

UNIVERSITY OF
CALGARY

SENG 421: Software Metrics
Sample Assignments 4
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Electronic Bookshop

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Executive Summary

After noticing the success of amazon.com, we have decided to open up our own online bookshop. This bookshop will allow customers to purchase books directly from home without having to go out and drive down to the nearest bookshop.

This document consists of a detailed analysis of our plan to develop this online bookshop using three phases. These phases are:

1. Application Composition Model
2. Early Design Model
3. Post-Architecture Model

Prior to implementing the three phases, we documented our project specifications, outlining all of the external inputs, outputs, interface files, and inquiries as well as all internal files required for the bookshop. With these specifications, we could easily predict the three phases with the aid of a COCOMO II tool.

At the Early Design stage, the estimate for source lines of code (SLOC) is 36,096 in C programming language. The most likely estimate for cost is \$983,764.00. The most likely schedule is 19.7 months and the number of required staff is 10.

At the Post-Architecture, the estimate for SLOC is still 36,096. The most likely estimate for cost is \$994,239.00. The most likely schedule is 19.7 months and the number of required staff is 10.1.

By the change of programming language for C to an OO language (C++ or Java) it is possible to reduce the costs by a factor of 3.

Project Specifications

In order to run this bookshop, we have devised a plan that we would now like to evaluate in terms of effort and cost. To accomplish this, we have decided to use the COCOMO II software estimation model. Prior to using COCOMO II, we clearly defined all of the project specifications. These specifications include all of the External inputs, outputs, interface files, inquiries, and internal files. Details about each of the specifications are listed below.

EXTERNAL INPUTS

Database of Books

Credit Card Validation System

Record of Transaction

Searching

- Subject
- Title
- Author
- Publisher
- ISBN

Personal Information

- First Name
- Last Name
- E-mail Address

Billing Information

- Street Address
- City
- Province
- Postal Code
- Country
- Phone Number

Credit Card Information

- Type
- Number
- Expiry Date

Shipping Method

- Type

EXTERNAL OUTPUTS

Book Information

- Title
- Author
- Publisher
- Date
- ISBN
- Availability
- Price

Buying

- Confirmation/Rejection

EXTERNAL INTERFACE FILES

Database of Books

Credit Card Validation System

Record of Transaction

EXTERNAL INQUIRIES

User Inquiry

- Search
- Buy

Database of Books

Credit Card Validation System

Record of Transaction

INTERNAL FILES

Book Order

Application Composition Model

For this first stage of COCOMO II, we must make estimates for our project. The model can produce estimates of effort with the equation:

$$\text{Effort} = \text{Object Points} / \text{Productivity}$$

To determine object points, we need to estimate the number of screens and data inputs in our program. Our estimates are:

<i>Screens</i>	<i>Data Inputs</i>
Title Screen	Enter
Search Screen	Title, Author, Publisher, ISBN
Results Screen	Purchase
Purchase Screen	First Name, Last Name, Address, Phone Number, City, Province, Country, Postal Code, E-mail Address, Credit Card Number, Expiration Date
Confirmation Screen	New Search, Print

We also need to estimate the number of reports that our program will generate and their data entries. Our estimates are:

<i>Reports</i>	<i>Data Entries</i>
Transaction Report	First Name, Last Name, Address, Phone Number, City, Province, Country, Postal Code, E-mail Address, Credit Card Number, Expiration Date, Title, Author, Publisher, ISBN, price
Inventory Update	Title, Author, Publisher, ISBN, price
Credit Card Validation	Credit Card Number, Expiration Date

Based on Boehm's object point complexity levels, we determine that the Title Screen, Search Screen, Results Screen, and Confirmation Screen are simple. The Purchase Screen is medium. The Transaction Report and the Inventory Update are medium, while the Credit Card Validation is an acquired component.

Thus our Object Points are:

$$OP = (4 \times 1) + (1 \times 2) + (2 \times 5) + (1 \times 10) = 36$$

Our team consists of 10 entry-level programmers. They all have 2+ years of experience in C++ and web programming. However, they have no experience working together. Furthermore, they are not familiar with the application domain. Thus, we expect team productivity to be low in the beginning, but improve throughout the project. For our Application Composition Model, we estimate our average productivity rate to be nominal.

The project effort is,

$$\text{Effort} = 36 / 13 = 2.77$$

Early Design

In the early design model stage, not enough information is known to support fine-grain cost estimations. COCOMO II uses function points and a set of seven cost drivers for personnel capability and experience, namely:

- Product Reliability and Complexity
- Required Reuse
- Platform Difficulty
- Personnel Capability
- Personnel Experience
- Facilities
- Schedule

From the project specifications, we have divided this project into four modules: Search, User Input, Validation, and Purchase. Figures 1-4 show the function point breakdown for each module.

SLOC Input Dialog - Search

Sizing Method:
 SLOC
 Function Points
 Adaptation

Breakage:
% of code thrown away due to requirements volatility
BRAK: 0.00

Module Size in Function Points
Language: C

Function Type	# of Function Points			SubTotal
	Low	Average	High	
Inputs	0	5	0	20
Outputs	0	7	0	35
Files	0	0	0	0
Interfaces	0	1	0	7
Queries	0	2	0	8
Total Unadjusted Function Points				70
Equivalent Total in SLOC				8960

OK Cancel Help

Figure 1 – Search Module

SLOC Input Dialog - User_Input

Sizing Method
 SLOC
 Function Points
 Adaptation

Breakage
 % of code thrown away due to requirements volatility
 BRAK

Module Size in Function Points
 Language

Function Type	# of Function Points			SubTotal
	Low	Average	High	
Inputs	<input type="text" value="0"/>	<input type="text" value="19"/>	<input type="text" value="0"/>	76
Outputs	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	0
Files	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	0
Interfaces	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	0
Queries	<input type="text" value="0"/>	<input type="text" value="2"/>	<input type="text" value="0"/>	8
Total Unadjusted Function Points				84
Equivalent Total in SLOC				10752

OK Cancel Help

Figure 2 – User Input Module

SLOC Input Dialog - Validation

Sizing Method
 SLOC
 Function Points
 Adaptation

Breakage
 % of code thrown away due to requirements volatility
 BRAK

Module Size in Function Points
 Language

Function Type	# of Function Points			SubTotal
	Low	Average	High	
Inputs	<input type="text" value="0"/>	<input type="text" value="1"/>	<input type="text" value="0"/>	4
Outputs	<input type="text" value="0"/>	<input type="text" value="1"/>	<input type="text" value="0"/>	5
Files	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	0
Interfaces	<input type="text" value="0"/>	<input type="text" value="1"/>	<input type="text" value="0"/>	7
Queries	<input type="text" value="0"/>	<input type="text" value="1"/>	<input type="text" value="0"/>	4
Total Unadjusted Function Points				20
Equivalent Total in SLOC				2560

OK Cancel Help

Figure 3 – Validation Module

SLOC Input Dialog - Purchase

Sizing Method
 SLOC
 Function Points
 Adaptation

Breakage
 % of code thrown away due to requirements volatility
 BRAK 0.00

Module Size in Function Points
 Language

Function Type	# of Function Points			SubTotal
	Low	Average	High	
Inputs	<input type="text" value="0"/>	<input type="text" value="14"/>	<input type="text" value="0"/>	56
Outputs	<input type="text" value="0"/>	<input type="text" value="1"/>	<input type="text" value="0"/>	5
Files	<input type="text" value="0"/>	<input type="text" value="1"/>	<input type="text" value="0"/>	10
Interfaces	<input type="text" value="0"/>	<input type="text" value="3"/>	<input type="text" value="0"/>	21
Queries	<input type="text" value="0"/>	<input type="text" value="4"/>	<input type="text" value="0"/>	16
Total Unadjusted Function Points				108
Equivalent Total in SLOC				13824

OK Cancel Help

Figure 4 – Purchase Module

For each module, we determined the seven EAF factors after discussing their effects on the project among the group members and set using the COCOMO II (Figure 5). In a real project the EAF factors may be derived by interviewing project managers and/or analyzing the previous software projects.

EAF - Search

base + incr % = rating

	RCPX	RUSE	PDIF	PERS	PREX	FCIL	USR1	USR2
base	NOM	NOM	NOM	NOM	NOM	NOM	NOM	NOM
Incr%	0%	0%	0%	0%	0%	0%	0%	0%

EAF is also affected by Schedule

EAF:

OK Cancel Help

Figure 5 – EAF factors for Early Design Model

EAF - Search

base + incr % = rating

	RCPX	RUSE	PDIF	PERS	PREX	FCIL	USR1	USR2
base	NOM	HI	HI	LO	LO	NOM	NOM	NOM
Incr%	0%	0%	0%	0%	0%	0%	0%	0%

EAF is also affected by Schedule

EAF: 1.95

OK Cancel Help

EAF - User_Input

base + incr % = rating

	RCPX	RUSE	PDIF	PERS	PREX	FCIL	USR1	USR2
base	NOM	NOM	LO	HI	HI	NOM	NOM	NOM
Incr%	0%	0%	0%	0%	0%	0%	0%	0%

EAF is also affected by Schedule

EAF: 0.63

OK Cancel Help

EAF - Purchase

base + incr % = rating

	RCPX	RUSE	PDIF	PERS	PREX	FCIL	USR1	USR2
base	HI	NOM	HI	HI	HI	LO	NOM	NOM
Incr%	0%	0%	0%	0%	0%	0%	0%	0%

EAF is also affected by Schedule

EAF: 1.33

OK Cancel Help

EAF - Validation

base + incr % = rating

	RCPX	RUSE	PDIF	PERS	PREX	FCIL	USR1	USR2
base	HI	NOM	HI	NOM	LO	HI	NOM	NOM
Incr%	0%	0%	0%	0%	0%	0%	0%	0%

EAF is also affected by Schedule

EAF: 1.63

OK Cancel Help

The EAF values for the 4 modules are calculated as:

- Search Module 1.95
- User Input Module 0.63
- Purchase Module 1.33
- Validation Module 1.63

COCOMO II generates the following Early Design report for our project.

