



A Modeling for Estimating Systems Engineering Schedule Acceleration

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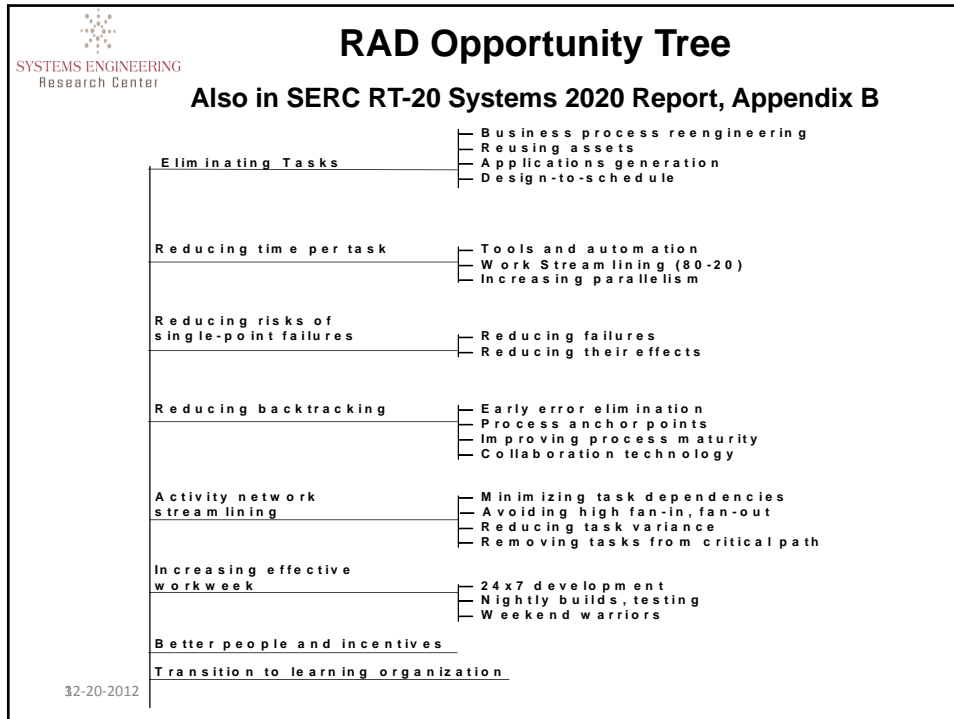


Outline

- **Baseline: CORADMO Expedited Software Development Model**
 - RAD: Rapid Application Development
 - Expedited Schedule Drivers
 - Relation to RAD Opportunity Tree
- **Nominal Systems Engineering effort and schedule obtained from COSYSMO effort estimation model, square-root effort-schedule relationship**
- **RAD Opportunity Tree elements reorganized around product-process-project-people-risk factors determined in SERC Expediting SE study**
- **Model calibrated to 12 agile project data points**
- **Case Study: From Plan-Driven to Agile**
- **Current Model Status**

