Software Engineering: Principles and Practices (Third Edition)

Chapter 12 Software Project Scheduling, Monitoring, and Control

Figure 7-8. Origin of software defects

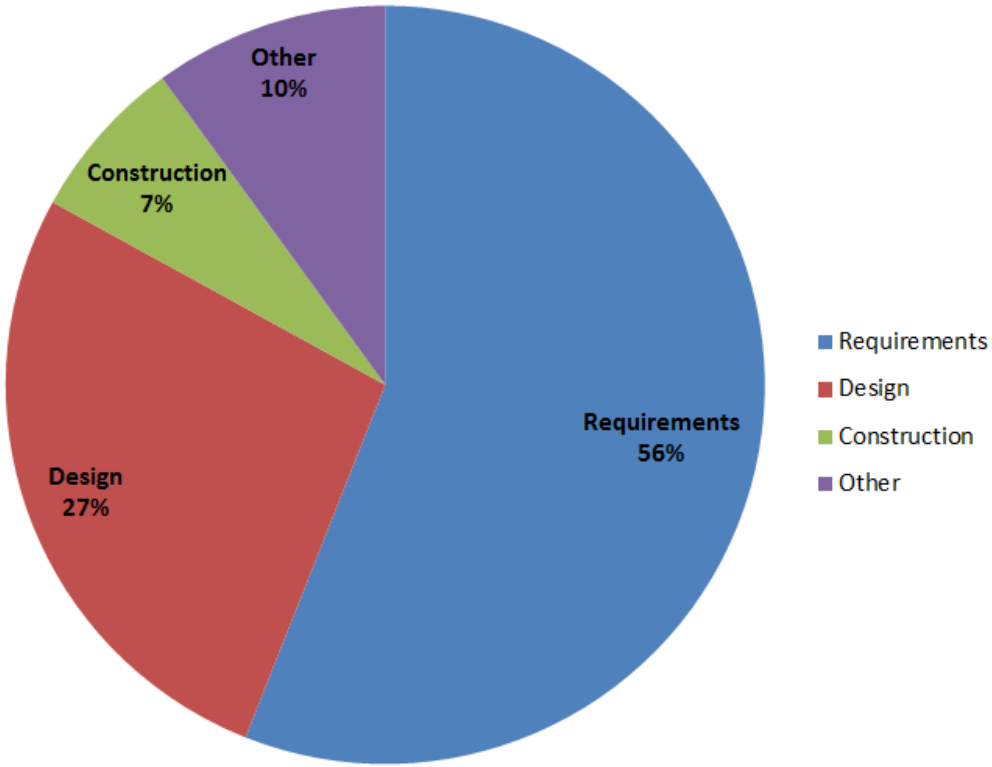
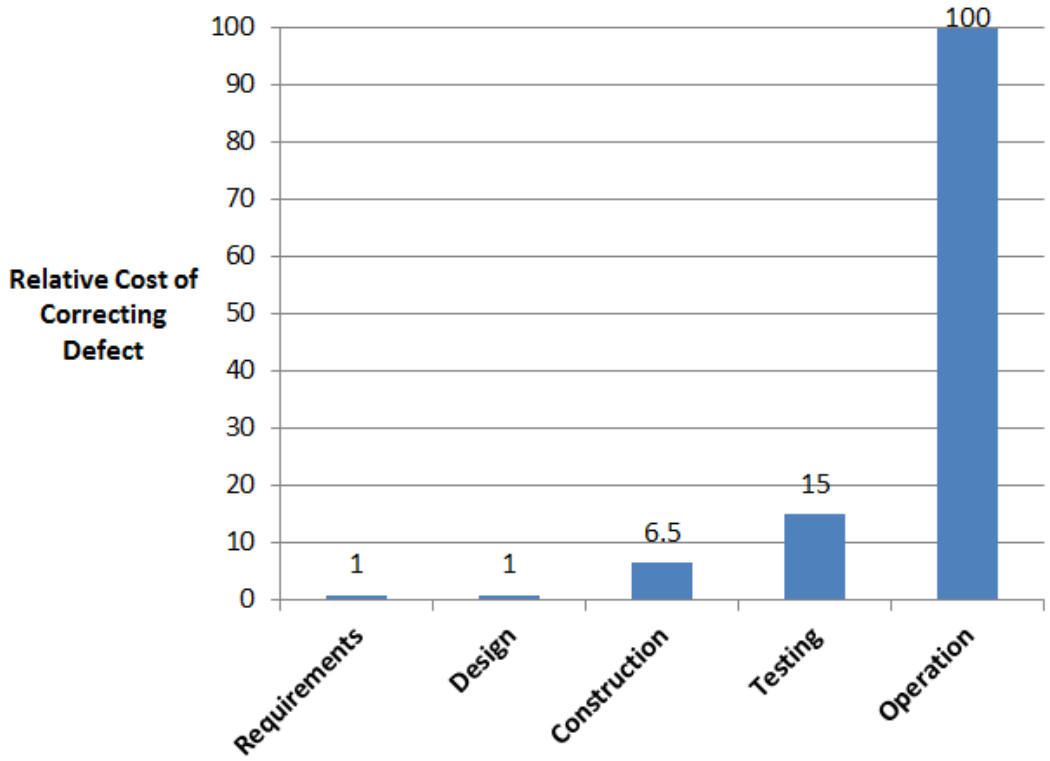


