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CORADMO

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Outline

Background

Model Overview

Schedule Drivers, Rating Scales

Examples of Use

Background

Another step

As COCOMO II evolves, it will have a more extensive schedule estimation model, reflecting the different classes of process model a project can use; the effects of reusable and COTS software; and the effects of applications composition capabilities.

COCOMO II Schedule

- Reflects a waterfall process model
- Duration calculation unreasonable for small projects
- Model does not address RAD strategies

COCOMO-II Staged Schedule & Effort Model and Constructive RAD Schedule Estimation Model

Need to Improve Classic Schedule Model

Need stronger capability to reason about RAD Opportunity
Tree strategies/tradeoffs

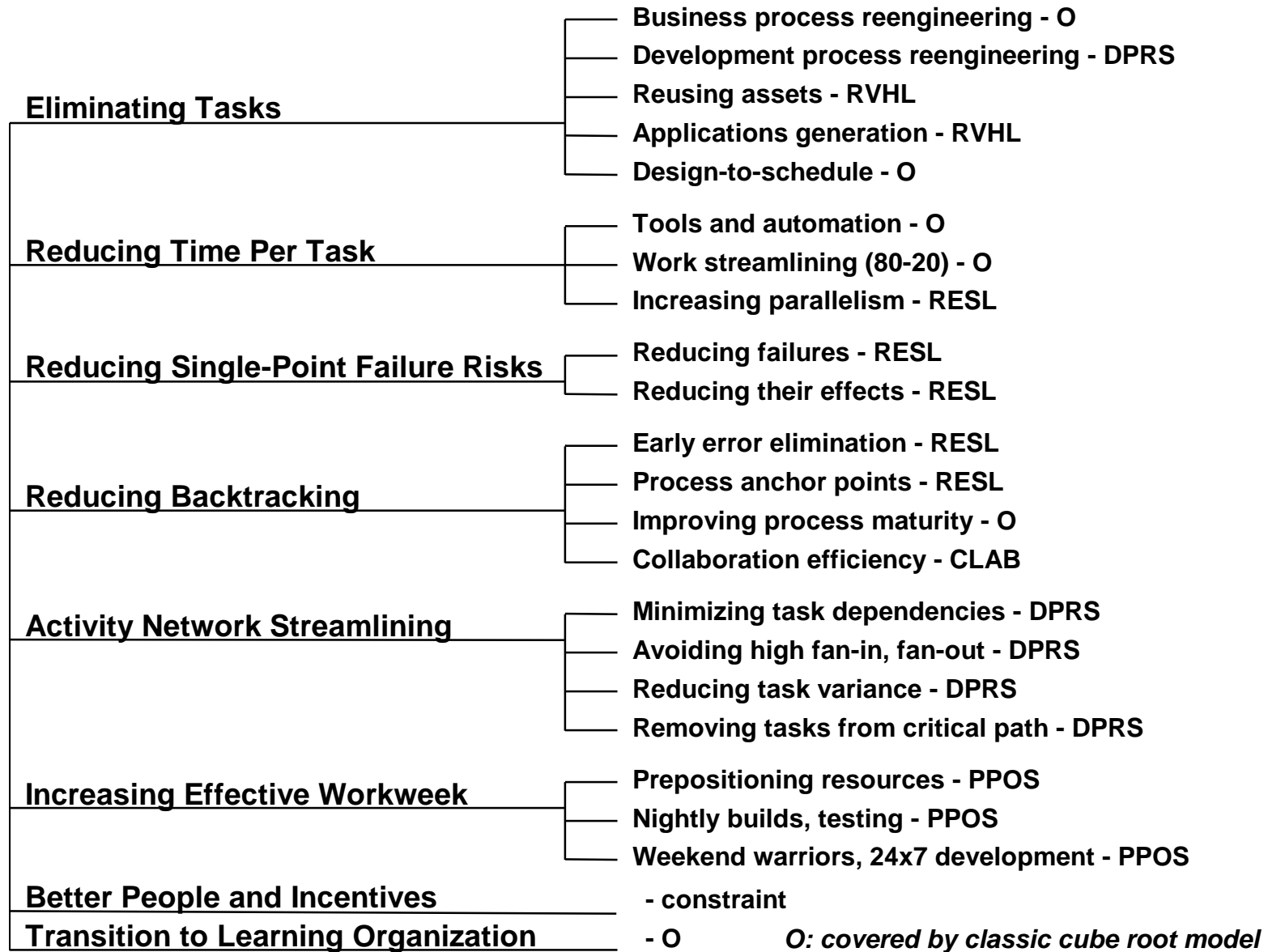
- Reuse, Very High Level Languages (VHLL) (RVHL)
- Development Process Reengineering (DPRS)
- Collaboration Technology (CLAB)
- Architecture, Risk Resolution (RESL)
- Prepositioning Assets (PPOS)