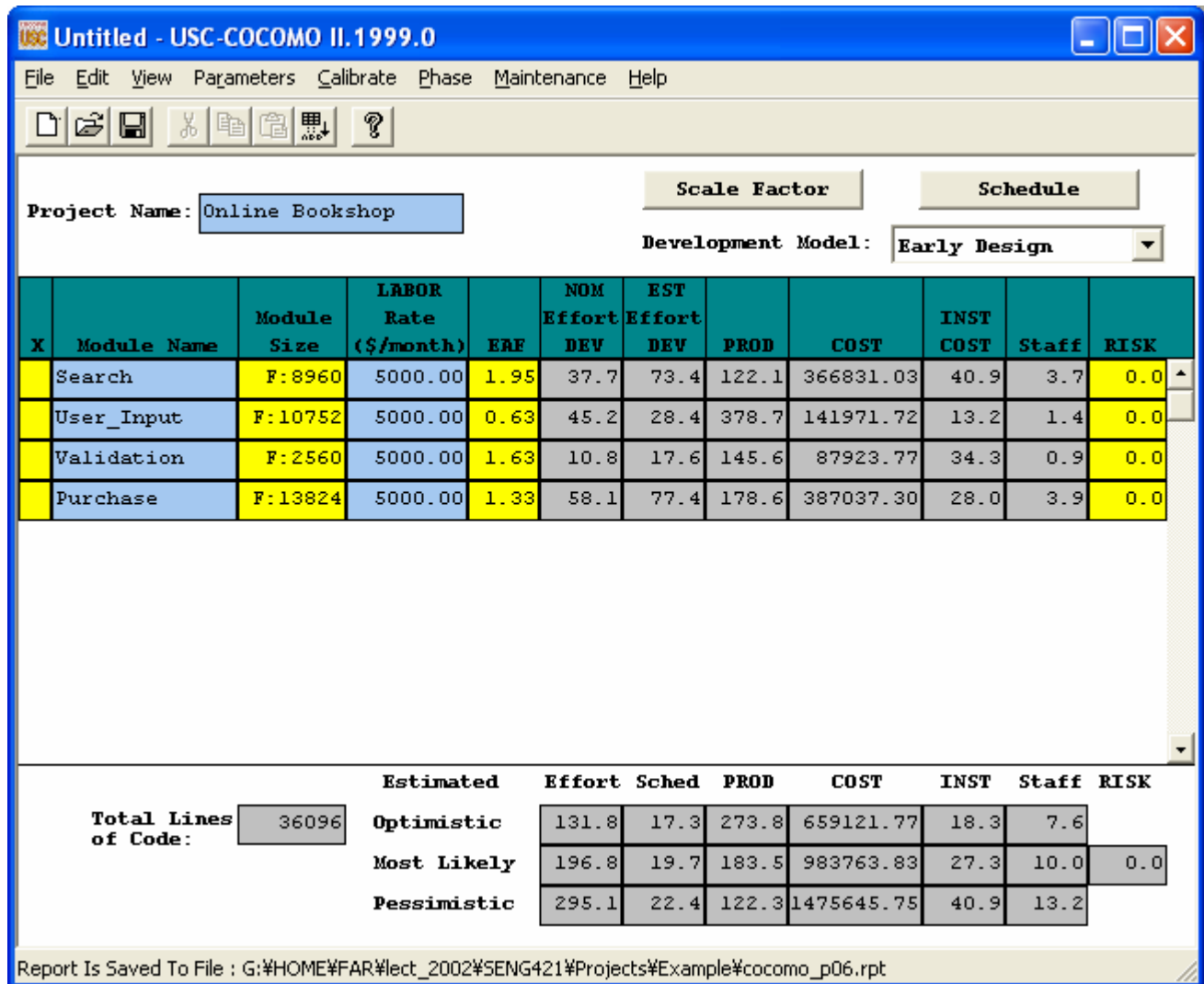


Figure 6 – The Early Design Model results

##USC COCOMO II.1999.0##

DEVELOPMENT MODEL: Early Design Model

Project Name: Online Bookshop

Scale Factors: PREC FLEX RESL TEAM PMAT
 N N N N N
 3.72 3.04 4.24 3.29 4.68

Module Name	Module Size	EAF	NOM Effort DEV	ACT Effort DEV	PROD	RATE & COST	INST COST	Staff	RISK
Search	FP 8960	1.95	37.7	73.4	122.1	5000.0 366831	40.9	3.7	0.0
User_Input	FP 10752	0.63	45.2	28.4	378.7	5000.0 141972	13.2	1.4	0.0
Validation	FP 2560	1.63	10.8	17.6	145.6	5000.0 87924	34.3	0.9	0.0
Purchase	FP 13824	1.33	58.1	77.4	178.6	5000.0 387037	28.0	3.9	0.0
TOTAL SLOC	36096		OPTIMISTIC	131.8	275.2	659122	18.3	7.6	0.0
			MOST LIKELY	196.8	183.5	983764	27.3	10.0	0.0
			PESSIMISTIC	295.1	122.9	1475646	40.9	13.2	0.0
SCHEDULE			OPTIMISTIC	17.3					
			MOST LIKELY	19.7					
			PESSIMISTIC	22.4					

Project Name: Online Bookshop

MODULE NAME SIZING DETAILS

Module	Language	Inputs	Outputs	Files	Interface	Queries
Search BRAK FP 0	C	0 5 0	0 7 0	0 0 0	0 1 0	0 2 0
User_Input BRAK FP 0	C	0 19 0	0 0 0	0 0 0	0 0 0	0 2 0
Validation BRAK FP 0	C	0 1 0	0 1 0	0 0 0	0 1 0	0 1 0
Purchase BRAK FP 0	C	0 14 0	0 1 0	0 1 0	0 3 0	0 4 0

Project Name: Online Bookshop

PROJECT PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

PROJECT		Online Bookshop			
SLOC		36096			
TOTAL EFFORT		196.753 Person Months			
	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	13.773	20.085	3.953	3.485
Product Design	17.000	33.448	26.043	5.125	6.527
Programming	57.872	113.865	47.829	9.412	12.098
- Detailed Design	24.957	49.104	----	----	----
- Code and Unit Test	32.915	64.761	----	----	----
Integration and Test	25.128	49.440	26.128	5.142	9.616
Life Cycle Phase		Plans And Requirements			
Life Cycle Effort		13.773 Person Months			
Life Cycle Schedule		3.953 Months			
	PCNT	EFFORT (PM)	SCHEDULE	Staff	
Requirements Analysis	45.957	6.330	3.953	1.601	
Product Design	17.021	2.344	3.953	0.593	
Programming	4.543	0.626	3.953	0.158	
Test Planning	3.521	0.485	3.953	0.123	
Verification and Validation	7.021	0.967	3.953	0.245	
Project Office	13.457	1.853	3.953	0.469	
CM/QA	3.000	0.413	3.953	0.105	
Manuals	5.479	0.755	3.953	0.191	

Project Name: Online Bookshop

PROJECT PHASE & ACTIVITY INFORMATION

Life Cycle Phase		Product Design
Life Cycle Effort		33.448 Person Months
Life Cycle Schedule		5.125 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	4.181	5.125	0.816
Product Design	41.000	13.714	5.125	2.676
Programming	13.021	4.355	5.125	0.850
Test Planning	5.521	1.847	5.125	0.360
Verification and Validation	7.021	2.348	5.125	0.458
Project Office	10.957	3.665	5.125	0.715
CM/QA	2.500	0.836	5.125	0.163
Manuals	7.479	2.501	5.125	0.488

Life Cycle Phase		Programming
Life Cycle Effort		113.865 Person Months
Life Cycle Schedule		9.412 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	4.555	9.412	0.484
Product Design	8.000	9.109	9.412	0.968
Programming	56.500	64.334	9.412	6.835
Test Planning	5.021	5.718	9.412	0.607
Verification and Validation	8.021	9.133	9.412	0.970
Project Office	6.479	7.377	9.412	0.784
CM/QA	6.500	7.401	9.412	0.786
Manuals	5.479	6.238	9.412	0.663

Life Cycle Phase		Integration and Test
Life Cycle Effort		49.440 Person Months
Life Cycle Schedule		5.142 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	1.236	5.142	0.240
Product Design	5.000	2.472	5.142	0.481
Programming	37.085	18.335	5.142	3.566
Test Planning	3.000	1.483	5.142	0.288
Verification and Validation	29.457	14.564	5.142	2.833
Project Office	7.479	3.697	5.142	0.719
CM/QA	8.000	3.955	5.142	0.769
Manuals	7.479	3.697	5.142	0.719

Project Name: Online Bookshop

PROJECT MAINTENANCE INFORMATION

```
=====
PROJECT                                Online Bookshop
Development SLOC                        36096
Development Nominal Person-Month       151.73
Development Adjusted Person-Month      196.75
Development Cost                         983763.83
Maintenance Labor Rate                  0.00
Percentage Added                         0.00%
Percentage Modified                      0.00%
Maintenance Software Understanding      30.00
Unfamiliarity with the Software         0.40

Annual Change Traffic                    0.00%

Effort Ajustment Factor                  1.00
```

```

RCPX    RUSE    PDIF    PERS    PREX    FCIL
Nominal Nominal Nominal Nominal Nominal Nominal
   0%     0%     0%     0%     0%     0%
USR1    USR2
Nominal Nominal
   0%     0%
```

```

                WORK LOAD PROJECTION FOR THE NEXT 1 YEARS
Year      KSLOC      Effort_Nom  Effort_Maint  Staff  KSLOC/Staff  Cost
  1        36.10         0.00         0.00      0.00      0.00         0.00
```

```

                SUMMARY OF PROJECTION
Cumulative Maintenance Person-month      0.00
Overall Development and Maintenance Person-month 196.75
Cumulative Maintenance Cost              0.00
Overall Development and Maintenance Cost  983763.83
```