Figure 7-7. Relative cost of correcting software defects



QUOTE:

“The best way to get a project done faster is to start sooner.”

Jim Highsmith (Software Engineer and Author)

What is Software Project Scheduling?

- Creating the list of tasks that must be performed to complete a project
- Identifying the dependencies that exist between those tasks
- Estimating the effort required to complete each task
- Assigning personnel to each task
- Assigning planned start dates and planned end dates to each task
- Defining project milestones

What is Software Project Monitoring?

- Collecting, analyzing, and interpreting the data required to understand the relationships that exist between a project's estimated progress and its actual progress

What is Software Project Control?

- Making adjustments to a project based on the relationships that exist between the project's estimated progress and its actual progress

Reasons software projects are delivered late

- Unrealistic deadlines
- Poorly performed analysis, design, and/or implementation tasks
- Poorly developed project plans
- Changing customer requirements
- Underestimates of project complexity
- Underestimates of required ancillary tasks
- Technical difficulties
- Human resource difficulties
- Miscommunication among project staff
- Failure to recognize that the project is falling behind schedule and a lack of action to correct the problem

Project scheduling

Work breakdown structure

- Used to decompose a project into its constituent parts, where decomposition continues until all of the project's elementary software development tasks have been identified
- Helps us
  - Define the project's elementary tasks
  - Group the project's related and interdependent tasks
  - Define the project's total scope of work

Figure 12-1. Work breakdown structure in outline form

WBS	Activity/Task
1	Analysis
1.1	Problem Identification
1.1.1	Review request for systems services
1.1.2	Meet with client
1.2	Problem Analysis
1.2.1	Analyze causes and effects
1.2.2	Sample documents
1.2.3	Conduct interviews
1.2.4	Observe system
1.3	Scope Definition
1.3.1	Define scope
1.4	Requirements Identification
1.4.1	Discover requirements
1.4.2	Analyze requirements
1.5	Decision Analysis
1.5.1	Identify candidate solutions
1.5.2	Analyze candidate solution feasibility
1.5.3	Compare candidate solutions
1.5.4	Select candidate solution
⋮	⋮
2	Design
	⋮
3	Implementation

Serial tasks vs. parallel tasks

- Examples of serial tasks include
  - Problem Identification → Problem Analysis
  - Requirements Identification → Decision Analysis
  - System Installation → System Changeover
- Examples of parallel tasks include
  - Interviewing ↔ System Observation
  - User-Interface Design ↔ Output Design
  - Construction
  - Maintenance

Figure 12-2. Budgeted effort for each task in the task list

		Budgeted
WBS	**Activity/Task**	**Effort**
1	Analysis	
1.1	Problem Identification	5.00
1.2	Problem Analysis	20.00
1.3	Scope Definition	10.00
1.4	Requirements Identification	120.00
1.5	Decision Analysis	10.00
2	Design	
2.1	Network Design	5.00
2.2	Database Design	25.00
2.3	Process Design	80.00
2.4	Input Design	20.00
2.5	User-Interface Design	50.00
2.6	Output Design	50.00
3	Implementation	
3.1	Construction	
3.1.1	Requirement 1	10.00
3.1.2	Requirement 2	10.00
3.1.3	Requirement 3-N	170.00
3.2	Testing	
3.2.1	Integration Testing	100.00
3.2.2	System Testing	50.00
3.2.3	Acceptance Testing	100.00
3.3	Data Migration	100.00
3.4	System Installation	50.00
3.5	System Changeover	15.00
	Total	**1,000.00**