COCOMO II Duration Calculation

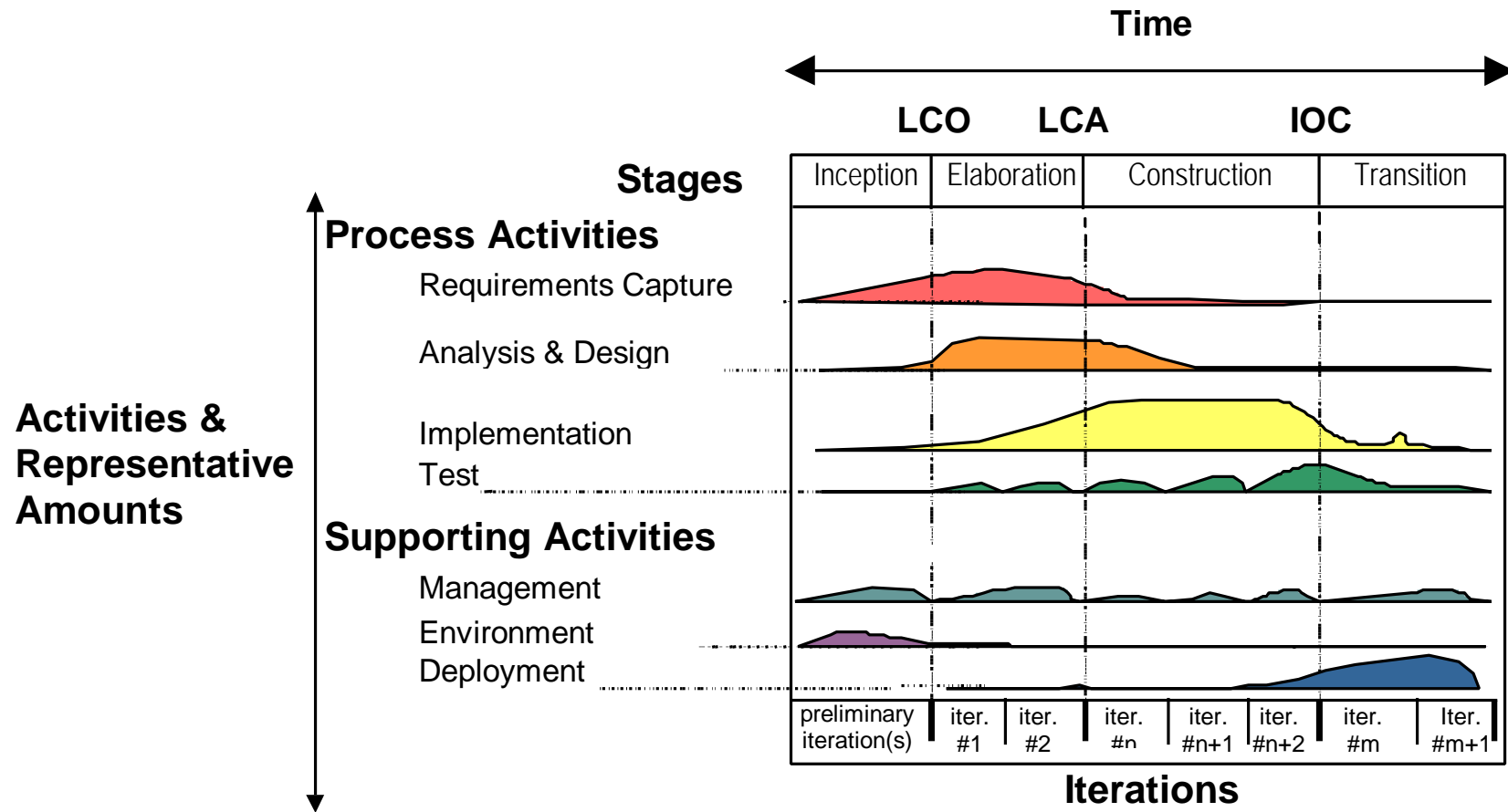
$$\text{Months} \sim 3 \sqrt[3]{\text{Person-Months}}$$



RAD Opportunity Tree



Process Model





Process Model Details

COCOMO II Submodel Usage	Early Design	Post-Architecture	Maintenance

	LCO		LCA	IOC	
Activities \ Stage	Inception	Elaboration	Construction	Transition	
Requirements Capture	Some usually	Most, peaks here	Minor	None	
Analysis & Design	A little	Majority, mostly constant effort	Some	Some, for repair during ODT&E	
Implementation	Practically none	Some, usually for risk reduction	Bulk; mostly constant effort	Some, for repair during ODT&E	
Test	None	Some, for prototypes	Most for unit test, integration test and qualification test.	Some, for repaired code.	