Project Name: Online Bookshop

Early Design Cost Drivers

MODULE NAME	RCPX	RUSE	PDIF	PERS	PREX	FCIL	SCED	USR1	USR2
	N	H	H	L	L	N	N	N	N
Search	0%	0%	0%	0%	0%	0%	0%	0%	0%
	1.00	1.07	1.29	1.26	1.12	1.00	1.00	1.00	1.00

MODULE PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

MODULE	Search
SLOC	8960
TOTAL EFFORT	73.366 Person Months

	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	5.136	20.085	3.953	1.299
Product Design	17.000	12.472	26.043	5.125	2.434
Programming	57.872	42.458	47.829	9.412	4.511
- Detailed Design	24.957	18.310	----	----	----
- Code and Unit Test	32.915	24.148	----	----	----
Integration and Test	25.128	18.435	26.128	5.142	3.586

Life Cycle Phase	Plans And Requirements
Life Cycle Effort	5.136 Person Months
Life Cycle Schedule	3.953 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	45.957	2.360	3.953	0.597
Product Design	17.021	0.874	3.953	0.221
Programming	4.543	0.233	3.953	0.059
Test Planning	3.521	0.181	3.953	0.046
Verification and Validation	7.021	0.361	3.953	0.091
Project Office	13.457	0.691	3.953	0.175
CM/QA	3.000	0.154	3.953	0.039
Manuals	5.479	0.281	3.953	0.071

Project Name: Online Bookshop

MODULE PHASE & ACTIVITY INFORMATION

Life Cycle Phase	Product Design
Life Cycle Effort	12.472 Person Months
Life Cycle Schedule	5.125 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	1.559	5.125	0.304
Product Design	41.000	5.114	5.125	0.998
Programming	13.021	1.624	5.125	0.317
Test Planning	5.521	0.689	5.125	0.134
Verification and Validation	7.021	0.876	5.125	0.171
Project Office	10.957	1.367	5.125	0.267
CM/QA	2.500	0.312	5.125	0.061
Manuals	7.479	0.933	5.125	0.182

Life Cycle Phase	Programming
Life Cycle Effort	42.458 Person Months
Life Cycle Schedule	9.412 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	1.698	9.412	0.180
Product Design	8.000	3.397	9.412	0.361
Programming	56.500	23.989	9.412	2.549
Test Planning	5.021	2.132	9.412	0.227
Verification and Validation	8.021	3.406	9.412	0.362
Project Office	6.479	2.751	9.412	0.292
CM/QA	6.500	2.760	9.412	0.293
Manuals	5.479	2.326	9.412	0.247

Life Cycle Phase	Integration and Test
Life Cycle Effort	18.435 Person Months
Life Cycle Schedule	5.142 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	0.461	5.142	0.090
Product Design	5.000	0.922	5.142	0.179
Programming	37.085	6.837	5.142	1.330
Test Planning	3.000	0.553	5.142	0.108
Verification and Validation	29.457	5.431	5.142	1.056
Project Office	7.479	1.379	5.142	0.268
CM/QA	8.000	1.475	5.142	0.287
Manuals	7.479	1.379	5.142	0.268

Project Name: Online Bookshop

MODULE MAINTENANCE INFORMATION

=====

MODULE	Search
Development SLOC	8960
Development Nominal Person-Month	37.66
Development Adjusted Person-Month	73.37
Development Cost	366831.03
Maintenance Labor Rate	0.00
Percentage Added	0.00%
Percentage Modified	0.00%
Maintenance Software Understanding	30.00
Unfamiliarity with the Software	0.40
Annual Change Traffic	0.00%
Effort Adjustment Factor	1.00

RCPX	RUSE	PDIF	PERS	PREX	FCIL
Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
0%	0%	0%	0%	0%	0%
USR1	USR2				
Nominal	Nominal				
0%	0%				

WORK LOAD PROJECTION FOR THE NEXT 1 YEARS						
Year	KSLOC	Effort_Nom	Effort_Maint	Staff	KSLOC/Staff	Cost
1	8.96	0.00	0.00	0.00	0.00	0.00

SUMMARY OF PROJECTION	
Cumulative Maintenance Person-month	0.00
Overall Development and Maintenance Person-month	73.37
Cumulative Maintenance Cost	0.00
Overall Development and Maintenance Cost	366831.03

Project Name: Online Bookshop

Early Design Cost Drivers

MODULE NAME	RCPX	RUSE	PDIF	PERS	PREX	FCIL	SCED	USR1	USR2
	N	N	L	H	H	N	N	N	N
User_Input	0%	0%	0%	0%	0%	0%	0%	0%	0%
	1.00	1.00	0.87	0.83	0.87	1.00	1.00	1.00	1.00

MODULE PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

MODULE	User_Input				
SLOC	10752				
TOTAL EFFORT	28.394 Person Months				

	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	1.988	20.085	3.953	0.503
Product Design	17.000	4.827	26.043	5.125	0.942
Programming	57.872	16.432	47.829	9.412	1.746
- Detailed Design	24.957	7.086	----	----	----
- Code and Unit Test	32.915	9.346	----	----	----
Integration and Test	25.128	7.135	26.128	5.142	1.388

Life Cycle Phase	Plans And Requirements	
Life Cycle Effort	1.988	Person Months
Life Cycle Schedule	3.953	Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	45.957	0.913	3.953	0.231
Product Design	17.021	0.338	3.953	0.086
Programming	4.543	0.090	3.953	0.023
Test Planning	3.521	0.070	3.953	0.018
Verification and Validation	7.021	0.140	3.953	0.035
Project Office	13.457	0.267	3.953	0.068
CM/QA	3.000	0.060	3.953	0.015
Manuals	5.479	0.109	3.953	0.028

Project Name: Online Bookshop

MODULE PHASE & ACTIVITY INFORMATION

Life Cycle Phase	Product Design
Life Cycle Effort	4.827 Person Months
Life Cycle Schedule	5.125 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	0.603	5.125	0.118
Product Design	41.000	1.979	5.125	0.386
Programming	13.021	0.629	5.125	0.123
Test Planning	5.521	0.267	5.125	0.052
Verification and Validation	7.021	0.339	5.125	0.066
Project Office	10.957	0.529	5.125	0.103
CM/QA	2.500	0.121	5.125	0.024
Manuals	7.479	0.361	5.125	0.070

Life Cycle Phase	Programming
Life Cycle Effort	16.432 Person Months
Life Cycle Schedule	9.412 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	0.657	9.412	0.070
Product Design	8.000	1.315	9.412	0.140
Programming	56.500	9.284	9.412	0.986
Test Planning	5.021	0.825	9.412	0.088
Verification and Validation	8.021	1.318	9.412	0.140
Project Office	6.479	1.065	9.412	0.113
CM/QA	6.500	1.068	9.412	0.113
Manuals	5.479	0.900	9.412	0.096

Life Cycle Phase	Integration and Test
Life Cycle Effort	7.135 Person Months
Life Cycle Schedule	5.142 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	0.178	5.142	0.035
Product Design	5.000	0.357	5.142	0.069
Programming	37.085	2.646	5.142	0.515
Test Planning	3.000	0.214	5.142	0.042
Verification and Validation	29.457	2.102	5.142	0.409
Project Office	7.479	0.534	5.142	0.104
CM/QA	8.000	0.571	5.142	0.111
Manuals	7.479	0.534	5.142	0.104

Project Name: Online Bookshop

MODULE MAINTENANCE INFORMATION

=====

MODULE	User_Input
Development SLOC	10752
Development Nominal Person-Month	45.20
Development Adjusted Person-Month	28.39
Development Cost	141971.72
Maintenance Labor Rate	0.00
Percentage Added	0.00%
Percentage Modified	0.00%
Maintenance Software Understanding	30.00
Unfamiliarity with the Software	0.40
Annual Change Traffic	0.00%
Effort Adjustment Factor	1.00

RCPX	RUSE	PDIF	PERS	PREX	FCIL
Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
0%	0%	0%	0%	0%	0%
USR1	USR2				
Nominal	Nominal				
0%	0%				

WORK LOAD PROJECTION FOR THE NEXT 1 YEARS						
Year	KSLOC	Effort_Nom	Effort_Maint	Staff	KSLOC/Staff	Cost
1	10.75	0.00	0.00	0.00	0.00	0.00

SUMMARY OF PROJECTION	
Cumulative Maintenance Person-month	0.00
Overall Development and Maintenance Person-month	28.39
Cumulative Maintenance Cost	0.00
Overall Development and Maintenance Cost	141971.72

Project Name: Online Bookshop

Early Design Cost Drivers

MODULE NAME	RCPX	RUSE	PDIF	PERS	PREX	FCIL	SCED	USR1	USR2
	H	N	H	N	L	H	N	N	N
Validation	0%	0%	0%	0%	0%	0%	0%	0%	0%
	1.30	1.00	1.29	1.00	1.12	0.87	1.00	1.00	1.00

