CENG 6101 Project Management

Project Control

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Construction Project Management

1. Decision to Bid
2. Project Planning (develop WBS and CMS)
3. Project Estimating and Scheduling
4. Resource Allocation and Leveling
5. Submit Bid (proceed if awarded contract)
6. Estimate then forms basis of budget during construction (both use similar WBS and CBS)
7. Schedule forms basis of execution plan (use similar WBS)
8. Cost control: compare actual to budgeted costs
9. Schedule control: compare actual to planned progress
10. Detect deviations and implement timely corrective actions

Job-based Cost Control

Two types of systems for job cost data collection:

- Financial control system: payroll, accounting, etc.
- Cost control system: man-hours spent on work packages, cost and productivity data, data on labour, material, equipment

Where are Cost Data Initiated?

- Labour: time sheets, foreman's daily work report, company's payroll system
- Labour data collected: craft, level (apprentice, journeyman), hours (regular, overtime), work package(s) worked on
- Equipment: equipment time sheets (similar to labour)
- Material: purchase orders, material delivery slips, material cost records (materials management system)

ATHABASCA OIL SANDS DOWNSTREAM PROJECT

Date : _____

Foreman's Time Card

Foreman: _____

Signature: _____

Approver: _____

Signature: _____

Description of Work	Description of Work	Description of Work	Description of Work	Description of Work
Contract	**Contract**	**Contract**	**Contract**	**Contract**
Area Unit	**Area Unit**	**Area Unit**	**Area Unit**	**Area Unit**
Cost Code	**Cost Code**	**Cost Code**	**Cost Code**	**Cost Code**
Change Order	**Change Order**	**Change Order**	**Change Order**	**Change Order**

Badge	Employee Name	Time IN	Total Hours	ST	OT	DT	ST	OT	DT	ST	OT	DT	ST	OT	DT	ST	OT	DT

Project Control

Monitoring Productivity

- Another component of control is tracking productivity on basis of manhours/unit (i.e., input/output)
- Three methods of measuring output:
  - Estimated % complete
  - Physical measurement
  - Earned value

Estimated % Complete

- Based on observation
- Simple and inexpensive
- Subjective and not sensitive to scope changes
- Estimated quantity complete

  = total quantity * estimated % complete

Project Control

Physical Measurement

- Output based on actually counting or measuring number of work units completed (e.g., diameter inches of pipe welds, m^3 of earthwork)
- Objective, detailed, accounts for scope changes
- Time consuming, expensive

Earned Value

- Actual manhours taken from time sheets
- Actual quantities based on “rules of credit” agreed upon in advance of work being undertaking (for budgeting and payment purposes)
- e.g., 80-20 rule: 20% credit given for commencing activity, 80% credit given for completing activity

Project Control

- Earned Value
- More common is milestone approach: e.g., formwork activity:
  - Fabricate = 60% credit, Erect = 20% credit, Remove forms = 15% credit, Clean forms = 5% credit
- Rules of credit may reflect effort or work involved