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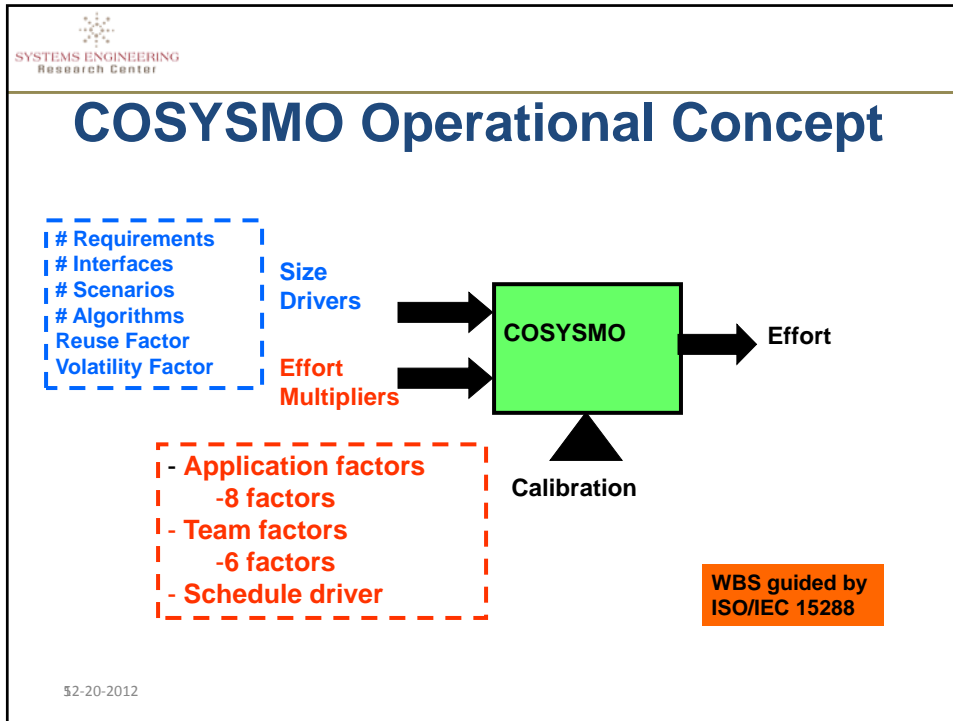
Basic Expedited SE Model Form

- **Estimate SE effort using COSYSMO**

- **Estimate nominal SE schedule as square root (SE effort)**
 - Agile software schedule = square root (effort)

- **Estimate deviations from nominal schedule using multipliers for product, process, project, people, and risk acceptance factors**
 - Very Low, Low factor ratings slow down schedule
 - High, Very High and Extra High factor ratings speed up schedule

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COSYSMO Cost Drivers - Application


TOC	COSYSMO Application Factor Selection											See Embedded Comments for Descriptions and Selection Criteria
COSYSMO Application Factor Description	Identifier	Current Prod. Range	Suggested Prod. Range	VLOW (VL)	LOW (L)	NOM (N)	HIGH (H)	VHIGH (VH)	XHIGH (XH)	Rating Selected	Resulting Multiplier	Application Factor Rating Selection Comments
Requirements Understanding	ROMT	1.73	1.73	1.40	1.20	1.00	0.90	0.81	****	N	1.00	
Architecture Complexity	ARCH	1.66	1.66	1.28	1.14	1.00	0.88	0.77	****	N	1.00	
Level of Service (KPP) Requirements	LSVC	2.50	2.50	0.66	0.83	1.00	1.33	1.65	****	N	1.00	
Migration Complexity	MIGR	1.50	1.50	****	****	1.00	1.25	1.50	****	N	1.00	
No. and Diversity of Installations/Platforms	INST	1.50	1.50	****	****	1.00	1.25	1.50	****	N	1.00	
No. of Recursive Levels in the Design	RECU	1.50	1.50	0.82	0.91	1.00	1.12	1.23	****	N	1.00	
Documentation to Match Lifecycle Needs	DOCU	0.67	0.67	0.82	0.91	1.00	1.12	1.23	****	N	1.00	
Technology Maturity	TMAT	2.50	2.50	1.75	1.37	1.00	0.85	0.70	****	N	1.00	Select the Rating from the pull that best represents the Rating program being estimated in the Mode or in the SE Data Collection Rating that best characterizes the program for which you are providing

Productivity Range (PR) is the Highest Number / Lowest Number and is an indication of the "Relative Degree of Influence" of this parameter on SE effort as currently

The "Suggested" column has no immediate impact in the COSYSMO SE Costing Mode. However, for the COSYSMO SE Data Collection Mode, it serves as a means of collecting your inputs as to what you think the "Relative Degree of Influence" of this parameter should be based upon your overall experience (not specific to the past program being characterized). If you agree with the "Current" number, do nothing. If you disagree, simply overwrite the current number with a new number n (n>1.0) in the appropriate cell.

