



# **COPLIMO: The Constructive Product Line Investment Model**

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# Outline

- **The Basic COPLIMO Model**
- **The Extended COPLIMO Model**
- **Conclusions**



# The Basic COPLIMO Model

## - Constructive Product Line Investment Model

- **Based on COCOMO II software cost model**
  - Statistically calibrated to 161 projects, representing 18 diverse organizations
- **Based on standard software reuse economic terms**
  - RCR: Relative cost of reuse
  - RCWR: Relative cost of writing for reuse
- **Avoids overestimation**
  - Avoids RCWR for non-reused components
- **Provides experience-based default parameter values**
- **Simple Excel spreadsheet model**
  - Easy to modify, extend, interoperate



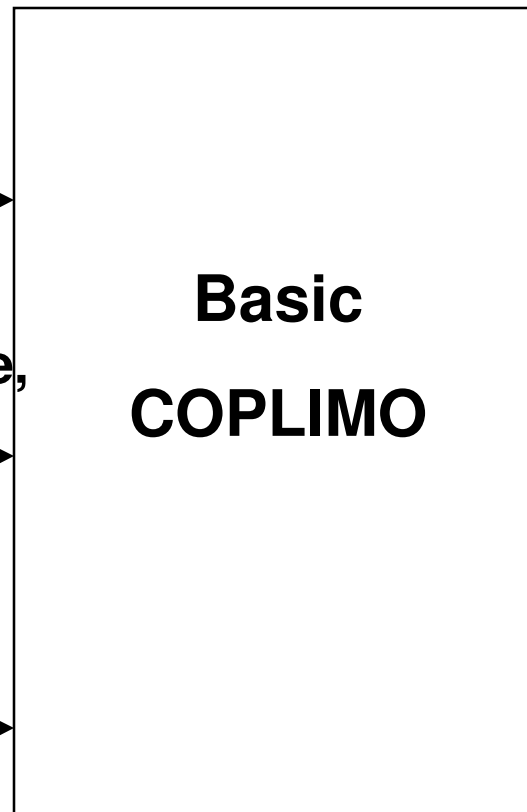
# Basic COPLIMO Inputs and Outputs

For current set of  
similar products,

Average product size,  
productivity

Percent mission-unique,  
reused-with-mods,  
black-box reuse

RCR, RCWR factors



As functions of # products,

Non-product line effort

Product line investment,  
effort

Product line savings, ROI



## Basic COPLIMO

Project Name:

Preparer:

Product Line Domain:

Date:

Comments:

Average SW productivity (AVPROD):  (SLOC/PM)

Average product size (AVSIZE):  (SLOC)

### Expected reuse category percentages (adding to 100 %):

Percent of software unique to each application (UNIQ%):	<input type="text" value="40"/>	(%)
Percent of software adapted from product line (ADAP %):	<input type="text" value="30"/>	(%)
Percent of software reused from product line (RUSE%):	<input type="text" value="30"/>	(%)

### Expected Relative Costs of Reuse (RCR):

For unique s/w (RCR-UNIQ):	<input type="text" value="100"/>	(%)
For adapted s/w (RCR-ADAP):	<input type="text" value="40"/>	(%)
For reuse s/w (RCR-RUSE):	<input type="text" value="5"/>	(%)

### Expected Relative Costs of Writing for Reuse (RCWR):

RCWR:	<input type="text" value="1.7"/>
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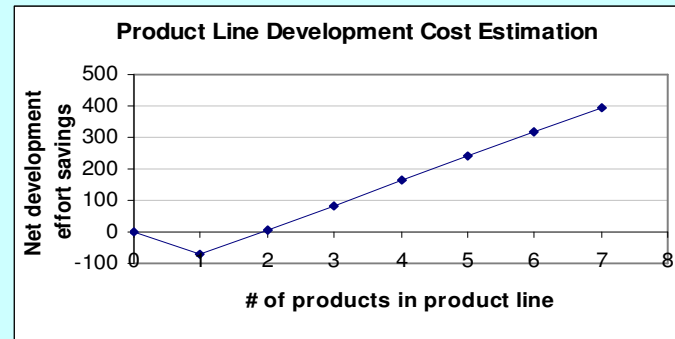
## Basic COPLIMO Output Summary

### Summary of Inputs :

AVPROD	300	
AVSIZE	50000	(SLOC)
UNIQ%	40	(%)
ADAP%	30	(%)
RUSE%	30	(%)
RCR-UNIQ	100	(%)
RCR-ADAP	40	(%)
RCR-RUSE	5	(%)
RCWR	1.7	

(Note: Do not change above values !)  
(Change from "Input" sheet.)

