

***An Auditable Parametric
Based Estimating
System***

Elements of Parametric Based System

- ***Parametric Model(s)***
- ***Parametric Database***
- ***Implementation = Adaptation
of Model to Database***

Parametric System Building **5 Steps**

- 1. Survey Data Sets Available For Use***
- 2. Extract Appropriate Information From Surveyed Sets***
- 3. Construct Parametric Database Using Extracted Information***
- 4. Calibrate Parametric Tool(s) to Parametric Database***
- 5. Use, Monitor, and Maintain System***

Step 1 - Survey Available Data Sets

- *Project Schedule Reports*
- *Project Financial Reports*
- *Project Development Plan*
- *Project Status Reports*
- *Inspection and Test Reports*
- *Test Plans and Procedures*
- *Project Experience Databases (Metrics)*

Step 2 - Extract Pertinent Information

- *Cost/Effort/Schedule*
 - *Expenditures: Currency & Labor*
 - *By Phase and By Category of Performer*
 - *Milestones*
- *Technical*
 - *Measures of Size*
 - *Technology/Tools/State-of-Art*
 - *Quality*
 - *Design & Manufacturing Heritage*
 - *Function*
- *Project Peculiar*
 - *End User Requirements*
 - *Applicable Standards*
 - *Problems and/or Complications*
 - *Resource Skills*

Step 3 - Build a Parametric Database

- *Define Fields/Structures for Access and Sorting*
- *Make it Easy to Maintain*
- *Expect Growth*
- *Optimize - Only As Much Information As Needed
for Project Differentiation*

Step 4 - Calibrate Tool to Database

- *By Record?*
- *By Subtotal?*
- *By Project?*
- *Yes To All of the Above*
- *Purpose is to Build Ready-to-Use Rationale For
New Estimating Requirements*

Step 5 - Use, Monitor, & Maintain System

- ***Database***
 - ***Current, Accurate, & Complete Information***
 - ***Applicable Information Only***
- ***Parametric Tool(s)***
 - ***Evolve With Database***
 - ***Train and Monitor Users***
- ***Implementation/Use***
 - ***Ensure Database and Model Are In Synch.***
 - ***Adhere to Development Boundaries***

**Example - GARF Corp. Software
Development**

- *SPC Case Study Company*
- *Developers of Information and Training Systems*
- *Employ 2167a Software Development Standard*
- *Sample Data From 3 Projects*
 - *AN/SIM-13: Sonar Ops. Training System*
 - *DI-MIS: Warehouse Distribution System*
 - *CRL-MIS: Transportation Control System*

Data Sets Used

- *Software Experience Database Report*
 - *For SIM-13 and DI-MIS*
 - *Program Schedules and Software Functions*
 - *Configuration Item Core Development Allocated Labor Month Expenditures*
 - *Configuration Item Size (SLOC)*
 - *By Type*
 - *New vs. Reused*
 - *Allocated Project Level Effort*
 - *Systems Engineering & Program Management*
 - *Quality Assurance*
 - *Configuration Management*
 - *System Test*

Data Sets Used

- *CRL-MIS Software Status Report*
 - *Component Level Status*
 - *Size (SLOC) in Three Domains*
 - *Core Development Phases Status*
 - *Configuration Item Core Development Schedule*
- *CRL-MIS Monthly Financial Report*
 - *Allocated Effort (Labor Months) Associated With*
 - *Status Report*
 - *Allocated Project Level Effort*
- *Project Development Plan - Qualified 2167a Impact On DI-MIS and CRL-MIS Customer Liaison*
- *Inspection Reports - Enhanced Software Character Understanding*
- *Test Reports - Documented Quality Performance and Schedule Slippage*

GARF Corp. Reports

- *Software Experience Database Report*
- *CRL-MIS Software Status Report - Month 15*
- *CRL-MIS Monthly Financial Report - Month 15*