MODULE PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

MODULE	Validation				
SLOC	2560				
TOTAL EFFORT	17.585 Person Months				
	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	1.231	20.085	3.953	0.311
Product Design	17.000	2.989	26.043	5.125	0.583
Programming	57.872	10.177	47.829	9.412	1.081
- Detailed Design	24.957	4.389	----	----	----
- Code and Unit Test	32.915	5.788	----	----	----
Integration and Test	25.128	4.419	26.128	5.142	0.859
Life Cycle Phase	Plans And Requirements				
Life Cycle Effort	1.231 Person Months				
Life Cycle Schedule	3.953 Months				
	PCNT	EFFORT (PM)	SCHEDULE	Staff	
Requirements Analysis	45.957	0.566	3.953	0.143	
Product Design	17.021	0.210	3.953	0.053	
Programming	4.543	0.056	3.953	0.014	
Test Planning	3.521	0.043	3.953	0.011	
Verification and Validation	7.021	0.086	3.953	0.022	
Project Office	13.457	0.166	3.953	0.042	
CM/QA	3.000	0.037	3.953	0.009	
Manuals	5.479	0.067	3.953	0.017	

Project Name: Online Bookshop

MODULE PHASE & ACTIVITY INFORMATION

=====				
Life Cycle Phase				
Product Design				
Life Cycle Effort			2.989	Person Months
Life Cycle Schedule			5.125	Months
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	0.374	5.125	0.073
Product Design	41.000	1.226	5.125	0.239
Programming	13.021	0.389	5.125	0.076
Test Planning	5.521	0.165	5.125	0.032
Verification and Validation	7.021	0.210	5.125	0.041
Project Office	10.957	0.328	5.125	0.064
CM/QA	2.500	0.075	5.125	0.015
Manuals	7.479	0.224	5.125	0.044
=====				
Life Cycle Phase				
Programming				
Life Cycle Effort			10.177	Person Months
Life Cycle Schedule			9.412	Months
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	0.407	9.412	0.043
Product Design	8.000	0.814	9.412	0.086
Programming	56.500	5.750	9.412	0.611
Test Planning	5.021	0.511	9.412	0.054
Verification and Validation	8.021	0.816	9.412	0.087
Project Office	6.479	0.659	9.412	0.070
CM/QA	6.500	0.661	9.412	0.070
Manuals	5.479	0.558	9.412	0.059
=====				
Life Cycle Phase				
Integration and Test				
Life Cycle Effort			4.419	Person Months
Life Cycle Schedule			5.142	Months
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	0.110	5.142	0.021
Product Design	5.000	0.221	5.142	0.043
Programming	37.085	1.639	5.142	0.319
Test Planning	3.000	0.133	5.142	0.026
Verification and Validation	29.457	1.302	5.142	0.253
Project Office	7.479	0.330	5.142	0.064
CM/QA	8.000	0.353	5.142	0.069
Manuals	7.479	0.330	5.142	0.064

Project Name: Online Bookshop

MODULE MAINTENANCE INFORMATION

=====

MODULE	Validation
Development SLOC	2560
Development Nominal Person-Month	10.76
Development Adjusted Person-Month	17.58
Development Cost	87923.77
Maintenance Labor Rate	0.00
Percentage Added	0.00%
Percentage Modified	0.00%
Maintenance Software Understanding	30.00
Unfamiliarity with the Software	0.40
Annual Change Traffic	0.00%
Effort Adjustment Factor	1.00

RCPX	RUSE	PDIF	PERS	PREX	FCIL
Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
0%	0%	0%	0%	0%	0%
USR1	USR2				
Nominal	Nominal				
0%	0%				

WORK LOAD PROJECTION FOR THE NEXT 1 YEARS						
Year	KSLOC	Effort_Nom	Effort_Maint	Staff	KSLOC/Staff	Cost
1	2.56	0.00	0.00	0.00	0.00	0.00

SUMMARY OF PROJECTION	
Cumulative Maintenance Person-month	0.00
Overall Development and Maintenance Person-month	17.58
Cumulative Maintenance Cost	0.00
Overall Development and Maintenance Cost	87923.77

Project Name: Online Bookshop

Early Design Cost Drivers

MODULE NAME	RCPX	RUSE	PDIF	PERS	PREX	FCIL	SCED	USR1	USR2
	H	N	H	H	H	L	N	N	N
Purchase	0%	0%	0%	0%	0%	0%	0%	0%	0%
	1.30	1.00	1.29	0.83	0.87	1.10	1.00	1.00	1.00

MODULE PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

MODULE	Purchase
SLOC	13824
TOTAL EFFORT	77.407 Person Months

	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	5.419	20.085	3.953	1.371
Product Design	17.000	13.159	26.043	5.125	2.568
Programming	57.872	44.797	47.829	9.412	4.760
- Detailed Design	24.957	19.319	----	----	----
- Code and Unit Test	32.915	25.478	----	----	----
Integration and Test	25.128	19.451	26.128	5.142	3.783

Life Cycle Phase	Plans And Requirements
Life Cycle Effort	5.419 Person Months
Life Cycle Schedule	3.953 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	45.957	2.490	3.953	0.630
Product Design	17.021	0.922	3.953	0.233
Programming	4.543	0.246	3.953	0.062
Test Planning	3.521	0.191	3.953	0.048
Verification and Validation	7.021	0.380	3.953	0.096
Project Office	13.457	0.729	3.953	0.184
CM/QA	3.000	0.163	3.953	0.041
Manuals	5.479	0.297	3.953	0.075

Project Name: Online Bookshop

MODULE PHASE & ACTIVITY INFORMATION

=====				
Life Cycle Phase				
Product Design				
Life Cycle Effort 13.159 Person Months				
Life Cycle Schedule 5.125 Months				
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	1.645	5.125	0.321
Product Design	41.000	5.395	5.125	1.053
Programming	13.021	1.714	5.125	0.334
Test Planning	5.521	0.727	5.125	0.142
Verification and Validation	7.021	0.924	5.125	0.180
Project Office	10.957	1.442	5.125	0.281
CM/QA	2.500	0.329	5.125	0.064
Manuals	7.479	0.984	5.125	0.192
=====				
Life Cycle Phase				
Programming				
Life Cycle Effort 44.797 Person Months				
Life Cycle Schedule 9.412 Months				
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	1.792	9.412	0.190
Product Design	8.000	3.584	9.412	0.381
Programming	56.500	25.310	9.412	2.689
Test Planning	5.021	2.249	9.412	0.239
Verification and Validation	8.021	3.593	9.412	0.382
Project Office	6.479	2.902	9.412	0.308
CM/QA	6.500	2.912	9.412	0.309
Manuals	5.479	2.454	9.412	0.261
=====				
Life Cycle Phase				
Integration and Test				
Life Cycle Effort 19.451 Person Months				
Life Cycle Schedule 5.142 Months				
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	0.486	5.142	0.095
Product Design	5.000	0.973	5.142	0.189
Programming	37.085	7.213	5.142	1.403
Test Planning	3.000	0.584	5.142	0.113
Verification and Validation	29.457	5.730	5.142	1.114
Project Office	7.479	1.455	5.142	0.283
CM/QA	8.000	1.556	5.142	0.303
Manuals	7.479	1.455	5.142	0.283

Project Name: Online Bookshop

MODULE MAINTENANCE INFORMATION

=====

MODULE	Purchase
Development SLOC	13824
Development Nominal Person-Month	58.11
Development Adjusted Person-Month	77.41
Development Cost	387037.30
Maintenance Labor Rate	0.00
Percentage Added	0.00%
Percentage Modified	0.00%
Maintenance Software Understanding	30.00
Unfamiliarity with the Software	0.40
Annual Change Traffic	0.00%
Effort Adjustment Factor	1.00

RCPX	RUSE	PDIF	PERS	PREX	FCIL
Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
0%	0%	0%	0%	0%	0%
USR1	USR2				
Nominal	Nominal				
0%	0%				

WORK LOAD PROJECTION FOR THE NEXT 1 YEARS						
Year	KSLOC	Effort_Nom	Effort_Maint	Staff	KSLOC/Staff	Cost
1	13.82	0.00	0.00	0.00	0.00	0.00

SUMMARY OF PROJECTION	
Cumulative Maintenance Person-month	0.00
Overall Development and Maintenance Person-month	77.41
Cumulative Maintenance Cost	0.00
Overall Development and Maintenance Cost	387037.30

Discussion

We studied the effect of changing the programming language from C to OO language (C++ or Java). Although COCOMO II does not distinguish between various OO languages but a simple comparison, having all the other EAF factors unchanged, shows that the change to OO languages may reduce the development cost and size and required staff (Figure 7)