Figure 12-4. Planned start and end dates of each task in the task list

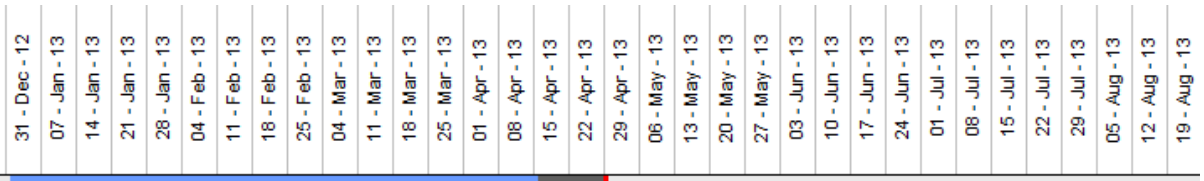
		Budgeted	Personnel	Planned	
WBS	**Activity/Task**	**Effort**	**Initials**	**Start Date**	**End Date**
1	Analysis				
1.1	Problem Identification	5.00	TF	01/01/13	01/07/13
1.2	Problem Analysis	20.00	TF	01/08/13	02/04/13
1.3	Scope Definition	10.00	TF	02/05/13	02/18/13
1.4	Requirements Identification	120.00	TF, KH, TK	02/19/13	04/15/13
1.5	Decision Analysis	10.00	TF	04/16/13	04/29/13
2	Design				
2.1	Network Design	5.00	TF, EA	04/30/13	05/02/13
2.2	Database Design	25.00	TF, ZJ	04/30/13	05/16/13
2.3	Process Design	80.00	TF, IB	05/17/13	07/11/13
2.4	Input Design	20.00	TF, ND	05/17/13	05/30/13
2.5	User-Interface Design	50.00	TF, EM	05/31/13	07/04/13
2.6	Output Design	50.00	TF, EM	05/31/13	07/04/13
3	Implementation				
3.1	Construction				
3.1.1	Requirement 1	10.00	AB, JT	07/05/13	07/11/13
3.1.2	Requirement 2	10.00	KH, JT	07/05/13	07/11/13
3.1.3	Requirement 3-N	170.00	AB, KH, TK, DM, JT	07/05/13	08/21/13
3.2	Testing				
3.2.1	Integration Testing	100.00	DS, DO	08/22/13	10/30/13
3.2.2	System Testing	50.00	DS, DO	10/31/13	12/04/13
3.2.3	Acceptance Testing	100.00	YC, CL, TF, DS, DO	12/05/13	01/01/14
3.3	Data Migration	100.00	TF, TK, DM	01/02/14	02/18/14
3.4	System Installation	50.00	TF, AB	02/19/14	03/25/14
3.5	System Changeover	15.00	TF, AG	03/26/14	04/05/14
	Total	**1,000.00**			**04/05/14**

Duration of a task is a function of the

- Estimated effort required to complete the task
- Number of personnel assigned to the task
- Abilities of the personnel assigned to the task
- Availability of the personnel assigned to the task

Macro and micro scheduling

WBS	Tasks	Task Lead	Start	End	Duration (Days)	% Complete	Working Days	Days Complete	Days Remaining
1	**Analysis**		01/01/13	04/29/13	119	89%	85	105	14
1.1	Problem Identification	TF	01/01/13	01/07/13	7	100%	5	7	0
1.2	Problem Analysis	TF	01/08/13	02/04/13	28	100%	20	28	0
1.3	Scope Definition	TF	02/05/13	02/18/13	14	100%	10	14	0
1.4	Requirements Identification	TF	02/19/13	04/15/13	56	100%	40	56	0
1.5	Decision Analysis	TF	04/16/13	04/29/13	14	0%	10	0	14
2	**Design**		04/30/13	07/04/13	66	0%	48	0	66
2.1	Design		04/30/13	07/04/13	66	0%	48	0	66
3	**Implementation**		07/05/13	04/05/14	275	0%	196	0	275
3.1	Implementation		07/05/13	04/05/14	275	0%	196	0	275



Project monitoring

- Collecting, analyzing, and interpreting the data required to understand the relationships that exist between a project's estimated progress and its actual progress
- Will look at Earned Value Analysis