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COSSEMO

COCOMO-II Staged Schedule & Effort Model

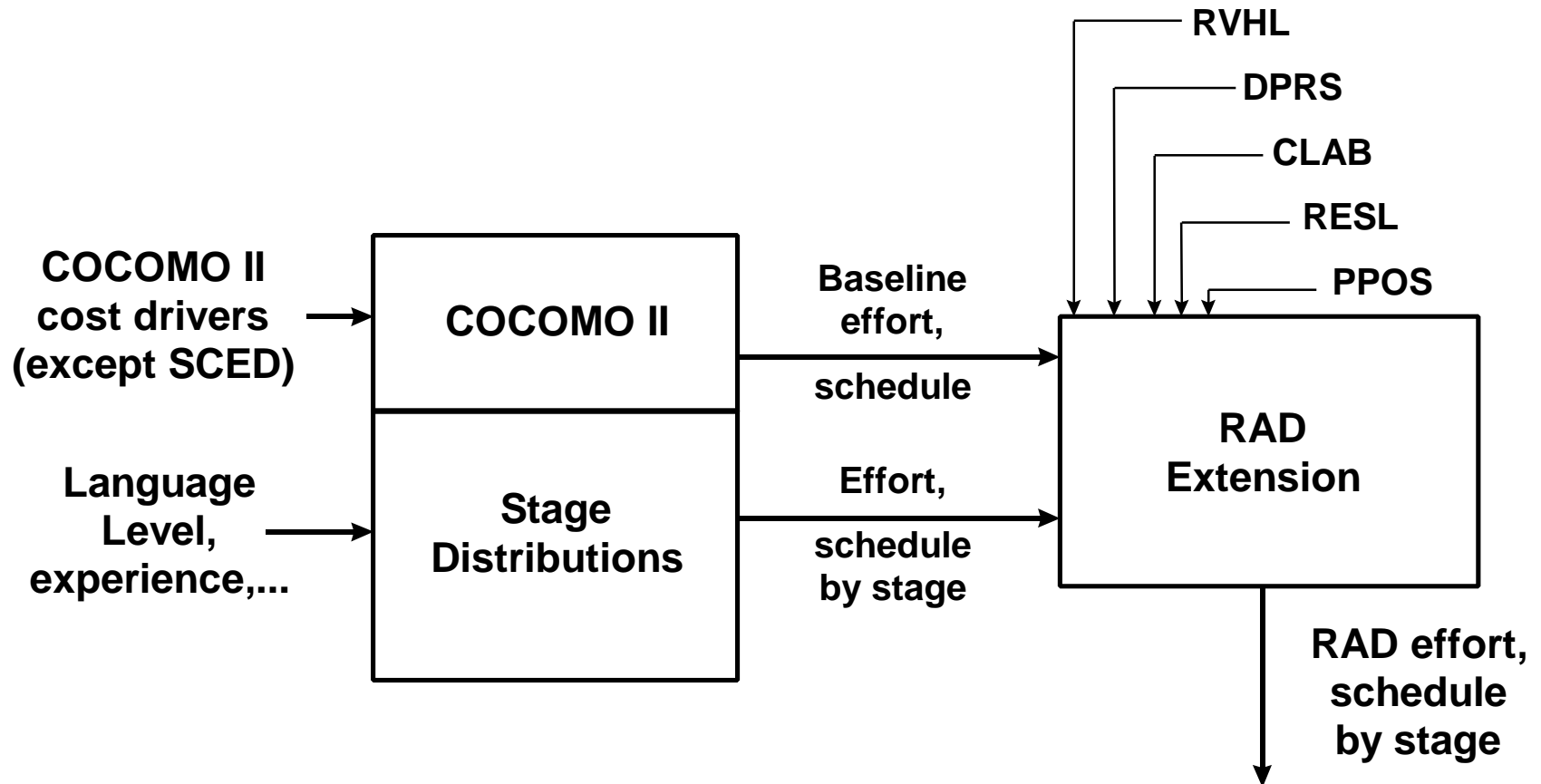
CORADMO

Constructive RAD Schedule Estimation Model

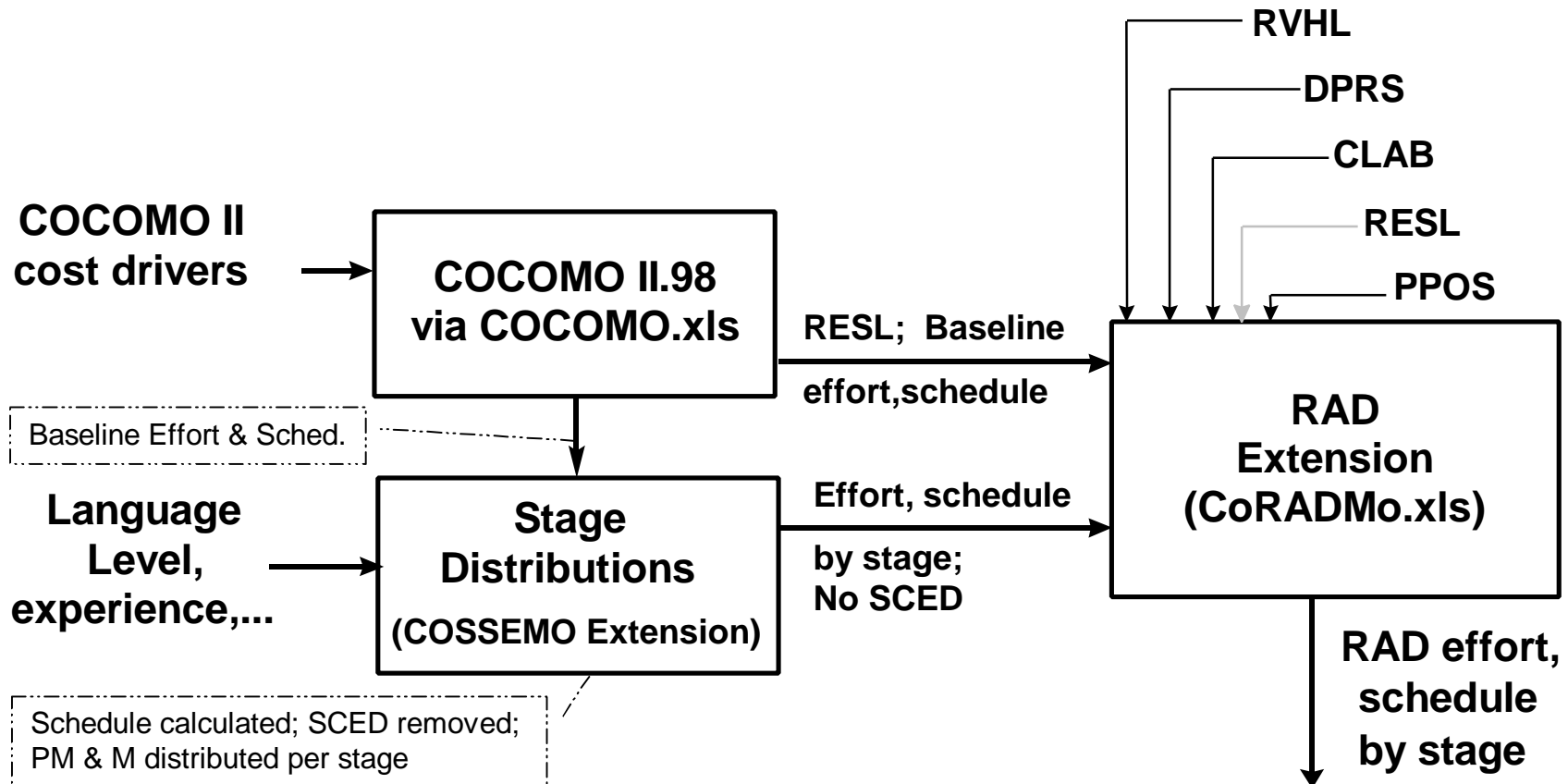
Implementation Models

- Logical
- Physical
- Spreadsheet

Logical COCOMO II RAD Extension

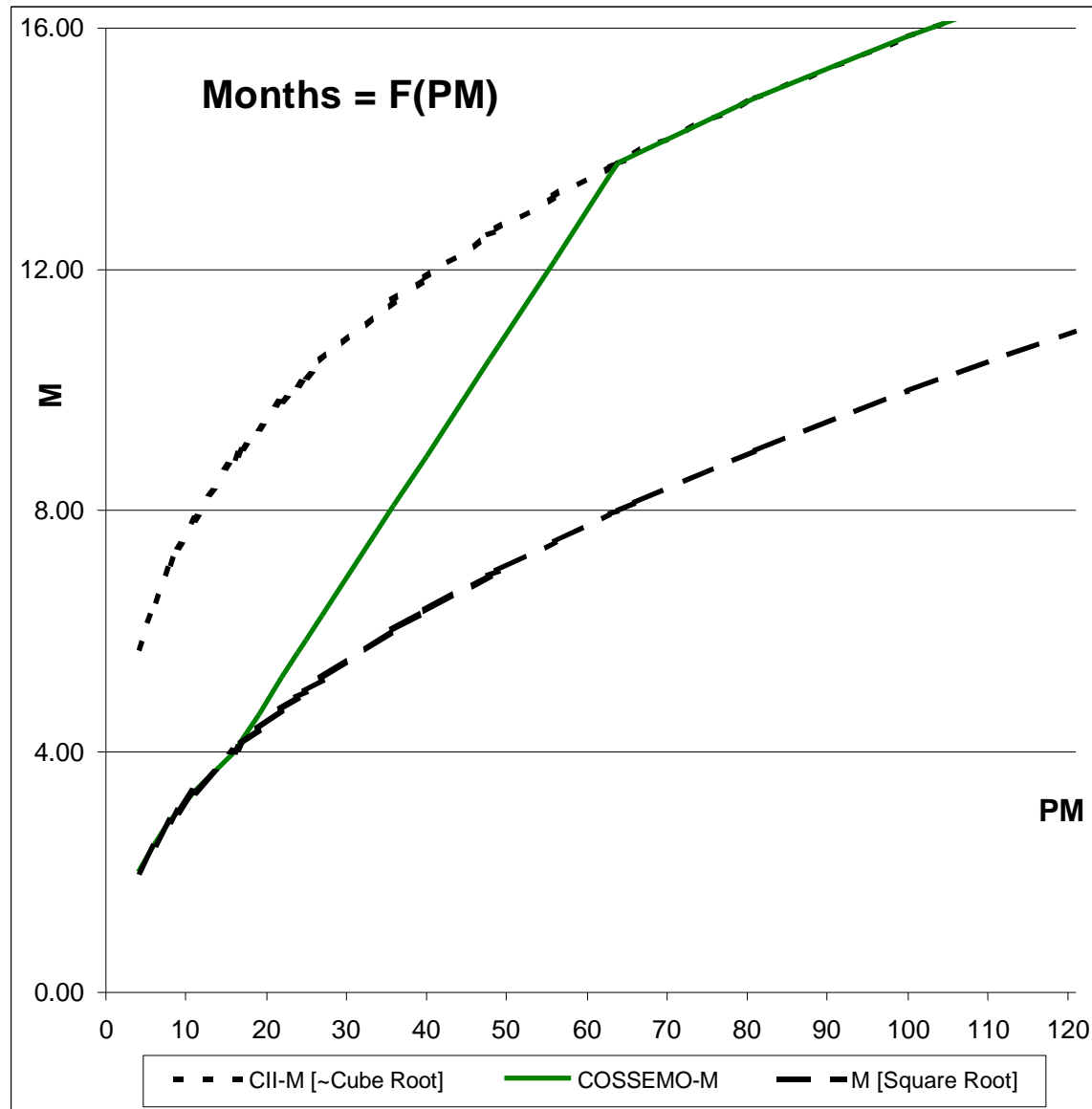


Physical COCOMO II RAD Extension





COSSEMO Duration Calculation



Driver Issues

RVHL: Reuse and VHLLs

- Different schedule impacts in different stages
 - Construction: no impact beyond COCOMO II 3GL reuse
 - Inception & Elaboration: prototyping and option exploration
- Same effect on effort; staff level not changed

RESL: Architecture / Risk Resolution beyond COCOMO II

- Construction: enables effective parallel development
- Inception & Elaboration: no impact
- Same effect on effort; staff level not changed

PPOS: Prepositioning Assets

- Different impacts on effort and schedule in different stages

COCOMO II RAD Extension Implementation

Baseline Stage Distribution Model: Early Design & Post Architecture