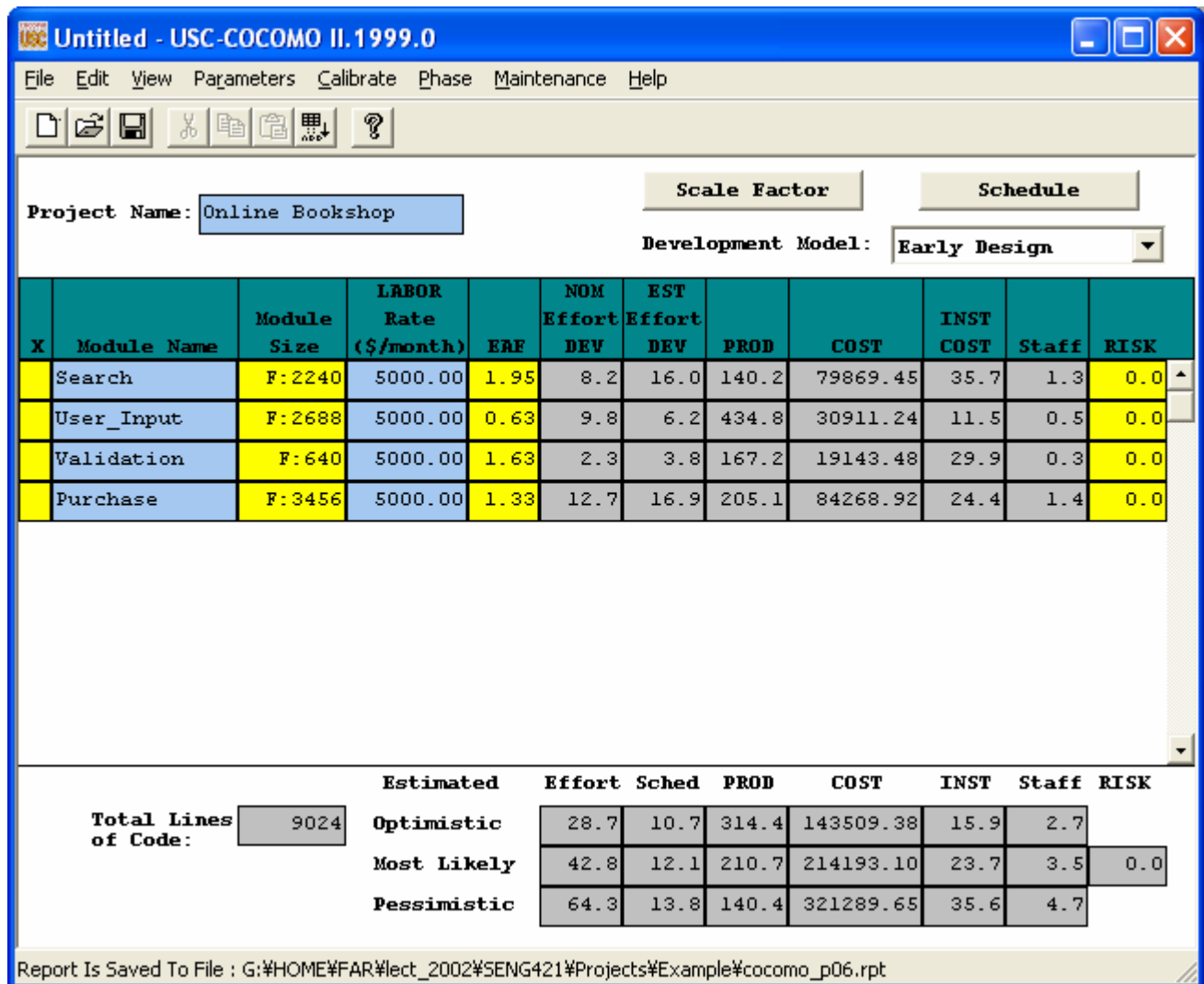


Figure 7 – Effects of changing of programming language

Post-Architecture Model

However, in the post-architecture model, COCOMO II uses source instructions and/or function points for sizing and 17 cost drivers covering various aspects of personnel capability, continuity, and experience. The cost drivers are listed below:

1. Required Software Reliability (RELY)
2. Database size (DATA)
3. Product complexity (CPLX)
4. Documentation match to life-cycle needs (DOCU).
5. Required Reuse (RUSE)
6. Execution time (TIME)
7. Main storage constraint (STOR)
8. Platform volatility (PVOL)
9. Analyst Capability (ACAP)
10. Programmer Capability (PCAP)
11. Personnel Continuity (PCON)
12. Applications Experience (AEXP)
13. Platform Experience (PEXP)
14. Language and Tool Experience (LTEX)
15. Use of Software Tools (TOOL)
16. Multi-Site Development (SITE)
17. Required Development Schedule (SCED)

The post-architecture model involves the actual development and maintenance of a software product.

For each module, we determined the seven EAF factors after discussing their effects on the project among the group members and set using the COCOMO II (Figure6). In a real project the EAF factors may be derived by interviewing project managers and/or analyzing the previous software projects.

The screenshot shows a dialog box titled "EAF - Search" with a close button in the top right corner. The dialog contains a grid of input fields for various cost drivers, categorized by Product, Platform, Personnel, Project, and User. Each category has "base" and "Incr%" fields. The "EAF" field at the bottom is set to 1.00. Buttons for "OK", "Cancel", and "Help" are at the bottom.

		base + Incr % = rating					
Product:		RELY	DATA	DOCU	CPLX	RUSE	
base		NOM	NOM	NOM	NOM	NOM	
Incr%		0%	0%	0%	0%	0%	
Platform:		TIME	STOR	PVOL			
base		NOM	NOM	NOM			
Incr%		0%	0%	0%			
Personnel:		ACAP	AEXP	PCAP	PEXP	LTEX	PCON
base		NOM	NOM	NOM	NOM	NOM	NOM
Incr%		0%	0%	0%	0%	0%	0%
Project:		TOOL	SITE				
base		NOM	NOM				
Incr%		0%	0%				
User:		USR1	USR2				
base		NOM	NOM				
Incr%		0%	0%				
		EAF is also affected by Schedule					
		EAF:	1.00				
		OK	Cancel	Help			

Figure 6 – EAF factors for Post Architecture Model

EAF - Search

base + Incr % = rating

Product:	RELY	DATA	DOCU	CPLX	RUSE
base	NOM	NOM	HI	HI	NOM
Incr%	0%	0%	0%	0%	0%

Platform:	TIME	STOR	PVOL
base	HI	NOM	NOM
Incr%	0%	0%	0%

Personnel:	ACAP	AEXP	PCAP	PEXP	LTEX	PCON
base	NOM	NOM	HI	NOM	LO	NOM
Incr%	0%	0%	0%	0%	0%	0%

Project:	TOOL	SITE
base	LO	HI
Incr%	0%	0%

User:	USR1	USR2
base	NOM	NOM
Incr%	0%	0%

EAF is also affected by Schedule

EAF: 1.40

OK Cancel Help

EAF - User_Input

base + Incr % = rating

Product:	RELY	DATA	DOCU	CPLX	RUSE
base	NOM	NOM	HI	HI	NOM
Incr%	0%	0%	0%	0%	0%

Platform:	TIME	STOR	PVOL
base	HI	NOM	NOM
Incr%	0%	0%	0%

Personnel:	ACAP	AEXP	PCAP	PEXP	LTEX	PCON
base	NOM	HI	NOM	HI	NOM	NOM
Incr%	0%	0%	0%	0%	0%	0%

Project:	TOOL	SITE
base	NOM	NOM
Incr%	0%	0%

User:	USR1	USR2
base	NOM	NOM
Incr%	0%	0%

EAF is also affected by Schedule

EAF: 1.15

OK Cancel Help

EAF - Validation ✖

base + Incr % = rating

Product:	RELY	DATA	DOCU	CPLX	RUSE
base	HI	HI	HI	HI	NOM
Incr%	0%	0%	0%	0%	0%

Platform:	TIME	STOR	PVOL
base	HI	NOM	NOM
Incr%	0%	0%	0%

Personnel:	ACAP	AEXP	PCAP	PEXP	LTEX	PCON
base	NOM	HI	NOM	NOM	NOM	NOM
Incr%	0%	0%	0%	0%	0%	0%

Project:	TOOL	SITE
base	HI	HI
Incr%	0%	0%

User:	USR1	USR2
base	NOM	NOM
Incr%	0%	0%

EAF is also affected by Schedule

EAF:

EAF - Purchase ✖

base + Incr % = rating

Product:	RELY	DATA	DOCU	CPLX	RUSE
base	HI	NOM	HI	HI	NOM
Incr%	0%	0%	0%	0%	0%

Platform:	TIME	STOR	PVOL
base	HI	NOM	NOM
Incr%	0%	0%	0%

Personnel:	ACAP	AEXP	PCAP	PEXP	LTEX	PCON
base	NOM	NOM	HI	NOM	LO	NOM
Incr%	0%	0%	0%	0%	0%	0%

Project:	TOOL	SITE
base	HI	NOM
Incr%	0%	0%

User:	USR1	USR2
base	NOM	NOM
Incr%	0%	0%

EAF is also affected by Schedule

EAF:

The EAF values for the 4 modules are calculated as:

- Search Module 1.40
- User Input Module 1.15
- Purchase Module 1.37
- Validation Module 1.33

COCOMO II generates the following Post Architecture report for our project.