We monitor software projects to determine

- How close we are to project completion
- How far we are behind (or ahead of) schedule
- How much more (or less) effort we have used than estimated
- How much more (or less) money we have spent than estimated

To monitor a software project, we can

- Meet formally or informally with our software team members at regular intervals or on an ad hoc basis to obtain their subjective assessments of project progress
- Determine whether or not our project milestones have been reached by their scheduled dates
- Compare the planned and actual start and end dates of all of our project's activities and tasks

Figure 12-5. Planned and actual start and end dates of each task in the task list

		Budgeted	Personnel	Planned		Actual		Actual
WBS	**Activity/Task**	**Effort**	**Initials**	**Start Date**	**End Date**	**Start Date**	**End Date**	**Effort**
1	Analysis							
1.1	Problem Identification	5.00	TF	01/01/13	01/07/13	01/01/13	01/04/13	4.00
1.2	Problem Analysis	20.00	TF	01/08/13	02/04/13	01/05/13	02/05/13	22.00
1.3	Scope Definition	10.00	TF	02/05/13	02/18/13	02/06/13	02/21/13	12.00
1.4	Requirements Identification	120.00	TF, KH, TK	02/19/13	04/15/13	02/22/13	04/29/13	125.00
1.5	Decision Analysis	10.00	TF	04/16/13	04/29/13			
2	Design							
2.1	Network Design	5.00	TF, EA	04/30/13	05/02/13			
2.2	Database Design	25.00	TF, ZJ	04/30/13	05/16/13			
2.3	Process Design	80.00	TF, IB	05/17/13	07/11/13			
2.4	Input Design	20.00	TF, ND	05/17/13	05/30/13			
2.5	User-Interface Design	50.00	TF, EM	05/31/13	07/04/13			
2.6	Output Design	50.00	TF, EM	05/31/13	07/04/13			
3	Implementation							
3.1	Construction							
3.1.1	Requirement 1	10.00	AB, JT	07/05/13	07/11/13			
3.1.2	Requirement 2	10.00	KH, JT	07/05/13	07/11/13			
3.1.3	Requirement 3-N	170.00	AB, KH, TK, DM, JT	07/05/13	08/21/13			
3.2	Testing							
3.2.1	Integration Testing	100.00	DS, DO	08/22/13	10/30/13			
3.2.2	System Testing	50.00	DS, DO	10/31/13	12/04/13			
3.2.3	Acceptance Testing	100.00	YC, CL, TF, DS, DO	12/05/13	01/01/14			
3.3	Data Migration	100.00	TF, TK, DM	01/02/14	02/18/14			
3.4	System Installation	50.00	TF, AB	02/19/14	03/25/14			
3.5	System Changeover	15.00	TF, AG	03/26/14	04/05/14			
	Total	**1,000.00**			**04/05/14**			**163.00**

Figure 12-6. Earned value analysis

Earned Value Analysis			
Assumptions			
	Today	4/29/2013	**Date**
	AMLR	8154	**USD/PM**
	AWD	**21.74**	**Days/Month**
	ADLR	**375.05**	**USD/PD**
Measures			
Effort	**BET**	**1000.00**	**PD**
	BEC	**155.00**	**PD**
	AEC	**163.00**	**PD**
Calendar	**PCDT**	**459**	**CD**
	PCDC	**104**	**CD**
	ACDC	**118**	**CD**
Metrics			
Effort	**BEU**	**16.30**	**%**
	EV	**8.00**	**PD**
	ECI	**0.95**	
	CV	**3000.40**	**USD**
Calendar	**PCDU**	**25.71**	**%**
	CDV	**14.00**	**CD**
	CDCI	**0.88**	

Table 12-2. Variables associated with the EVA process (Part 1)

	Variable	Description	Rule
Assumption	Today	Current Date	NA
	AMLR – Average Monthly Labor Rate	The average cost in USD per PM for a single software professional (including overhead)	NA
	AWD – Average Work Days	The average number of work days per month (21.74)	(((((365*3)+366)/7)*5)/48)
	ADLR – Average Daily Labor Rate	The average cost in USD per PD for a single software professional (including overhead)	AMLR / AWD
Effort Measure	BET – Budgeted Effort Total	The total budgeted effort of the project	$\sum_{i=0}^{n}$ Budgeted Effort
	BEC – Budgeted Effort Completed	The budgeted effort completed as of today	$\sum_{i=0}^{n}$ Budgeted Effort completed
	AEC – Actual Effort Completed	The actual effort completed as of today	$\sum_{i=0}^{n}$ Actual Effort completed
Calendar Measure	PCDT – Planned Calendar Days Total	The total number of calendar days planned for the project	Planned End Date of project - Planned Start Date of project
	PCDC – Planned Calendar Days Completed	The number of planned calendar days completed as of today	Planned End Date of tasks completed - Planned Start Date of tasks completed
	ACDC – Actual Calendar Days Completed	The number of actual calendar days completed as of today	Actual End Date of tasks completed - Actual Start Date of tasks completed (Assumes planned and actual start dates are equal)