4. Parameters I / 5. Parameters II / 6a. Staffing Table / 6b. Staffing Chart / 7. Labor Distribution / Local SE Data Repository / 8a. Application Factors


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Product Factor Elements

- **Product simplicity (of interfaces, legacy migration, -ilities)**
 - Very Low: Extremely complex; Extra High: Extremely simple
- **Ability to reuse product elements**
 - Very Low: None; Extra High: 90%
- **Ability to defer low-impact aspects**
 - Very Low: Never; Extra High: Anytime
- **System definition via models vs. documents**
 - Very low: None; Extra High: 90%
- **Technology maturity of key capabilities**
 - Very Low: >0 Level 1-2 or >1 Level 3; Extra High: All >Level 7


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Process Factor Elements

- **Concurrency of OpCon, Rqts., Architecture, V&V**
 - Very Low: Highly sequential; Extra High: Fully concurrent
- **Process streamlining**
 - Very Low: Heavily Bureaucratic; Extra High: Fully streamlined
- **General SE tool support (coverage, integration, maturity: CIM)**
 - Very Low: Simple tools, weak CIM; Extra High: Very strong CIM

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Project Factor Elements

- **Collaboration support**
 - **Very Low:** Globally distributed; weak communications, data sharing
 - **Extra High:** Largely collocated; very strong communications, data sharing

- **Single-domain models, methods, processes, tools (MMPTs)**
 - **Very Low:** Simple MMPTs, weak CIM; **Extra High:** Extensive CIM

- **Multi-domain models, methods, processes, tools (MMPTs)**
 - **Very Low:** Simple MMPTs, weak CIM; **Extra High:** Extensive CIM

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People Factor Elements

- **General-SE Knowledge, Skills, and Agility (KSA)**
 - **Very Low:** Very weak KSA; **Extra High:** Very strong KSA

- **Single-domain Knowledge, Skills, and Agility (KSA)**
 - **Very Low:** Very weak KSA; **Extra High:** Very strong KSA

- **Multi-domain Knowledge, Skills, and Agility (KSA)**
 - **Very Low:** Very weak KSA; **Extra High:** Very strong KSA

- **Team compatibility**
 - **Very Low:** Very difficult interactions
 - **Extra High:** Seamless interactions


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Risk Acceptance Factor

- **Risk Acceptance**
 - **Very Low: High risk-averse;**
 - **Extra High: Strongly risk-accepting**


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CORADMO-SE Rating Scales, Schedule Multipliers