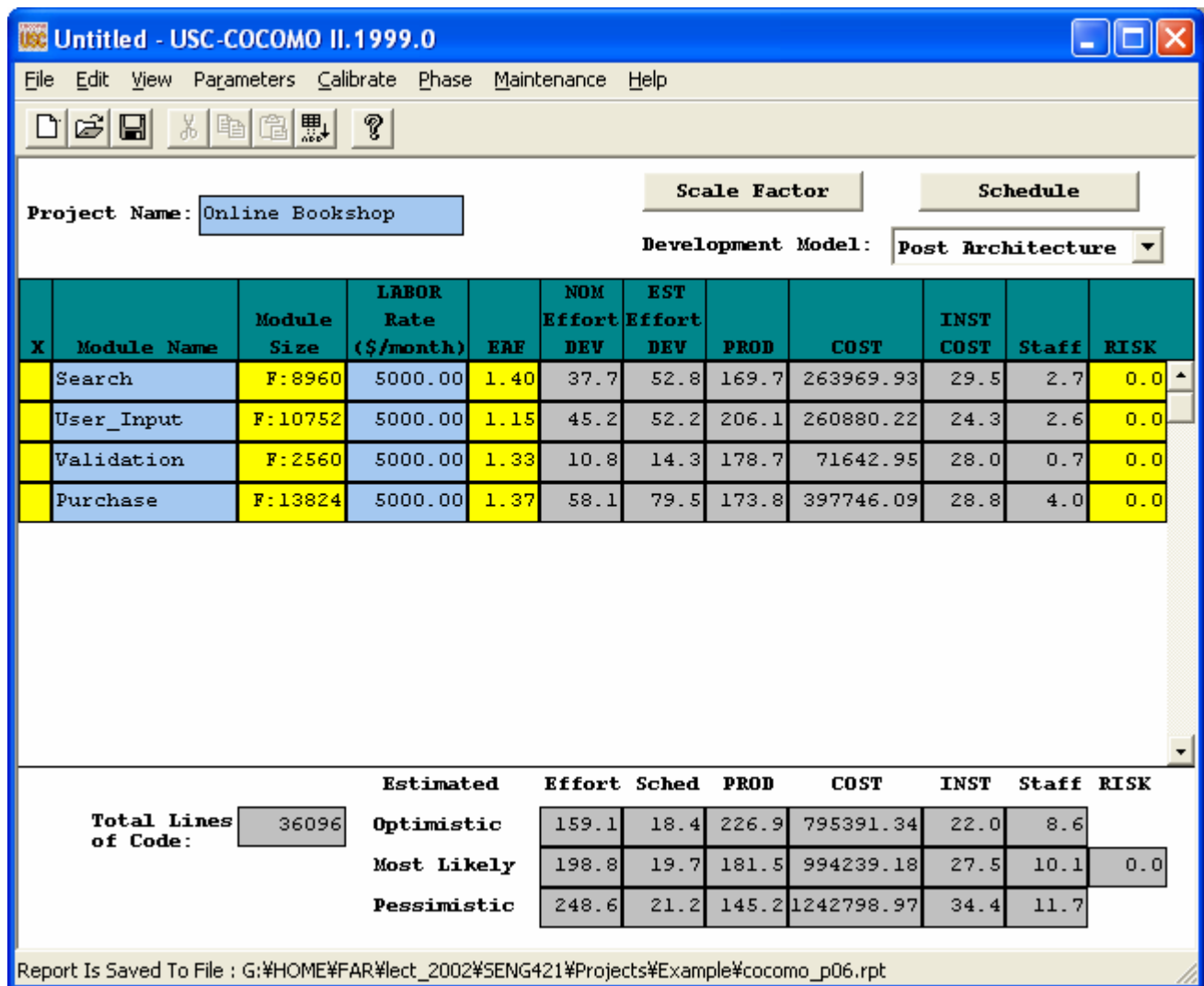


Figure 8 – The Post Architecture Model results

##USC COCOMO II.1999.0##

DEVELOPMENT MODEL: Post Architecture Model

Project Name: Online Bookshop

Scale Factors:	PREC	FLEX	RESL	TEAM	PMAT
	N	N	N	N	N
	3.72	3.04	4.24	3.29	4.68

Module Name	Module Size	EAF	NOM Effort DEV	ACT Effort DEV	PROD	RATE & COST	INST COST	Staff	RISK
Search	FP 8960	1.40	37.7	52.8	169.7	5000.0 263970	29.5	2.7	0.0
User_Input	FP 10752	1.15	45.2	52.2	206.1	5000.0 260880	24.3	2.6	0.0
Validation	FP 2560	1.33	10.8	14.3	178.7	5000.0 71643	28.0	0.7	0.0
Purchase	FP 13824	1.37	58.1	79.5	173.8	5000.0 397746	28.8	4.0	0.0
TOTAL SLOC	36096		OPTIMISTIC	159.1	226.9	795391	22.0	8.6	0.0
			MOST LIKELY	198.8	181.5	994239	27.5	10.1	0.0
			PESSIMISTIC	248.6	145.2	1242799	34.4	11.7	0.0
SCHEDULE		OPTIMISTIC	MOST LIKELY	PESSIMISTIC					
		18.4	19.7	21.2					

Project Name: Online Bookshop

MODULE NAME SIZING DETAILS

Module Name	Language	Inputs	Outputs	Files	Interface	Queries
Search BRAK FP 0	C	0 5 0	0 7 0	0 0 0	0 1 0	0 2 0
User_Input BRAK FP 0	C	0 19 0	0 0 0	0 0 0	0 0 0	0 2 0
Validation BRAK FP 0	C	0 1 0	0 1 0	0 0 0	0 1 0	0 1 0
Purchase BRAK FP 0	C	0 14 0	0 1 0	0 1 0	0 3 0	0 4 0

Project Name: Online Bookshop

PROJECT PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

PROJECT	Online Bookshop				
SLOC	36096				
TOTAL EFFORT	198.848 Person Months				
	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	13.919	20.085	3.966	3.510
Product Design	17.000	33.804	26.043	5.142	6.574
Programming	57.872	115.077	47.829	9.444	12.185
- Detailed Design	24.957	49.627	----	----	----
- Code and Unit Test	32.915	65.450	----	----	----
Integration and Test	25.128	49.966	26.128	5.159	9.685
Life Cycle Phase	Plans And Requirements				
Life Cycle Effort	13.919 Person Months				
Life Cycle Schedule	3.966 Months				
	PCNT	EFFORT (PM)	SCHEDULE	Staff	
Requirements Analysis	45.957	6.397	3.966	1.613	
Product Design	17.021	2.369	3.966	0.597	
Programming	4.543	0.632	3.966	0.159	
Test Planning	3.521	0.490	3.966	0.124	
Verification and Validation	7.021	0.977	3.966	0.246	
Project Office	13.457	1.873	3.966	0.472	
CM/QA	3.000	0.418	3.966	0.105	
Manuals	5.479	0.763	3.966	0.192	

Project Name: Online Bookshop

PROJECT PHASE & ACTIVITY INFORMATION

=====				
Life Cycle Phase		Product Design		
Life Cycle Effort		33.804 Person Months		
Life Cycle Schedule		5.142 Months		
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	4.226	5.142	0.822
Product Design	41.000	13.860	5.142	2.695
Programming	13.021	4.402	5.142	0.856
Test Planning	5.521	1.866	5.142	0.363
Verification and Validation	7.021	2.374	5.142	0.462
Project Office	10.957	3.704	5.142	0.720
CM/QA	2.500	0.845	5.142	0.164
Manuals	7.479	2.528	5.142	0.492
=====				
Life Cycle Phase		Programming		
Life Cycle Effort		115.077 Person Months		
Life Cycle Schedule		9.444 Months		
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	4.603	9.444	0.487
Product Design	8.000	9.206	9.444	0.975
Programming	56.500	65.019	9.444	6.885
Test Planning	5.021	5.778	9.444	0.612
Verification and Validation	8.021	9.231	9.444	0.977
Project Office	6.479	7.455	9.444	0.789
CM/QA	6.500	7.480	9.444	0.792
Manuals	5.479	6.305	9.444	0.668
=====				
Life Cycle Phase		Integration and Test		
Life Cycle Effort		49.966 Person Months		
Life Cycle Schedule		5.159 Months		
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	1.249	5.159	0.242
Product Design	5.000	2.498	5.159	0.484
Programming	37.085	18.530	5.159	3.592
Test Planning	3.000	1.499	5.159	0.291
Verification and Validation	29.457	14.719	5.159	2.853
Project Office	7.479	3.737	5.159	0.724
CM/QA	8.000	3.997	5.159	0.775
Manuals	7.479	3.737	5.159	0.724
=====				

Project Name: Online Bookshop

PROJECT MAINTENANCE INFORMATION

```

=====
PROJECT                                Online Bookshop
Development SLOC                        36096
Development Nominal Person-Month        151.73
Development Adjusted Person-Month       198.85
Development Cost                         994239.18
Maintenance Labor Rate                   0.00
Percentage Added                         0.00%
Percentage Modified                      0.00%
Maintenance Software Understanding       30.00
Unfamiliarity with the Software         0.40

Annual Change Traffic                   0.00%

Effort Ajustment Factor                 1.00
  
```

```

+          Product          ++ Platform          +
  RELY    DATA    DOCU    CPLX    RUSE    TIME    STOR    PVOL
  Nominal Nominal  Nominal Nominal Nominal Nominal Nominal Nominal
    0%     0%     0%     0%     0%     0%     0%     0%
+          Personnel        +
  ACAP    AEXP    PCAP    PEXP    LTEX    PCON
  Nominal Nominal Nominal Nominal Nominal Nominal
    0%     0%     0%     0%     0%     0%
+   Project   +   User   +
  TOOL    SITE    USR1    USR2
  Nominal Nominal Nominal Nominal
    0%     0%     0%     0%
  
```

```

          WORK LOAD PROJECTION FOR THE NEXT 1 YEARS
Year      KSLOC      Effort_Nom  Effort_Maint  Staff  KSLOC/Staff  Cost
  1        36.10        0.00        0.00        0.00    0.00        0.00
  
```

```

          SUMMARY OF PROJECTION
Cumulative Maintenance Person-month      0.00
Overall Development and Maintenance Person-month 198.85
Cumulative Maintenance Cost              0.00
Overall Development and Maintenance Cost  994239.18
  
```

Project Name: Online Bookshop

		Product					Platform					
	+	RELY	DATA	DOCU	CPLX	RUSE	TIME	STOR	PVOL			
		N	N	H	H	N	H	N	N			
	Search	0%	0%	0%	0%	0%	0%	0%	0%			
		1.00	1.00	1.11	1.17	1.00	1.11	1.00	1.00			
+	Personnel	++ Project					++	User	+			
	+	ACAP	AEXP	PCAP	PEXP	LEXP	PCON	TOOL	SCED	SITE	USR1	
USR2												
	Search	N	N	H	N	L	N	L	N	H	N	
N												
0%	Search	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
1.00		1.00	1.00	0.88	1.00	1.09	1.00	1.09	1.00	0.93	1.00	

MODULE PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

MODULE	Search				
SLOC	8960				
TOTAL EFFORT	52.794 Person Months				
	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	3.696	20.085	3.966	0.932
Product Design	17.000	8.975	26.043	5.142	1.745
Programming	57.872	30.553	47.829	9.444	3.235
- Detailed Design	24.957	13.176	----	----	----
- Code and Unit Test	32.915	17.377	----	----	----
Integration and Test	25.128	13.266	26.128	5.159	2.571
Life Cycle Phase	Plans And Requirements				
Life Cycle Effort	3.696 Person Months				
Life Cycle Schedule	3.966 Months				
	PCNT	EFFORT (PM)	SCHEDULE	Staff	
Requirements Analysis	45.957	1.698	3.966	0.428	
Product Design	17.021	0.629	3.966	0.159	
Programming	4.543	0.168	3.966	0.042	
Test Planning	3.521	0.130	3.966	0.033	
Verification and Validation	7.021	0.259	3.966	0.065	
Project Office	13.457	0.497	3.966	0.125	
CM/QA	3.000	0.111	3.966	0.028	
Manuals	5.479	0.202	3.966	0.051	