Table 12-2. Variables associated with the EVA process (Part 2)

Effort Metric	BEU – Budgeted Effort Used	The percentage of the total budgeted effort that has been used as of today	(AEC / BET) * 100
	EV – Effort Variance	The difference between the actual effort completed and the budgeted effort completed as of today	AEC - BEC
	ECI – Effort Conformance Index	The degree of agreement between the budgeted effort completed and the actual effort completed as of today	BEC / AEC
	CV – Cost Variance	The difference between the actual cost of the project and the budgeted cost of the project as of today	ADLR * EV
Calendar Metric	PCDU – Planned Calendar Days Used	The percentage of the total number of planned calendar days that have been used as of today	(ACDC / PCDT) * 100
	CDV – Calendar Days Variance	The difference between the actual number of calendar days completed and the planned number of calendar days completed as of today	ACDC - PCDC
	CDCI – Calendar Days Conformance Index	The degree of agreement between the planned number of calendar days completed and the actual number of calendar days completed as of today	PCDC / ACDC

We can conclude that, as of today

- We have used 16.30 percent of the total effort we have budgeted for our project (BEU = 16.30)
- We have used 8.00 person days more than we have budgeted to this point (EV = 8.00)
- We have done a good job of budgeting project effort to this point (ECI = 0.95)
- We are $3,000.40 over cost to this point (CV = 3,000.40)
- We have used 25.71 percent of the total number of calendar days we have planned for our project, that is, we are approximately one quarter of the way to our project's deadline (PCDU = 25.71)
- We have used 14 calendar days more than we have planned to this point (CDV = 14.00)
- We have done a poor job of planning calendar days to this point (CDCI = 0.88)

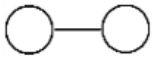
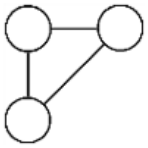
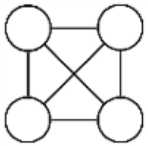
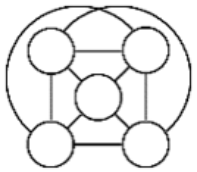
Earned Value Analysis			
Assumptions			
	Today	4/29/2013	**Date**
	AMLR	8154	**USD/PM**
	AWD	**21.74**	**Days/Month**
	ADLR	**375.05**	**USD/PD**
Measures			
Effort	**BET**	**1000.00**	**PD**
	BEC	**155.00**	**PD**
	AEC	**163.00**	**PD**
Calendar	**PCDT**	**459**	**CD**
	PCDC	**104**	**CD**
	ACDC	**118**	**CD**
Metrics			
Effort	**BEU**	**16.30**	**%**
	EV	**8.00**	**PD**
	ECI	**0.95**	
	CV	**3000.40**	**USD**
Calendar	**PCDU**	**25.71**	**%**
	CDV	**14.00**	**CD**
	CDCI	**0.88**	

Project control

- Making adjustments to a project based on the relationships that exist between the project's estimated progress and its actual progress

When a project falls behind schedule and finishing it by the deadline becomes problematic, we can

- Demand that the deadline be changed
- Estimate the effort required to complete the project and then (re)negotiate the deadline
- Release the software in increments
- Require our staff to work overtime
- Add personnel to the project

Project Team Members and Communication Paths	Formula
	$1 = \frac{2(2-1)}{2}$
	$3 = \frac{3(3-1)}{2}$
	$6 = \frac{4(4-1)}{2}$
	$10 = \frac{5(5-1)}{2}$

Activity

- In pairs, do Project #4 in Chapter 12. Create a reusable spreadsheet (project schedule and EVA) using figure 12–5 and figure 12–6 as your guide. Use the same input data in the figures to ensure that your calculations are correct. Post a screenshot with both partners names in the comments to Piazza as a note.