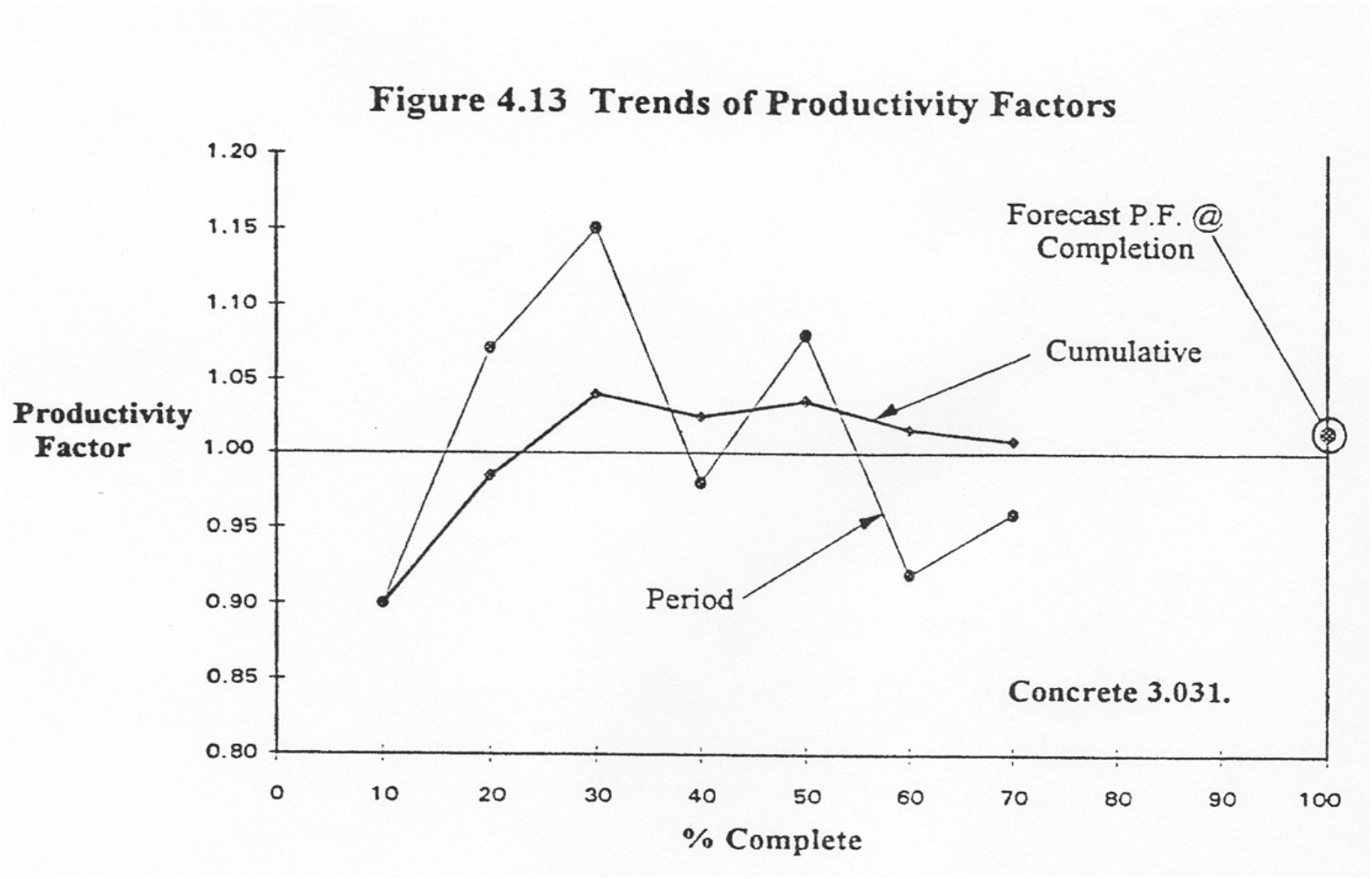
Earned value for manhours

= earned value for quantities * estimated (budgeted) productivity

- EV (mhrs) = EV (m^3) * estimated mhr/m^3
- Performance (Productivity) Factor (PF)

= Earned value mhrs / Actual mhrs

(PF > 1.0 is good in this case)



- Period PF used for immediate control purposes to remedy trends.
- Cumulative PF used to forecast costs at completion.