Accelerators/Ratings	Very Low 1.09	Low 1.05	Nominal 1.0	High 0.96	Very High 0.92	Extra High 0.87
Product Factors						
Simplicity	Extremely complex	Highly complex	Mod. complex	Moderately simple	Highly simple	Extremely simple
Element Reuse	None (0%)	Minimal (15%)	Some (30%)	Moderate (50%)	Considerate (70%)	Extensive (90%)
Low-Priority Deferrals	Never	Rarely	Sometimes	Often	Usually	Anytime
Models vs Documents	None (0%)	Minimal (15%)	Some (30%)	Moderate (50%)	Considerate (70%)	Extensive (90%)
Key Technology Maturity	>0 TRL 1, 2 or >1 TRL 3	1 TRL 3 or > 1 TRL 4	1 TRL 4 or > 2 TRL 5	1-2 TRL 5 or >2 TRL 6	1-2 TRL 6	All > TRL 7
Process Factors	1.09	1.05	1.0	0.96	0.92	0.87
Concurrent Operational Concept, Requirements, Architecture, V&V	Highly sequential	Mostly sequential	2 artifacts mostly concurrent	3 artifacts mostly concurrent	All artifacts mostly concurrent	Fully concurrent
Process Streamlining	Heavily bureaucratic	Largely bureaucratic	Conservative bureaucratic	Moderate streamline	Mostly streamlined	Fully streamlined
General SE tool support CIM (Coverage, Integration, Maturity)	Simple tools, weak integration	Minimal CIM	Some CIM	Moderate CIM	Considerable CIM	Extensive CIM
Project Factors	1.08	1.04	1.0	0.96	0.93	0.9
Project size (peak # of personnel)	Over 300	Over 100	Over 30	Over 10	Over 3	≤ 3
Collaboration support	Globally distributed, weak comm., data sharing	Nationally distributed, some sharing	Regionally distributed, moderate sharing	Metro-area distributed, good sharing	Simple campus, strong sharing	Largely collocated, Very strong sharing
Single-domain MMPTs (Models, Methods, Processes, Tools)	Simple MMPTs, weak integration	Minimal CIM	Some CIM	Moderate CIM	Considerable CIM	Extensive CIM
Multi-domain MMPTs	Simple, weak integration	Minimal CIM	Some CIM or not needed	Moderate CIM	Considerable CIM	Extensive CIM
People Factors	1.13	1.06	1.0	0.94	0.89	0.84
General SE KSAs (Knowledge, Skills, Agility)	Weak KSAs	Some KSAs	Moderate KSAs	Good KSAs	Strong KSAs	Very strong KSAs
Single-Domain KSAs	Weak	Some	Moderate	Good	Strong	Very strong
Multi-Domain KSAs	Weak	Some	Moderate or not needed	Good	Strong	Very strong
Team Compatibility	Very difficult interactions	Some difficult interactions	Basically cooperative interactions	Largely cooperative	Highly cooperative	Seamless interactions
Risk Acceptance Factor	1.13	1.06	1.0	0.94	0.89	0.84
	Highly risk-averse	Partly risk-averse	Balanced risk aversion, acceptance	Moderately risk-accepting	Considerably risk-accepting	Strongly risk-accepting

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CORADMO-SE Calibration Data
Mostly Commercial; Some DoD

Application Type	Technologies	Person Months	Duration (Months)	Duration / \PM	Product	Process	Project	People	Risk	Multiplier	Error %
Insurance agency system	HTML/VB	34.94	3.82	0.65	VH	VH	XH	VH	N	0.68	5%
Scientific/engineering	C++	18.66	3.72	0.86	L	VH	VH	VH	N	0.80	-7%
Compliance - expert	HTML/VB	17.89	3.36	0.79	VH	VH	XH	VH	N	0.68	-15%
Barter exchange	SQL/VB/ HTML	112.58	9.54	0.90	VH	H	H	VH	N	0.75	-16%
Options exchange site	HTML/SQL	13.94	2.67	0.72	VH	VH	XH	VH	N	0.68	-5%
Commercial HMI	C++	205.27	13.81	0.96	L	N	N	VH	N	0.93	-3%
Options exchange site	HTML	42.41	4.48	0.69	VH	VH	XH	VH	N	0.68	-1%
Time and billing	C++/VB	26.87	4.80	0.93	L	VH	VH	VH	N	0.80	-14%
Hybrid Web/client-server	VB/HTML	70.93	8.62	1.02	L	N	VH	VH	N	0.87	-15%
ASP	HTML/VB/SQL	9.79	1.39	0.44	VH	VH	XH	VH	N	0.68	53%
On-line billing/tracking	VB/HTML	17.20	2.70	0.65	VH	VH	XH	VH	N	0.68	4%
Palm email client	C/HTML	4.53	1.45	0.68	N	VH	VH	VH	N	0.76	12%

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- **RAD Opportunity Tree elements reorganized around product-process-project-people-risk factors determined in RT-34**
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- ➔ **Case Study: From Plan-Driven to Agile**
 - **Current Model Status**

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Case Study: From Plan-Driven to Agile