Parametric Database Construction

- *Project, Configuration Item, and Component IDs*
- *Start and End Dates*
- *Software Development Language*
- *Type of Software by Size (SLOC)*
 - *Function: Execution & Character*
 - *Heritage: New & Reused*
- *Allocated Labor Month Expenditures*
 - *Core Development by Configuration Item*
 - *Project Level Where Complete*
- *Calibrated Parametric Data*
 - *Fit to Rest of Database with PRICE S*
 - *PROFAC for Core Develop. by Configuration Item*
 - *5 Phase Allocation Parameters of Core Develop.*
 - *3 Category Allocation Parameters of Project Effort*

Mapping To Parametrics

- *Start Date = SDR (CSCI)*
- *End Date = FCA (CSCI)*
- *Type*
 - *data = Non-executable*
 - *All Indicate Character (APPL)*
- *# SLOC*
 - *New = % New Design & Code*
 - *New + Reused = Total Size*
- *All Other Factors Nominal*
 - *Tools, Experience, Interface Machine, Product*
 - *Knowledge*
 - *Integration*
 - *Processor Resource Utilization*

Mapping To Parametrics

- *Productivity Factor Calibration*
 - *Computed Per CSCI*
 - *Based On Core Development*
 - *Requirements Analysis (2 PRICE S Phases)*
 - *Preliminary Design*
 - *Detail Design*
 - *Code & Unit Test (Part of PRICE S Code/Test)*
 - *CSC Test (Part of PRICE S Code/Test)*
 - *CSCI Test*
 - *Design, Programming, & Data Engineering*
- *Allocation Parameter Calibration - Ratio of Labor Month Expenditures to PRICE S Estimates For Same Categories*
- *Project Level Parameter Calibration*
 - *Systems Engineering/Program Management, Quality Assurance, & Configuration Management*
 - *Ratio of Project Level Labor Months to PRICE S Est.*

Parametric Database

Parametric Database Example Caveats

- *Represents a Logical and Rational Approach, But There Are Others Just as Logical and Rational*
- *Most Likely Contains More Information Than Needed for Existing Projects, But Not Enough For Future Projects*
- *Candidates*
 - *Complicating & Mitigating Parameters*
 - *Development Tools*
 - *Language & Machine Knowledge*
 - *Variations in Team Experience*
 - *Multi-Site Project*
 - *Software Character*
 - *Component, Config. Item, & System Integration*
 - *Requirements & Volatility*

Parametric Database Summary

Garf Corporation Software Experience Database									
Project	PROFAC	Reqmt. Analysis	Prelim. Design	Detailed Design	Code & Unit Test	CSCI Test	Sys. En./ Pgm. Mgt.	Qual. Assur.	Config. Mgt.
AN/SIM-13 (Avg.)	8.69666667	1.17333333	1	0.71666667	1.23	0.9433333333	1	0.33	0.07
AN/SIM-13 (SD)	0.08504901	0.0635085	0	0.0208167	0.02645751	0.015275252			
DI-MIS (Avg.)	8.013333333	1.32	0.94	1.09666667	1.45666667	0.4333333333	0.97	0.34	0.07
DI-MIS (SD)	0.02886751	0.0173205	0.01	0.0057735	0.02081666	0.011547005			
CRL-MIS (Avg.)	7.9625	1.355	1.0975	1.095	1.53	0.26			
CRL-MIS (SD)	0.02362908	0.2568398	0.131244	0.0655744	0.05597619	0.027080128			
Database (Avg.)		1.29	1.021	0.982	1.418	0.517	0.985	0.335	0.07
Database (SD)		0.1722401	0.103435	0.1872491	0.13838754	0.304304307			

- *Variations By Application (IS vs. Training)*
 - *Productivity Factor (PROFAC)*
 - *Core Development Allocations*
- *Project Allocations Very Consistent*