BETTER SUPERVISION PUMPSTATION PROJECT
PROGRESS AND PERFORMANCE REPORT
AS OF 13-JUNE-94

						5/1380 / 100		7 X 6	7 X 5		10 / 9
	1	2	3	4	5	6	7	8	9	10	11
ID	Description	Dur	Start	Finish	Mhrs	% Value	% Compl	Earned Value	Earned Mnhrs	Spent Mnhrs	Perf. Factor
1	CONTRACT AWARD	0	30-May	30-May	0	0.00	100%	0	0	0	1.00
2	MOBILIZE	4	30-May	2-Jun	32	2.32	80%	1.86	25.6	22	0.86
3	SPOOL DWGS	3	30-May	1-Jun	24	1.74	100%	1.74	24	26	1.08
4	DEL. PIPE & FITTINGS	6	30-May	4-Jun	4	0.29	100%	0.29	4	4	1.00
5	DEL. PUMP & VALVES	10	30-May	8-Jun	2	0.14	100%	0.14	2	2	1.00
6	DEL. PMPHSE BLD'G PKG	7	30-May	5-Jun	2	0.14	0%	0.00	0	0	1.00
7	SURVEY	1	3-Jun	3-Jun	16	1.16	100%	1.16	16	12	0.75
8	FAB. PIPE SPOOLS	6	2-Jun	7-Jun	64	4.64	60%	2.78	38.4	36	0.94
9	DRILL AND CAST PILES	2	4-Jun	5-Jun	64	4.64	100%	4.64	64	72	1.13
10	EXCAVATE FOR FDN'S	3	6-Jun	8-Jun	48	3.48	100%	3.48	48	41	0.85
11	FORM FDN'S & REBAR	5	9-Jun	13-Jun	120	8.70	100%	8.70	120	130	1.08
12	POUR CONC. FDN'S	1	14-Jun	14-Jun	40	2.90	100%	2.90	40	45	1.13
13	STRIP FORMS	2	15-Jun	16-Jun	32	2.32	100%	2.32	32	30	0.94
14	BACKFILL	5	17-Jun	21-Jun	120	8.70	60%	5.22	72	63	0.88
15	INSTALL PUMP	3	17-Jun	19-Jun	48	3.48	0%	0	0		
16	CONC. SLAB	1	22-Jun	22-Jun	48	3.48	0%	0	0		
17	INSTALL PIPING	10	23-Jun	2-Jul	240	17.39	0%	0	0		
18	ERECT PUMPHOUSE	12	30-Jun	11-Jul	300	21.74	0%	0	0		
19	INSTALL INSTRUMENTS	2	3-Jul	4-Jul	32	2.32	0%	0	0		
20	INSTALL DOORS	3	12-Jul	14-Jul	32	2.32	0%	0	0		
21	PULL & TERM. CABLE	4	5-Jul	8-Jul	64	4.64	0%	0	0		
22	DEMOBILIZE SITE	3	15-Jul	17-Jul	48	3.48	0%	0	0		
23	PROJECT COMPLETE	0	17-Jul	17-Jul	0	0.00	0%	0	0		
	Total				**1380**	**100.00**		**35.22**	**486.00**	**483.00**	**0.99**

(PF < 1.0 is good in this case)

Project Control

- Earned Value Management (EVM)
  - Developed as Cost/Schedule Planning Control Specification (C/SPCS) by US Air Force in 1966
  - Primary EVM users include US, Europe, England, Canada, Australia, China and Japan.
- Objectives of EVMS
  - Relate time phased budgets to specific contract tasks and/or statements of work
  - Provide the basis to capture work progress assessments against the base line
  - Relate technical, schedule, and cost performances
  - Provide valid, timely, and auditable data/information for proactive project management analysis and action

Project Control

- Project and Budget Performance
- BCWS (planned value - PV) = budgeted cost of work scheduled
- BCWP (earned value - EV) = budgeted cost of work performed
- ACWP (actual cost - AC) = actual cost of work performed = commitments + payments due + payments made

Project Control

- Cost Performance
- CV = cost variance
  - CV = BCWP–ACWP = EV-AC
- CPI = cost performance index (periodic)
  - CPI = BCWP/ACWP = EV/AC
  - CPI < 1.0 indicates cost overrun
  - CPI > 1.0 indicates cost underrun
- Cumulative cost performance index (CPI^C) (sum of periodic values for each index):
  - $CPI^C = EV^C/AC^C$
  - Used to forecast project costs at completion

Project Control

- Schedule Performance
- SV = schedule variance
  - SV = BCWP–BCWS = EV-PV
- SPI = schedule performance index (periodic)
  - SPI = BCWP/BCWS = EV/PV
  - SPI < 1.0 indicates behind schedule
  - SPI > 1.0 indicates ahead of schedule
- SPI used to predict project completion date, and in conjunction with CPI to forecast costs at completion