	LCO	LCA	IOC	
	Inception	Elaboration	Construction	Total E&C
Effort %	14.00	28.00	72.00	100.00
Schedule %	40.00	40.00	60.00	100.00
P / Ave(P)	0.35	0.70	1.20	1.00
PM / M=P				
32K	16.8/4.8 = 3.5	33.6/4.8 = 7	86.4/7.2 = 12	120/12 = 10
512K	361/13.7 = 26	722/13.7 = 53	1858/20.6 = 90	2580/34.3 = 75



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Schedule Drivers, Rating Scales

Examples of Use

Reuse and VHLLs (RVHL)

Standard 3GL module reuse: no adjustment

Schedule compression in Inception and Elaboration stages due to faster prototyping, option exploration

- effect depends on level of capability and experience in doing this (similar to Rapid Prototyping experience)
- same effect on effort; staff level held constant

Schedule and Effort Multipliers	Rapid Prototyping Experience Level				
	VL	L	N	H	VH
Inception	1.04	1.0	.98	.94	.90
Elaboration	1.02	1.0	.99	.97	.95
Construction	1.0	1.0	1.0	1.0	1.0

Development Process Reengineering and Streamlining (DPRS)

Detailed rating scale provided

Gains depend on current level of bureaucracy

- **Same effect on effort; staff level held constant**

Schedule and Effort Multipliers	Inception	Elaboration	Construction
VL - Heavily Bureaucratic	1.20	1.15	1.15
L - Bureaucratic	1.08	1.06	1.06
N - Basic good business practices	1.0	1.0	1.0
H - Partly streamlined	.96	.98	.98
VH - Fully streamlined	.90	.95	.95



DPRS Rating Scale

	VL	L	N	H	VH
Number of approvals required per task	Excessive	Occasionally Reduced	Mature	Actively Reduced	Actively Minimized
Time taken per approval	Excessive	Occasionally Reduced	Mature	Actively Reduced	Actively Minimized
Reduced task dependencies, critical path tasks	None	Little	Mature Tech. Adopted	Advanced Tech. Adopted	Pioneering
Followup to expedite task completion	None	Little	Encouraged	Emphasized	Strongly Emphasized
Process measurement & streamlining	None	Little	Mature Tech. Adopted	Advanced Tech. Adopted	Pioneering

Collaboration Efficiency (CLAB)

Detailed rating scale provided

- Judgement-based average of COCOMO II ratings:
SITE, TEAM & PREX
- SITE ratings also include
 - collaboration tool maturity, experience
 - scope effects: domain, negotiation, option-analysis tool support