PRICE Systems

Global Table

Garf Corp. Calibrated Globals - Jan. 1995

MULTIPLIERS	Cost						Sched	
	Des	Pgm	Data	SEPM	Q/A	CFM	Mult	Elin Pha:
System Concept	1.10	1.10	1.10	1.00	0.33	0.07	1.00	<input checked="" type="checkbox"/>
System SW Req	1.29	1.29	1.29	1.00	0.33	0.07	1.00	<input type="checkbox"/>
SW Req Anlys	1.29	1.29	1.29	1.00	0.33	0.07	1.00	<input type="checkbox"/>
Prelim Design	1.00	1.00	1.00	1.00	0.33	0.07	1.00	<input type="checkbox"/>
Detail Design	1.00	1.00	1.00	1.00	0.33	0.07	1.00	<input type="checkbox"/>
Code/Test	1.40	1.40	1.40	1.00	0.33	0.07	1.00	<input type="checkbox"/>
CSCI Test	0.50	0.50	0.50	1.00	0.33	0.07	1.00	<input type="checkbox"/>
System Test	1.00	1.00	1.00	1.00	0.33	0.07	1.00	<input checked="" type="checkbox"/>
Operational T&E	1.00	1.00	1.00	1.00	0.33	0.07	1.00	<input checked="" type="checkbox"/>

Calibration

PROFAC: 8.7 (Tng.)
8.0 (Inf.)

Globals

Accuracy

	Actual	Predicted	Var.
SIM-13	1826	1783	-2%
DI-MIS	1048	1047	0%
G-MIS*	469	464	-1%

* Includes completed CSCIs only and excludes SE/PM, QA, and CM

Database Application Example

Ops CSCI of CRL-MIS

- *5th CSCI of the CRL-MIS System*
- *Start Date: 1/94 End Date: 4/95*
- *50740 Executable SLOC & 12580 Non-executable SLOC - All New*
- *Completed Are:*
 - *Requirements Analysis*
 - *Preliminary Design*
- *Partially Completed Are:*
 - *Detail Design - 80% SLOC Done*
 - *Code & Unit Test - 45% SLOC Done*
 - *Project Level Tasks*
- *CSCI Test Yet to Begin*

Ops CSCI With Nominal Allocations

Acquisition Costs / CSCI							
	Ops		Development		Item		
	Costs in Person Months						
	Design	Pgming	Data	S/PM	Q/A	Config	TOTAL
Sys Concept	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sys/SW Req't	12.4	0.0	2.1	0.0	0.0	0.0	14.5
SW Reqment	22.2	0.0	5.6	0.0	0.0	0.0	27.9
Prelim Des	35.5	11.5	8.2	0.0	0.0	0.0	55.3
Detail Des	56.5	18.3	13.0	0.0	0.0	0.0	87.8
Code/Test	18.0	82.8	9.6	0.0	0.0	0.0	110.3
CSCI Test	63.9	44.3	25.6	0.0	0.0	0.0	133.8
Sys Test	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oper TE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	208.5	157.0	64.1	0.0	0.0	0.0	429.6
SCHEDULE INFORMATION							
Concept Start				TRR	Jan 95*	(3.3)	
SRR	Oct 93*	(0.0)		FCA	Mar 95	(2.2)	
SDR	Dec 93	(2.2)		PCA		(0.0)	
SSR	Mar 94*	(3.4)		FQR		(0.0)	
PDR	Jun 94*	(2.7)		OTE		(0.0)	
CDR	Sep 94*	(3.4)					
SUPPLEMENTAL INFORMATION							
	Source Lines of Code			63320			
	Source Lines of Code/Person Months			163.51			
SCHEDULE ACCELERATION EFFECT							
	Specified/Nominal Cost Ratio			1.60			