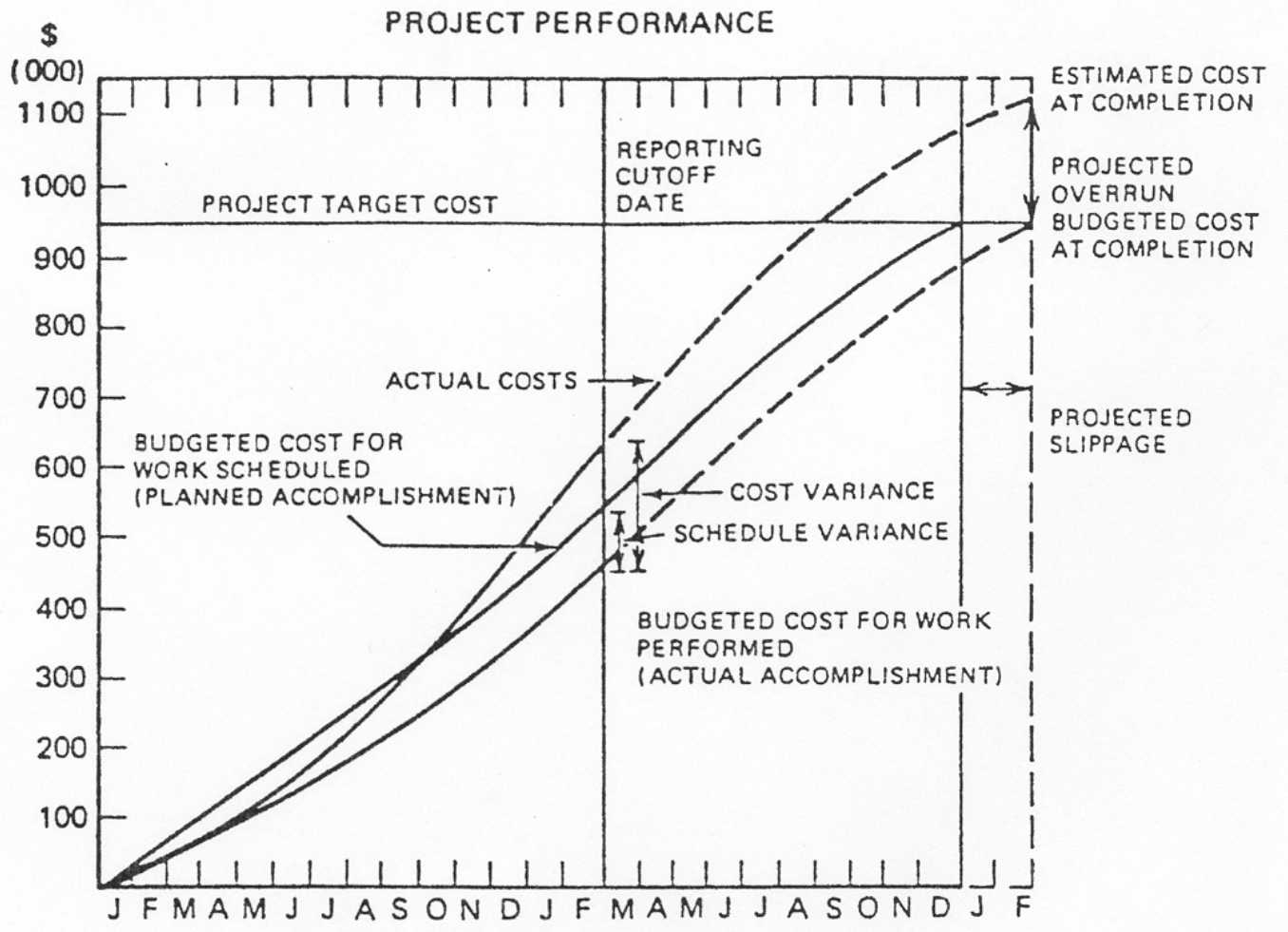


FIGURE 14.18 Performance Curves

Earned Value Technique

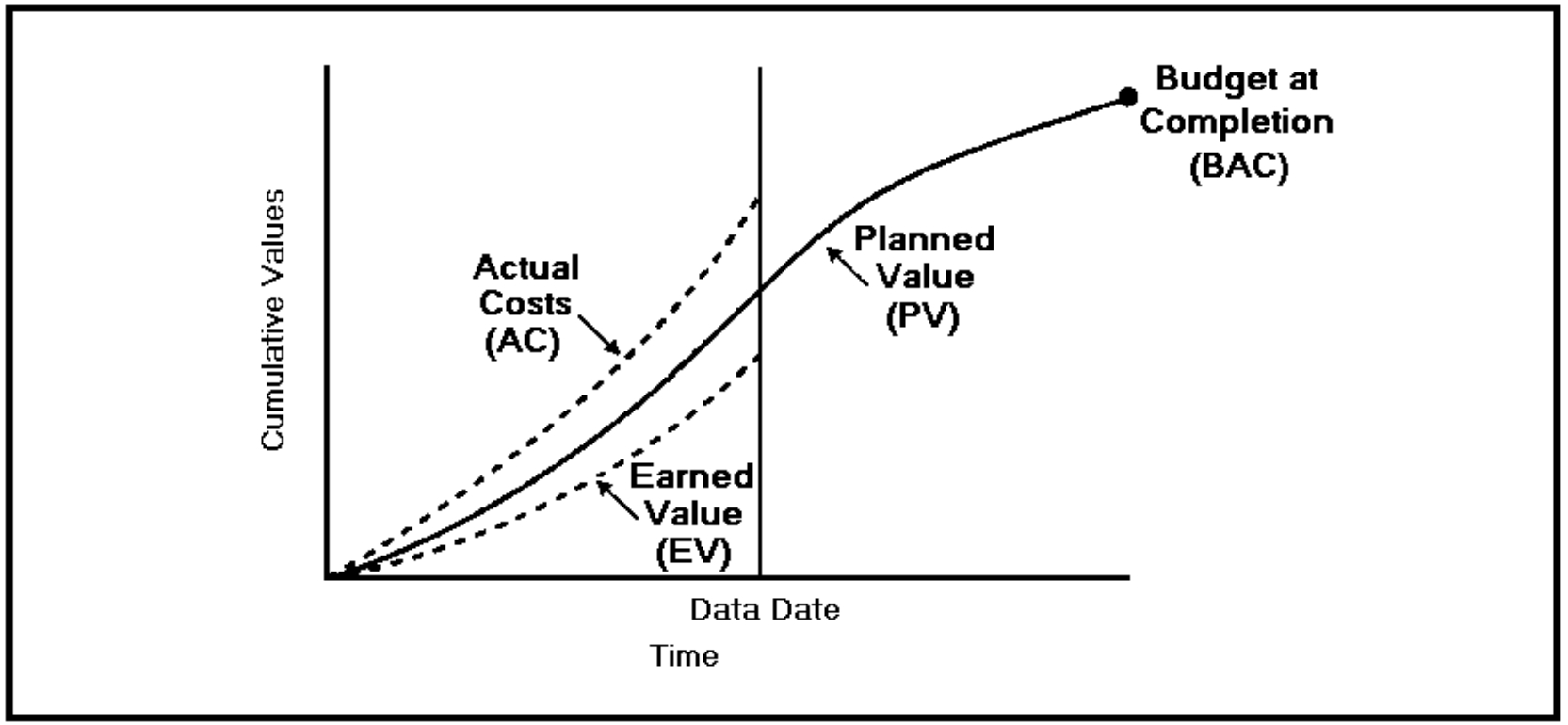


Figure 7-7. Illustrative Graphic Performance Report

Forecasting

- Budget at completion (BAC):
  - BAC = total cumulative PV at completion
- Estimate to complete (ETC): estimate for completing remaining work
- ETC can be calculated based on 3 different scenarios

Scenario 1:

- ETC based on new estimate:
  - Revised estimate for work remaining
  - Original estimate assumptions flawed or no longer relevant

Scenario 2:

- ETC based on atypical variances:
  - ETC = BAC – EV^C
  - Current variances atypical and will not occur in future

Forecasting

Scenario 3:

- ETC based on typical variances:
  - ETC = (BAC – EV^C)/CPI^C
  - Current variances typical of future variances

Estimate at completion (EAC): projected or anticipated total cost when project is completed. Accordingly, EAC can be calculated based on 3 different scenarios

Scenario 1:

- EAC based on new estimate
  - EAC = AC^C + ETC (new estimate)
  - Original estimate assumptions flawed or no longer relevant