Same effect on effort; staff level held constant

Schedule & Effort	VL	L	N	H	VH	EH
Multipliers						
Inception	1.21	1.10	1.00	0.93	0.86	0.80
Elaboration	1.15	1.07	1.00	0.95	0.90	0.86
Construction	1.10	1.05	1.00	0.98	0.95	0.93



CLAB Rating Scale

Judgement-based average of COCOMO II SITE, TEAM, PREX factors

	VL	L	N	H	VH	EH
SITE	<== COCOMO II Post-Arch. Ratings ==>				plus negotiation/tradeoff tools	
					basic	advanced
TEAM	<=== <=== <=== COCOMO II Scale Factor Ratings ===> ===> ===>					
PREX	(EL & VL) <=== <=== <=== COCOMO II Early Design Ratings ===> ===> ===>					

Architecture / Risk Resolution (RESL)

Same as COCOMO II RESL rating scale

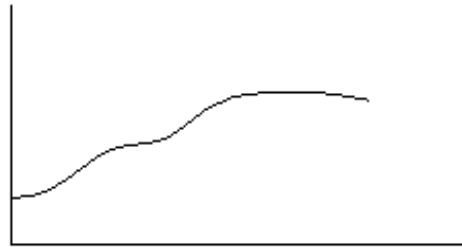
Enables parallel construction

- Assumes higher level of staffing available and used (case b & c on next page)
- Otherwise no schedule compression (case a on next page)

Schedule Multipliers (Effort Unchanged)	VL	L	N	H	VH	EH
Inception	1.0	1.0	1.0	1.0	1.0	1.0
Elaboration	1.0	1.0	1.0	1.0	1.0	1.0
Construction	1.0	1.0	1.0	.91	.83	.75

Architecture / Risk Resolution (RESL) (cont.)

(a)
Good RESL
conventional
staffing



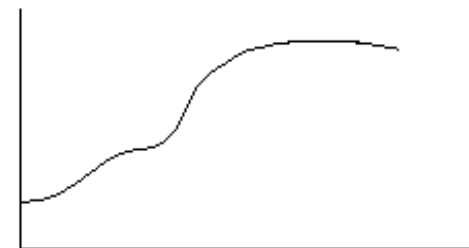
$$M=2.5(PM)^{1/3}$$

(b)
Good RESL
higher staffing



same effort
 $M < 2.5(PM)^{1/3}$

(c)
Poor RESL
higher staffing



more effort
 (via RESL rating)
 $M = 2.5(PM \phi)^{1/3}$
 PM ϕ due to poor RESL

Prepositioning Assets (PPOS)

Degree to which assets are pre-tailored to project and furnished to project for use on demand

- People skills and teambuilding
- Processes and tools
- Architecture and componentry

**Requires product-line approach
or added (3, 6, 10%) pre-LCO (e.g. Inception) effort investment**

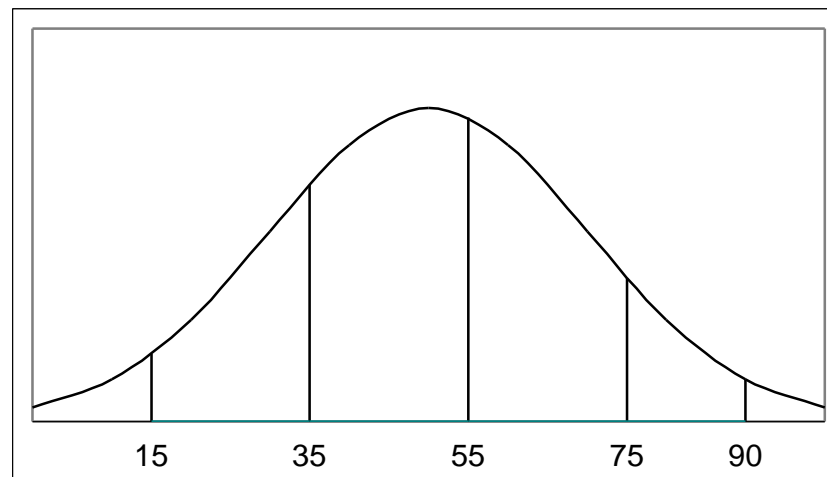
PM/M=P Multipliers	N	H	VH	EH
Rating	Basic project legacy, no tailoring	Some prepositioning & tailoring	Key items prepositioned & tailored	All items prepositioned & tailored
Inception	1.0/1.0=1.0	1.03/.93=1.11	1.06/.86=1.23	1.1/.80=1.37
Elaboration	1.0/1.0=1.0	1.03/.93=1.11	1.06/.86=1.23	1.1/.80=1.37
Construction	1.0/1.0=1.0	1.03/.93=1.11	1.06/.86=1.23	1.1/.80=1.37

People Factors

People Capabilities as Constraint

- Use Early Design Personnel Capability Rating (merge ACAP, PCAP & PCON) as constraint
- RAD driver ratings can't be higher than personnel capability rating

COCOMO people factors cover the primary range of people capabilities (15-90%)



People Factors (cont.)