### 7 year Product Line Effort Savings :



### Table of Results :

# of Products	0	1	2	3	4	5	6	7
Unique SLOC	0	20000	40000	60000	80000	100000	120000	140000
Adapted SLOC	0	15000	30000	45000	60000	75000	90000	105000
Reused SLOC	0	15000	30000	45000	60000	75000	90000	105000
Total Non-PL SLOC	0	50000	100000	150000	200000	250000	300000	350000
Non-PL Effort (PM)	0	166.667	333.333	500	666.667	833.333	1000	1166.667
1-Product Equiv. SLOC	0	71000	26750	26750	26750	26750	26750	26750
1-Product Equiv. Effort	0	236.667	89.1667	89.1667	89.1667	89.1667	89.1667	89.1667
Cum. Equiv. PL SLOC	0	71000	97750	124500	151250	178000	204750	231500
Cum. PL Effort	0	236.667	325.833	415	504.167	593.333	682.5	771.6667
PL Effort Savings	0	-70	7.5	85	162.5	240	317.5	395
PL Reuse Investment	0	70						
Return on Investment	N/A	-1	0.10714	1.21429	2.32143	3.42857	4.53571	5.642857



# Extended COPLIMO Model

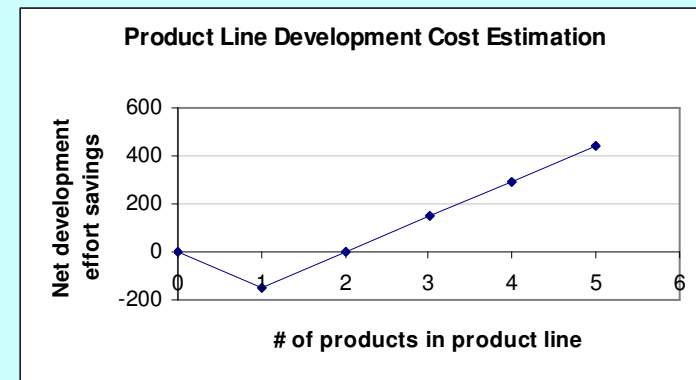
- **Separate factors for calculating RCR**
  - Design, code, test fractions modified
  - Software understanding, assessment factors
- **Separate factors for calculating RCWR**
  - Reusability, reliability, documentation
- **Full set of COCOMO II cost drivers**
- **Maintenance and life cycle cost estimation**
- **Further extensions feasible**
  - Components with different sizes, RCR, RCWR factors
  - Present-value discounting of future savings
  - Monte Carlo probability distributions



## COPLIMO Estimation Summary

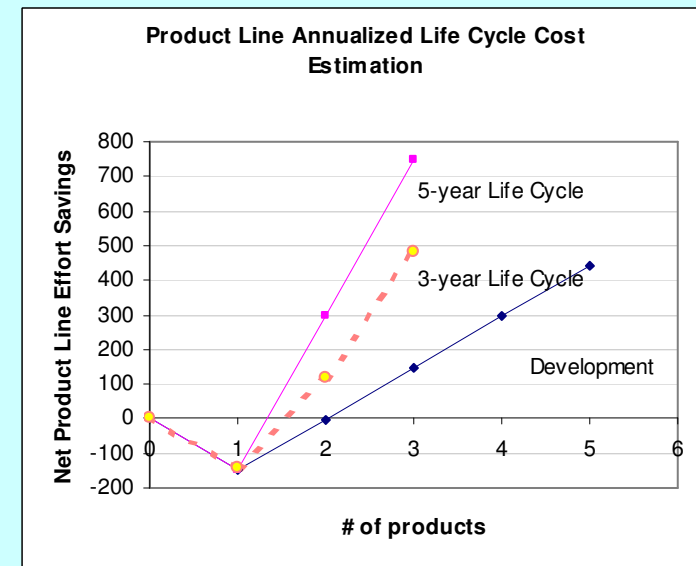
### Part I Product Line Development Cost Estimation Summary:

# of Products Effort (PM)	0	1	2	3	4	5
No Reuse	0	294	588	882	1176	1470
Product Line	0	444	589	735	881	1026
Product Line Savings	0	-150	-1	147	295	444
ROI	0	-1.00	-0.01	0.98	1.97	2.96



### Part II Product Line Annualized Life Cycle Cost Estimation Summary:

# of Products	0	1	2	3	4	5
AMSIZ-P	0	8.1	16.2	24.2	32.3	40.4
AMSIZ-R	0	6.1	6.1	6.1	6.1	6.1
AMSIZ-A	0	6.1	7.7	9.3	11.0	12.6
Total Equiv. KSLOC	0	20.2	29.9	39.6	49.3	59.1
Effort (AM) (*2.94)	0	59.4	88.0	116.5	145.1	173.7
5-year Life Cycle PM	0	296.9	439.8	582.6	725.4	868.3
PM(N, 5)-R (+444)	0	740.9	883.7	1026.5	1169.4	1312.2
PM(N, 5)-NR	0	590.9	1181.9	1772.8	2363.8	2954.7
Product Line Savings (PM)	0	-149.9	298.2	746.3	1194.4	1642.5
ROI	0	-1.00	1.99	4.98	7.97	10.96
Devel. ROI	0	-1.00	-0.01	0.98	1.97	2.96
3-year Life Cycle	0	-142.0	120.0	480.0		



AMSIZ: Annually Maintained Software Size



# Conclusions

- **Software product line payoffs are significant**
  - Especially across life cycle
  - Less code to maintain
- **Magnitude of product line payoffs is situation-dependent**
- **Cost models and business case analysis enable assessment of situation-dependencies**
  - Lead to better product line decisions