Accelerators/Ratings	VL	L	N	H	VH	XH
Product Factors	1.09	1.05	1.0	0.96	0.92	0.87
Simplicity			X			
Element Reuse	X					
Low-Priority Deferrals	X					
Models vs Documents		X				
Key Technology Maturity					X	
Process Factors	1.09	1.05	1.0	0.96	0.92	0.87
Concurrent Operational Concept, Requirements, Architecture, V&V	X					
Process Streamlining		X				
General SE tool support CIM (Coverage, Integration, Maturity)				X		
Project Factors	1.08	1.04	1.0	0.96	0.93	0.9
Project size (peak # of personnel)				X		
Collaboration support				X		
Single-domain MMPTs (Models, Methods, Processes, Tools)				X		
Multi-domain MMPTs		X				
People Factors	1.13	1.06	1.0	0.94	0.89	0.84
General SE KSAs (Knowledge, Skills, Agility)				X		
Single-Domain KSAs				X		
Multi-Domain KSAs		X				
Team Compatibility				X		
Risk Acceptance Factor	1.13	1.06	1.0	0.94	0.89	0.84
			X			

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Case Study: From Plan-Driven to Agile
Initial Project: Focus on Concurrent SE

Accelerators/Ratings	VL	L	N	H	VH	XH
Product Factors	1.09	1.05	1.0	0.96	0.92	0.87
Simplicity			X			
Element Reuse	X					
Low-Priority Deferrals	X					
Models vs Documents		X				
Key Technology Maturity			X			
Process Factors	1.09	1.05	1.0	0.96	0.92	0.87
Concurrent Operational Concept, Requirements, Architecture, V&V				X		
Process Streamlining		X				
General SE tool support CIM (Coverage, Integration, Maturity)				X		
Project Factors	1.08	1.04	1.0	0.96	0.93	0.9
Project size (peak # of personnel)				X		
Collaboration support				X		
Single-domain MMPTs (Models, Methods, Processes, Tools)				X		
Multi-domain MMPTs		X				
People Factors	1.13	1.06	1.0	0.94	0.89	0.84
General SE KSAs (Knowledge, Skills, Agility)			X			
Single-Domain KSAs				X		
Multi-Domain KSAs		X				
Team Compatibility			X			
Risk Acceptance Factor	1.13	1.06	1.0	0.94	0.89	0.84
			X			

Expected schedule reduction of $1.09/0.96 = 0.88$ (green arrow)
 Actual schedule delay of 15% due to side effects (red arrows)
 Model prediction: $0.88*1.09*1.04*1.06*1.06 = 1.13$

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Case Study: From Plan-Driven to Agile Next Project: Fix Side Effects; Reduce Bureaucracy

Accelerators/Ratings	VL	L	N	H	VH	XH
Product Factors	1.09	1.05	1.0	0.96	0.92	0.87
Simplicity			X			
Element Reuse	X					
Low-Priority Deferrals	X					
Models vs Documents		X				
Key Technology					X	
Maturity						
Process Factors	1.09	1.05			0.92	0.87
Concurrent Operational Concept, Requirements, Architecture, V&V					C	
Process Streamlining						
General SE tool support						
CIM (Coverage, Integration, Maturity)					C	
Project Factors	1.08	1.04	1.0	0.96	0.93	0.9
Project size (peak # of personnel)				X		
Collaboration support				X		
Single-domain MMPTs (Models, Methods, Processes, Tools)				X		
Multi-domain MMPTs		X				
People Factors	1.13	1.06	1.0	0.94	0.89	0.84
General SE KSAs (Knowledge, Skills, Agility)					C	
Single-Domain KSAs				X		
Multi-Domain KSAs		X				
Team Compatibility					C	
Risk Acceptance Factor	1.13	1.06	1.0	0.94	0.89	0.84
			X			

Model estimate: $0.88 \cdot (0.92/0.96) \cdot (0.96/1.05) = 0.77$ speedup

Project results: 0.8 speedup

Model tracks project status; identifies further speedup potential

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Current Model Status

- **Considerable interest, experimental use**
 - Large aerospace companies, DoD Services
- **Also considered useful for planning**
- **Preparing, iterating data collection instrument**
- **Applying to agile software projects**
 - Mostly knowledge work

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