Range of capabilities much wider outside 15-90% range

Too difficult to calibrate models outside 15-90% range

- Wide range of effects
- Few data points
- Hard to create organization-independent rating scale

For RAD, the situation is the same

- Really big schedule compressions achievable with outstanding people
- However, additional effect needs to be assessed outside the model



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Application Development Example - 1

Use best possible schedule compression ratings.

Multipliers	Inception	Elaboration	Construction
	PM / M = P	PM / M = P	PM / M = P
RVHL	0.90 / 0.90 = 1.00	0.95 / 0.95 = 1.00	1.00 / 1.00 = 1.00
DPRS	0.90 / 0.90 = 1.00	0.95 / 0.95 = 1.00	0.95 / 0.95 = 1.00
CLAB	0.80 / 0.80 = 1.00	0.86 / 0.86 = 1.00	0.93 / 0.93 = 1.00
RESL	1.00 / 1.00 = 1.00	1.00 / 1.00 = 1.00	1.00 / 0.75 = 1.33
PPOS	1.10 / 0.80 = 1.38	1.10 / 0.80 = 1.38	1.10 / 0.80 = 1.38
Π	0.71 / 0.52 = 1.38	0.85 / 0.62 = 1.38	0.97 / 0.53 = 1.83

Application Development Example - 2

32 KSLOC Project (PM / M = P)

	Inception	Elaboration	Construction	Total for E&C
	PM / M = P	PM / M = P	PM / M = P	PM / M = P
Baseline	16.8 / 9.8 = 1.7	33.6 / 4.8 = 7.0	86.4 / 7.2 = 12.0	120.0 / 12.0 = 10.0
P	0.71 / 0.52 = 1.38	0.85 / 0.62 = 1.38	0.97 / 0.53 = 1.83	
RAD	12.0 / 5.1 = 2.4	28.7 / 3.0 = 9.6	84.0 / 3.8 = 22.0	112.7 / 6.8 = 16.6
			Total for I&E&C	124.63 / 6.80 = 18.34

512 KSLOC Project (PM / M = P)

	Inception	Elaboration	Construction	Total for E&C
	PM / M = P	PM / M = P	PM / M = P	PM / M = P
Baseline	361.0 / 13.7 = 26.4	722.0 / 13.7 = 52.7	1868.0 / 20.6 = 90.7	2580.0 / 34.3 = 75.2
P	0.71 / 0.52 = 1.38	0.85 / 0.62 = 1.38	0.97 / 0.53 = 1.83	
RAD	257.3 / 7.1 = 36.2	616.4 / 8.5 = 72.5	1815.4 / 10.9 = 166.2	2689.2 / 26.5 = 101.4
			Total for I&E&C	2932.0 / 28.2 = 104.0