Project Name: Online Bookshop

MODULE PHASE & ACTIVITY INFORMATION

=====				
Life Cycle Phase			Product Design	
Life Cycle Effort			8.975 Person Months	
Life Cycle Schedule			5.142 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	1.122	5.142	0.218
Product Design	41.000	3.680	5.142	0.716
Programming	13.021	1.169	5.142	0.227
Test Planning	5.521	0.496	5.142	0.096
Verification and Validation	7.021	0.630	5.142	0.123
Project Office	10.957	0.983	5.142	0.191
CM/QA	2.500	0.224	5.142	0.044
Manuals	7.479	0.671	5.142	0.131
=====				
Life Cycle Phase			Programming	
Life Cycle Effort			30.553 Person Months	
Life Cycle Schedule			9.444 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	1.222	9.444	0.129
Product Design	8.000	2.444	9.444	0.259
Programming	56.500	17.262	9.444	1.828
Test Planning	5.021	1.534	9.444	0.162
Verification and Validation	8.021	2.451	9.444	0.260
Project Office	6.479	1.979	9.444	0.210
CM/QA	6.500	1.986	9.444	0.210
Manuals	5.479	1.674	9.444	0.177
=====				
Life Cycle Phase			Integration and Test	
Life Cycle Effort			13.266 Person Months	
Life Cycle Schedule			5.159 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	0.332	5.159	0.064
Product Design	5.000	0.663	5.159	0.129
Programming	37.085	4.920	5.159	0.954
Test Planning	3.000	0.398	5.159	0.077
Verification and Validation	29.457	3.908	5.159	0.757
Project Office	7.479	0.992	5.159	0.192
CM/QA	8.000	1.061	5.159	0.206
Manuals	7.479	0.992	5.159	0.192
=====				

Project Name: Online Bookshop

MODULE MAINTENANCE INFORMATION

=====

MODULE	Search
Development SLOC	8960
Development Nominal Person-Month	37.66
Development Adjusted Person-Month	52.79
Development Cost	263969.93
Maintenance Labor Rate	0.00
Percentage Added	0.00%
Percentage Modified	0.00%
Maintenance Software Understanding	30.00
Unfamiliarity with the Software	0.40
Annual Change Traffic	0.00%
Effort Adjustment Factor	1.00

+			Product		++	Platform		+
	RELY	DATA	DOCU	CPLX	RUSE	TIME	STOR	PVOL
	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
	0%	0%	0%	0%	0%	0%	0%	0%
+			Personnel					+
	ACAP	AEXP	PCAP	PEXP	LTEX	PCON		
	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal		
	0%	0%	0%	0%	0%	0%		
+	Project		+	User				+
	TOOL	SITE		USR1	USR2			
	Nominal	Nominal		Nominal	Nominal			
	0%	0%		0%	0%			

	WORK LOAD PROJECTION FOR THE NEXT 1 YEARS					
Year	KSLOC	Effort_Nom	Effort_Maint	Staff	KSLOC/Staff	Cost
1	8.96	0.00	0.00	0.00	0.00	0.00

SUMMARY OF PROJECTION	
Cumulative Maintenance Person-month	0.00
Overall Development and Maintenance Person-month	52.79
Cumulative Maintenance Cost	0.00
Overall Development and Maintenance Cost	263969.93

Project Name: Online Bookshop

		Product				Platform					
+	MODULE NAME	RELY	DATA	DOCU	CPLX	RUSE	TIME	STOR	PVOL		
		N	N	H	H	N	H	N	N		
	User_Input	0%	0%	0%	0%	0%	0%	0%	0%		
		1.00	1.00	1.11	1.17	1.00	1.11	1.00	1.00		
+	Personnel	++ Project				++ User				+	
+	MODULE NAME	ACAP	AEXP	PCAP	PEXP	LEXP	PCON	TOOL	SCED	SITE	USR1
USR2											
		N	H	N	H	N	N	N	N	N	N
N	User_Input	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0%		1.00	0.88	1.00	0.91	1.00	1.00	1.00	1.00	1.00	1.00
1.00											

MODULE PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

MODULE	User_Input				
SLOC	10752				
TOTAL EFFORT	52.176 Person Months				
	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	3.652	20.085	3.966	0.921
Product Design	17.000	8.870	26.043	5.142	1.725
Programming	57.872	30.195	47.829	9.444	3.197
- Detailed Design	24.957	13.022	----	----	----
- Code and Unit Test	32.915	17.174	----	----	----
Integration and Test	25.128	13.111	26.128	5.159	2.541

Life Cycle Phase	Plans And Requirements			
Life Cycle Effort	3.652 Person Months			
Life Cycle Schedule	3.966 Months			
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	45.957	1.679	3.966	0.423
Product Design	17.021	0.622	3.966	0.157
Programming	4.543	0.166	3.966	0.042
Test Planning	3.521	0.129	3.966	0.032
Verification and Validation	7.021	0.256	3.966	0.065
Project Office	13.457	0.492	3.966	0.124
CM/QA	3.000	0.110	3.966	0.028
Manuals	5.479	0.200	3.966	0.050

Project Name: Online Bookshop

MODULE PHASE & ACTIVITY INFORMATION

=====				
Life Cycle Phase			Product Design	
Life Cycle Effort			8.870 Person Months	
Life Cycle Schedule			5.142 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	1.109	5.142	0.216
Product Design	41.000	3.637	5.142	0.707
Programming	13.021	1.155	5.142	0.225
Test Planning	5.521	0.490	5.142	0.095
Verification and Validation	7.021	0.623	5.142	0.121
Project Office	10.957	0.972	5.142	0.189
CM/QA	2.500	0.222	5.142	0.043
Manuals	7.479	0.663	5.142	0.129
=====				
Life Cycle Phase			Programming	
Life Cycle Effort			30.195 Person Months	
Life Cycle Schedule			9.444 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	1.208	9.444	0.128
Product Design	8.000	2.416	9.444	0.256
Programming	56.500	17.060	9.444	1.806
Test Planning	5.021	1.516	9.444	0.161
Verification and Validation	8.021	2.422	9.444	0.256
Project Office	6.479	1.956	9.444	0.207
CM/QA	6.500	1.963	9.444	0.208
Manuals	5.479	1.654	9.444	0.175
=====				
Life Cycle Phase			Integration and Test	
Life Cycle Effort			13.111 Person Months	
Life Cycle Schedule			5.159 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	0.328	5.159	0.064
Product Design	5.000	0.656	5.159	0.127
Programming	37.085	4.862	5.159	0.942
Test Planning	3.000	0.393	5.159	0.076
Verification and Validation	29.457	3.862	5.159	0.749
Project Office	7.479	0.981	5.159	0.190
CM/QA	8.000	1.049	5.159	0.203
Manuals	7.479	0.981	5.159	0.190
=====				

Project Name: Online Bookshop

MODULE MAINTENANCE INFORMATION

=====

MODULE	User_Input
Development SLOC	10752
Development Nominal Person-Month	45.20
Development Adjusted Person-Month	52.18
Development Cost	260880.22
Maintenance Labor Rate	0.00
Percentage Added	0.00%
Percentage Modified	0.00%
Maintenance Software Understanding	30.00
Unfamiliarity with the Software	0.40
Annual Change Traffic	0.00%
Effort Adjustment Factor	1.00

+			Product		++	Platform		+
	RELY	DATA	DOCU	CPLX	RUSE	TIME	STOR	PVOL
	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
	0%	0%	0%	0%	0%	0%	0%	0%
+			Personnel					+
	ACAP	AEXP	PCAP	PEXP	LTEX	PCON		
	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal		
	0%	0%	0%	0%	0%	0%		
+	Project		+	User				+
	TOOL	SITE		USR1	USR2			
	Nominal	Nominal		Nominal	Nominal			
	0%	0%		0%	0%			

	WORK LOAD PROJECTION FOR THE NEXT 1 YEARS					
Year	KSLOC	Effort_Nom	Effort_Maint	Staff	KSLOC/Staff	Cost
1	10.75	0.00	0.00	0.00	0.00	0.00

SUMMARY OF PROJECTION	
Cumulative Maintenance Person-month	0.00
Overall Development and Maintenance Person-month	52.18
Cumulative Maintenance Cost	0.00
Overall Development and Maintenance Cost	260880.22

Project Name: Online Bookshop

		Product					Platform					
+	MODULE NAME	RELY	DATA	DOCU	CPLX	RUSE	TIME	STOR	PVOL			
		H	H	H	H	N	H	N	N			
	Validation	0%	0%	0%	0%	0%	0%	0%	0%			
		1.10	1.14	1.11	1.17	1.00	1.11	1.00	1.00			
+	Personnel	++ Project					++	User	+			
USR2	MODULE NAME	ACAP	AEXP	PCAP	PEXP	LEXP	PCON	TOOL	SCED	SITE	USR1	
		N	H	N	N	N	N	H	N	H	N	
N	Validation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
0%		1.00	0.88	1.00	1.00	1.00	1.00	0.90	1.00	0.93	1.00	
1.00												

