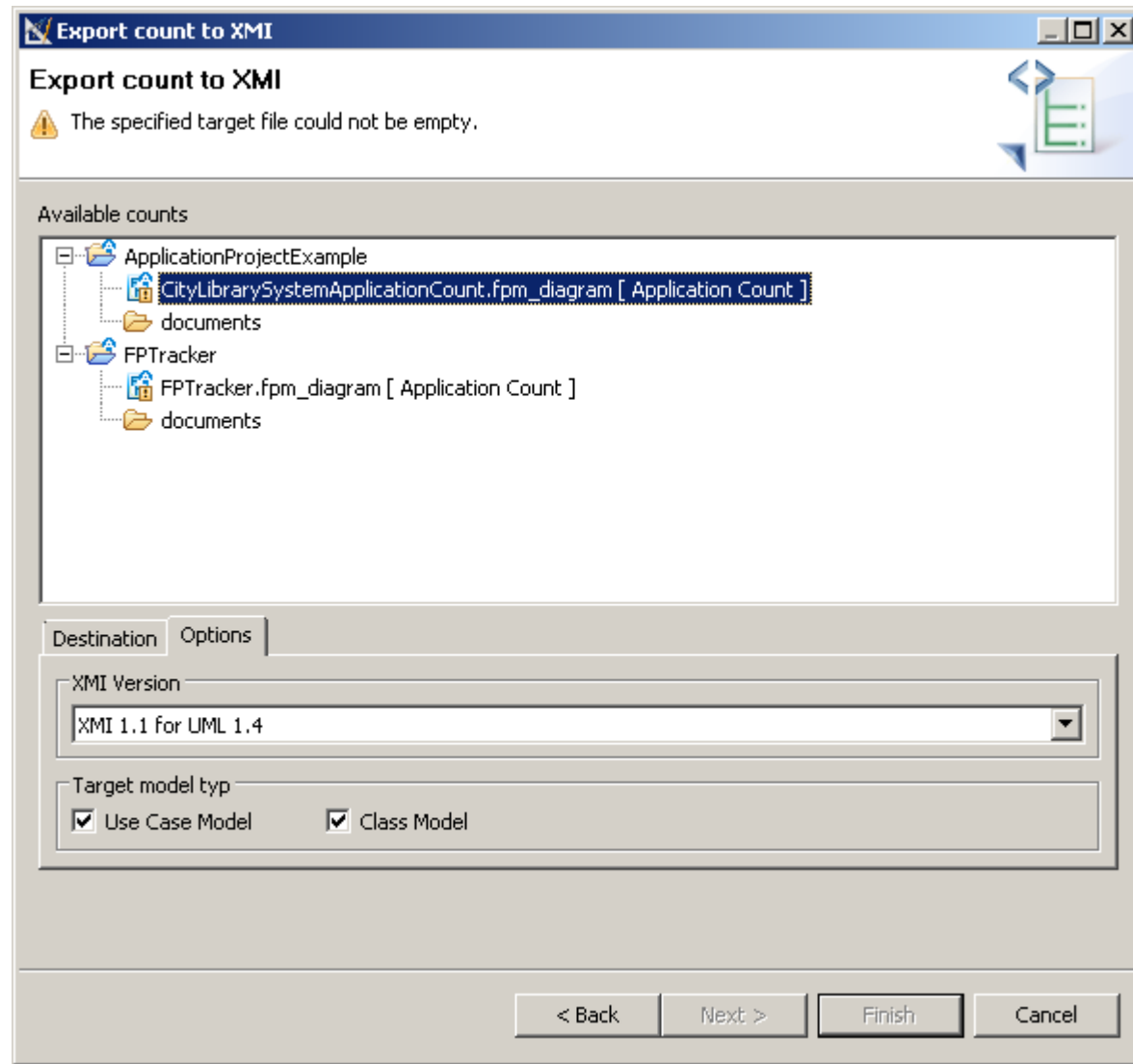


Data Function

- Type ILF or ELF
- Complexity
- UFP
- Enhancement Type



Model Driven Architecture (MDA)



Enterprise Version Features

- Metrics Management Tool plugin
 - manages all IT metrics
- software life cycle experience database (SLED)
- COCOMO II plugin
- Report Designer plugin
- Export to MS Project
- Software Development Process
 - RUP
 - Waterfall
 - Custom

Summary

- COCOMO II
 - Estimation and COCOMO II
 - Center for Systems and Software Engineering
- Estimation Tools
 - Construx
 - Costar
- Function Point Analysis tool
 - Standard edition
 - Enterprise edition

References

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Questions?