Spreadsheet Implementation

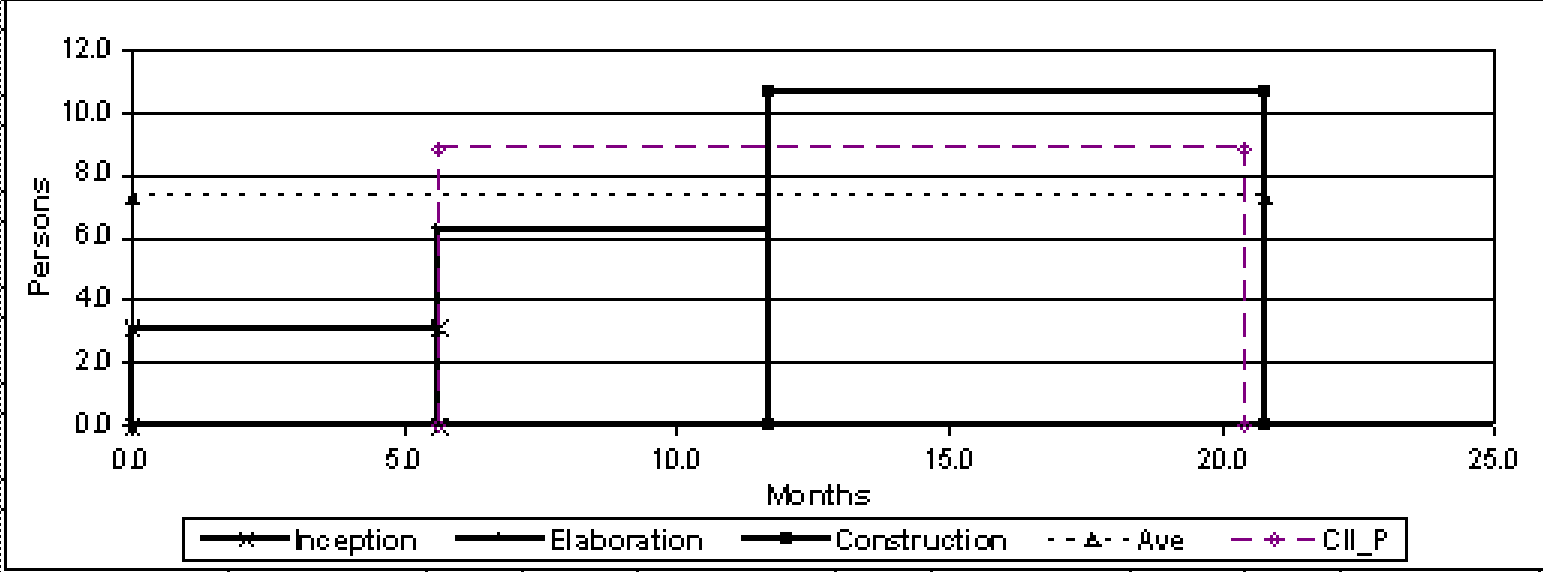
	A	B	C	E	G	H	J	L	M	O	Q	R	T	V	W	Y	AA	
1		CORADMO																
2		Step																
3	1.D	Currently implemented only for projects (not modules)																
4		Get COCOMO-II.98 data																
5	2.D	BOLD: required	IFatic: optional	Project: 32K Norm+SCED=1.07							Total Size=	32000	PM_C=	142.2	M_C=	14.77		
6		(automatically from COCOMO.xls)		SCED R=	L	SCEDinc=	50%	SCEDM=	1.07									
7		Including Scale Factor Ratings			PREC R=	N	FLEX R=	N	RESL R=	N	TEAM R=	N	PMAT R=	N				
13																		
14	3.D	Start with M_BS (i.e. After applying COSSEMO's M-fr(PM) to COCOMO-II.1998 Effort (PM_C) and P_BS calculated from PM_CAM_BS.																
20		M_BS=	16.0	P_BS=	8.8796													
21																		
22	4.D	Get Eff% & Sched % per stage																
23		% Effort	14.0	% Sched	40.0	% Effort	28.0	% Sched	40.0	% Effort	72.0	% Sched	60.0					
24		Inception		Inception		Elaboration		Elaboration		Construction		Construction						
25																		
26	5.D	Distribute PM (PM_C) and M (M_BS) according to the Effort% & Schedule% per stage; and calculate P for the stage from its PM/M.																
36			Inception			Elaboration			Construction			Total ESC			Total			
37		Effort %	14.0	28.0	72.0	100.0	114.0											
38		Schedule %	40.0	40.0	60.0	100.0	140.0											
39		PM/M(P)	0.35	0.70	1.20	1.00	Does not apply											
40		PM/M-P	PM %	M %	P	PM %	M %	P	PM %	M %	P	PM %	M %	P	PM %	M %	P-ave	
41	BS	32000	19.91 %	6.41 %	3.11	39.82 %	6.41 %	6.22	102.09 %	9.81 %	10.88	142.2 %	16.0 %	8.9	162.1 %	22.4 %	7.2	
42																		
43	6.D	Get the Schedule Multipliers values.																
44						RVHL		DPRS		CLAB		RESL		PPOS				
45																		
46			Inception			Elaboration			Construction									
47			PM %	M %	P	PM %	M %	P	PM %	M %	P							
48	N	RVHL	0.980	0.980	1.000	0.99	0.99	1.00	1.00	1.00	1.00							
49	VH	DPRS	0.900	0.900	1.000	0.950	0.950	1.000	0.950	0.950	1.000							
50	N	CLAB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000							
51	N	RESL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000							
52	N	PPOS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000							
53		II	0.882	0.882	1.000	0.941	0.941	1.000	0.950	0.950	1.000							
54																		

Spreadsheet Implementation (cont.)

Constructive RAD schedule estimation Model (CoRADMo) Development

Sheet: ED8PO-Dev

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	ZA
55	7.0	Apply the product of user selected Schedule Multipliers to each PM, M and P in each stage.																								
56																										
57	8.0	Calculate PM and M*Total ESC and Total (H-E-C) by adding the stages PM and M. Calculate P*Total ESC and Total (H-E-C) by dividing total PM by total M.																								
60		Inception			Elaboration			Construction			Total ESC			Total												
61		Effort %	14.0			28.0			72.0			100.0			114.0											
62		Schedule %	40.0			40.0			60.0			100.0			140.0											
63		P/Ave(P)	0.35			0.70			1.20			1.00														
64		PM/M/P	PM	M	P	PM	M	P	PM	M	P	PM	M	P	PM	M	P	PM	M	P-ave						
65	ES	3200000	19.91	6.41	3.11	39.82	6.41	6.22	102.29	9.61	10.68	142.2	16.0	8.9	162.1	22.4	7.2									
66		n	0.88	0.88	1.00	0.94	0.94	1.00	0.95	0.95	1.00															
67	RAD Effort	Send	17.98	5.65	3.11	37.45	6.00	6.22	97.27	9.13	10.68	134.7	15.2	8.9	152.3	20.8	7.3									
70																										
71	9.0	Courtesy plot of P vs M																								
80																										
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