Ops CSCI With Calibrated Allocations

Acquisition Costs / CSCI									
	Ops Development Item						TOTAL		
	Costs in Person Months								
	Design	Pgming	Data	S/PM	Q/A	Config			
Sys Concept	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Sys/SW Reqmt	15.9	0.0	2.7	0.0	0.0	0.0	18.6		
SW Reqment	28.5	0.0	7.2	0.0	0.0	0.0	35.8		
Prelim Des	35.4	11.5	8.1	0.0	0.0	0.0	55.0		
Detail Des	56.2	18.3	12.9	0.0	0.0	0.0	87.4		
Code/Test	25.0	115.2	13.3	0.0	0.0	0.0	153.6		
CSCI Test	31.8	22.1	12.7	0.0	0.0	0.0	66.5		
Sys Test	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Oper TE	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
TOTAL	192.8	167.0	57.0	0.0	0.0	0.0	416.8		
SCHEDULE INFORMATION									
Concept Start			TRR	Jan 95*	(3.3)		
SRR	Oct 93*	(0.0)	FCA	Mar 95	(2.2)
SDR	Dec 93	(2.2)	PCA		(0.0)
SSR	Mar 94*	(3.4)	FQR		(0.0)
PDR	Jun 94*	(2.7)	OTE		(0.0)
CDR	Sep 94*	(3.4)					
SUPPLEMENTAL INFORMATION									
	Source Lines of Code				63320				
	Source Lines of Code/Person Months				174.70				
SCHEDULE ACCELERATION EFFECT									
	Specified/Nominal Cost Ratio				1.53				

Comparison - Parametric Estimates vs. Actuals To Date OPS CSCI

	<i>Nominal</i>	<i>Calibrated</i>	<i>To Date</i>
	<i>Allocations</i>	<i>Allocations</i>	<i>Actuals</i>
<i>Rqmts. Anal.</i>	<i>44.4</i>	<i>54.4</i>	<i>48.1</i>
<i>Prelim. Design</i>	<i>55.3</i>	<i>55.0</i>	<i>55.1</i>
<i>Detail Design</i>	<i>87.8</i>	<i>87.4</i>	<i>72.4 (80%)</i>
<i>Code/Unit Test</i>	<i>110.3</i>	<i>153.6</i>	<i>66.5 (45%)</i>
<i>CSCI Test</i>	<i>133.8</i>	<i>66.5</i>	<i>0 (0%)</i>
<i>Subtotal</i>	<i>429.6</i>	<i>416.8</i>	<i>242.1</i>

CRL-MIS Project Parametric Estimate

Acquisition Costs / System							
	CRL-MIS Parametric Estimate					System	
	Costs in Person Months						
	Design	Pgming	Data	S/PM	Q/A	Config	TOTAL
Sys Concept	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sys/SW Req't	35.9	0.0	6.2	12.9	0.4	0.1	55.5
SW Reqment	60.4	0.0	14.7	56.7	2.2	0.5	134.4
Prelim Des	77.6	25.1	17.1	49.1	3.4	0.7	173.0
Detail Des	121.2	39.3	26.8	76.8	5.2	1.1	270.5
Code/Test	56.2	240.2	28.0	29.5	10.4	2.2	366.6
CSCI Test	63.6	44.1	24.5	65.0	20.7	4.4	222.3
Sys Test	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oper TE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-Total	414.9	348.7	117.2	290.1	42.3	9.0	1222.3

Comparison - Parametric Est./Est. At Completion/Incurred To Date Total Project

	<i>Parametric</i>	<i>ITD</i>	<i>EAC</i>	<i>Var.</i>	<i>Budget</i>
<i>Rqmts. Anal.</i>	117.2	118.9	118.9	1%	
<i>Prelim. Des.</i>	119.8	126.8	127.8	7%	
<i>Detail Des.</i>	187.3	180.6	189.3	1%	
<i>Code/Test</i>	324.4	251.2	332.9	3%	
<i>CSCI Test</i>	132.3	33.5	56.5	-57%	
<i>Sys. En./Prog. Mgt.</i>	290.1	160.5	241.3	-17%	
<i>Qual. Assur.</i>	42.3	40.1	54.3	28%	
<i>Config. Mgmt.</i>	9	7	10	11%	
Total	1222.4	918.6	1131	-7%	1085

Observations

- *Parametric Estimating Requires No New Data*
- *Parametric Databases Are Often Constructed With Pieces From Other Databases*
- *Calibrated Parameter Variations Should Be Expected*
 - *Search For Explanation(s) Why*
 - *Enlarge Database to Include New Discriminating Parameters*
- *Consistent & Rational Mapping Is More Important Than Air Tight Precision Mapping Since:*
 - *It Conforms With Reality*
 - *It's Hard To Go Wrong!*