MODULE PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

MODULE	Validation				
SLOC	2560				
TOTAL EFFORT	14.329 Person Months				
	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	1.003	20.085	3.966	0.253
Product Design	17.000	2.436	26.043	5.142	0.474
Programming	57.872	8.292	47.829	9.444	0.878
- Detailed Design	24.957	3.576	----	----	----
- Code and Unit Test	32.915	4.716	----	----	----
Integration and Test	25.128	3.600	26.128	5.159	0.698
Life Cycle Phase	Plans And Requirements				
Life Cycle Effort	1.003 Person Months				
Life Cycle Schedule	3.966 Months				
	PCNT	EFFORT (PM)	SCHEDULE	Staff	
Requirements Analysis	45.957	0.461	3.966	0.116	
Product Design	17.021	0.171	3.966	0.043	
Programming	4.543	0.046	3.966	0.011	
Test Planning	3.521	0.035	3.966	0.009	
Verification and Validation	7.021	0.070	3.966	0.018	
Project Office	13.457	0.135	3.966	0.034	
CM/QA	3.000	0.030	3.966	0.008	
Manuals	5.479	0.055	3.966	0.014	

Project Name: Online Bookshop

MODULE PHASE & ACTIVITY INFORMATION

Life Cycle Phase	Product Design
Life Cycle Effort	2.436 Person Months
Life Cycle Schedule	5.142 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	0.304	5.142	0.059
Product Design	41.000	0.999	5.142	0.194
Programming	13.021	0.317	5.142	0.062
Test Planning	5.521	0.134	5.142	0.026
Verification and Validation	7.021	0.171	5.142	0.033
Project Office	10.957	0.267	5.142	0.052
CM/QA	2.500	0.061	5.142	0.012
Manuals	7.479	0.182	5.142	0.035

Life Cycle Phase	Programming
Life Cycle Effort	8.292 Person Months
Life Cycle Schedule	9.444 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	0.332	9.444	0.035
Product Design	8.000	0.663	9.444	0.070
Programming	56.500	4.685	9.444	0.496
Test Planning	5.021	0.416	9.444	0.044
Verification and Validation	8.021	0.665	9.444	0.070
Project Office	6.479	0.537	9.444	0.057
CM/QA	6.500	0.539	9.444	0.057
Manuals	5.479	0.454	9.444	0.048

Life Cycle Phase	Integration and Test
Life Cycle Effort	3.600 Person Months
Life Cycle Schedule	5.159 Months

	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	0.090	5.159	0.017
Product Design	5.000	0.180	5.159	0.035
Programming	37.085	1.335	5.159	0.259
Test Planning	3.000	0.108	5.159	0.021
Verification and Validation	29.457	1.061	5.159	0.206
Project Office	7.479	0.269	5.159	0.052
CM/QA	8.000	0.288	5.159	0.056
Manuals	7.479	0.269	5.159	0.052

Project Name: Online Bookshop

MODULE MAINTENANCE INFORMATION

=====

MODULE	Validation
Development SLOC	2560
Development Nominal Person-Month	10.76
Development Adjusted Person-Month	14.33
Development Cost	71642.95
Maintenance Labor Rate	0.00
Percentage Added	0.00%
Percentage Modified	0.00%
Maintenance Software Understanding	30.00
Unfamiliarity with the Software	0.40
Annual Change Traffic	0.00%
Effort Adjustment Factor	1.00

+			Product		++	Platform		+
	RELY	DATA	DOCU	CPLX	RUSE	TIME	STOR	PVOL
	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
	0%	0%	0%	0%	0%	0%	0%	0%
+			Personnel					+
	ACAP	AEXP	PCAP	PEXP	LTEX	PCON		
	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal		
	0%	0%	0%	0%	0%	0%		
+	Project		User					
	TOOL	SITE	USR1	USR2				
	Nominal	Nominal	Nominal	Nominal				
	0%	0%	0%	0%				

	WORK LOAD PROJECTION FOR THE NEXT 1 YEARS					
Year	KSLOC	Effort_Nom	Effort_Maint	Staff	KSLOC/Staff	Cost
1	2.56	0.00	0.00	0.00	0.00	0.00

SUMMARY OF PROJECTION	
Cumulative Maintenance Person-month	0.00
Overall Development and Maintenance Person-month	14.33
Cumulative Maintenance Cost	0.00
Overall Development and Maintenance Cost	71642.95

Project Name: Online Bookshop

		Product					Platform				
+ MODULE NAME		RELY	DATA	DOCU	CPLX	RUSE	TIME	STOR	PVOL		
		H	N	H	H	N	H	N	N		
Purchase		0%	0%	0%	0%	0%	0%	0%	0%		
		1.10	1.00	1.11	1.17	1.00	1.11	1.00	1.00		
+ Personnel		++ Project					++ User		+		
+ MODULE NAME		ACAP	AEXP	PCAP	PEXP	LEXP	PCON	TOOL	SCED	SITE	USR1
USR2											
		N	N	H	N	L	N	H	N	N	N
N Purchase		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0%		1.00	1.00	0.88	1.00	1.09	1.00	0.90	1.00	1.00	1.00
1.00											

MODULE PHASE & ACTIVITY INFORMATION

Overall Phase Distribution

MODULE	Purchase				
SLOC	13824				
TOTAL EFFORT	79.549 Person Months				
	PCNT	EFFORT (PM)	PCNT	SCHEDULE	Staff
Plans And Requirements	7.000	5.568	20.085	3.966	1.404
Product Design	17.000	13.523	26.043	5.142	2.630
Programming	57.872	46.037	47.829	9.444	4.875
- Detailed Design	24.957	19.853	-----	-----	-----
- Code and Unit Test	32.915	26.183	-----	-----	-----
Integration and Test	25.128	19.989	26.128	5.159	3.875
Life Cycle Phase	Plans And Requirements				
Life Cycle Effort	5.568 Person Months				
Life Cycle Schedule	3.966 Months				
	PCNT	EFFORT (PM)	SCHEDULE	Staff	
Requirements Analysis	45.957	2.559	3.966	0.645	
Product Design	17.021	0.948	3.966	0.239	
Programming	4.543	0.253	3.966	0.064	
Test Planning	3.521	0.196	3.966	0.049	
Verification and Validation	7.021	0.391	3.966	0.099	
Project Office	13.457	0.749	3.966	0.189	
CM/QA	3.000	0.167	3.966	0.042	
Manuals	5.479	0.305	3.966	0.077	

Project Name: Online Bookshop

MODULE PHASE & ACTIVITY INFORMATION

=====				
Life Cycle Phase			Product Design	
Life Cycle Effort			13.523 Person Months	
Life Cycle Schedule			5.142 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	12.500	1.690	5.142	0.329
Product Design	41.000	5.545	5.142	1.078
Programming	13.021	1.761	5.142	0.342
Test Planning	5.521	0.747	5.142	0.145
Verification and Validation	7.021	0.950	5.142	0.185
Project Office	10.957	1.482	5.142	0.288
CM/QA	2.500	0.338	5.142	0.066
Manuals	7.479	1.011	5.142	0.197
=====				
Life Cycle Phase			Programming	
Life Cycle Effort			46.037 Person Months	
Life Cycle Schedule			9.444 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	4.000	1.841	9.444	0.195
Product Design	8.000	3.683	9.444	0.390
Programming	56.500	26.011	9.444	2.754
Test Planning	5.021	2.312	9.444	0.245
Verification and Validation	8.021	3.693	9.444	0.391
Project Office	6.479	2.983	9.444	0.316
CM/QA	6.500	2.992	9.444	0.317
Manuals	5.479	2.522	9.444	0.267
=====				
Life Cycle Phase			Integration and Test	
Life Cycle Effort			19.989 Person Months	
Life Cycle Schedule			5.159 Months	
=====				
	PCNT	EFFORT (PM)	SCHEDULE	Staff
Requirements Analysis	2.500	0.500	5.159	0.097
Product Design	5.000	0.999	5.159	0.194
Programming	37.085	7.413	5.159	1.437
Test Planning	3.000	0.600	5.159	0.116
Verification and Validation	29.457	5.888	5.159	1.141
Project Office	7.479	1.495	5.159	0.290
CM/QA	8.000	1.599	5.159	0.310
Manuals	7.479	1.495	5.159	0.290
=====				

Project Name: Online Bookshop

MODULE MAINTENANCE INFORMATION

=====

MODULE	Purchase
Development SLOC	13824
Development Nominal Person-Month	58.11
Development Adjusted Person-Month	79.55
Development Cost	397746.09
Maintenance Labor Rate	0.00
Percentage Added	0.00%
Percentage Modified	0.00%
Maintenance Software Understanding	30.00
Unfamiliarity with the Software	0.40
Annual Change Traffic	0.00%
Effort Adjustment Factor	1.00

+			Product		++	Platform		+
	RELY	DATA	DOCU	CPLX	RUSE	TIME	STOR	PVOL
	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
	0%	0%	0%	0%	0%	0%	0%	0%
+			Personnel					+
	ACAP	AEXP	PCAP	PEXP	LTEX	PCON		
	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal		
	0%	0%	0%	0%	0%	0%		
+	Project		+	User				+
	TOOL	SITE		USR1	USR2			
	Nominal	Nominal		Nominal	Nominal			
	0%	0%		0%	0%			

	WORK LOAD PROJECTION FOR THE NEXT 1 YEARS					
Year	KSLOC	Effort_Nom	Effort_Maint	Staff	KSLOC/Staff	Cost
1	13.82	0.00	0.00	0.00	0.00	0.00

SUMMARY OF PROJECTION	
Cumulative Maintenance Person-month	0.00
Overall Development and Maintenance Person-month	79.55
Cumulative Maintenance Cost	0.00
Overall Development and Maintenance Cost	397746.09

Conclusion

For our online bookshop project, COCOMO II provided many estimates.

At the Early Design stage, the estimate for source lines of code (SLOC) is 36,096 in C programming language. The most likely estimate for cost is \$983,764.00. The most likely schedule is 19.7 months and the number of required staff is 10.

At the Post-Architecture, the estimate for SLOC is still 36,096. The most likely estimate for cost is \$994,239.00. The most likely schedule is 19.7 months and the number of required staff is 10.1.