Forecasting

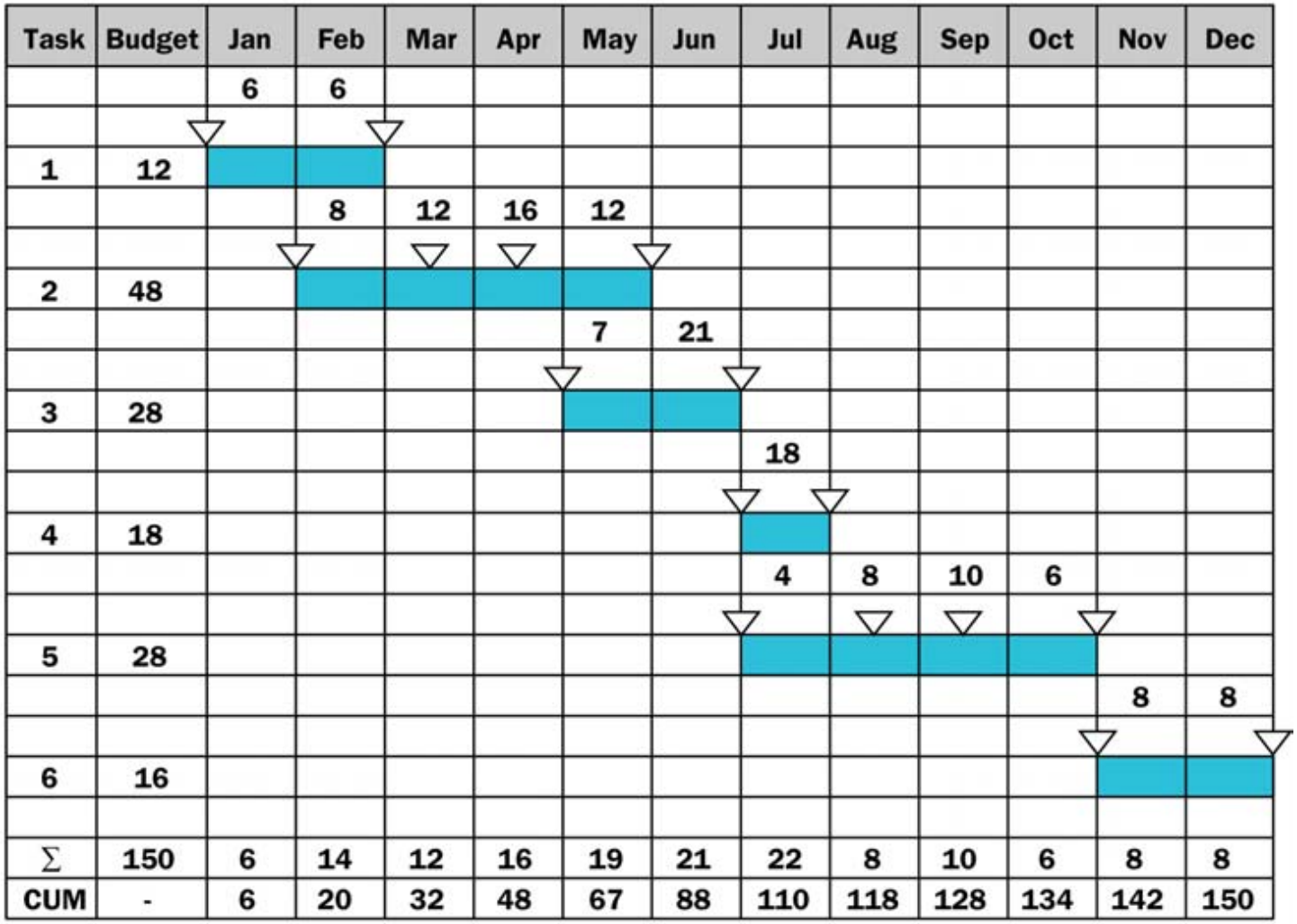
Scenario 2:

- EAC based on atypical variances:
  - $EAC = AC^C + BAC - EV^C$
  - Current variances atypical and will not occur in future

Scenario 3:

- EAC based on typical variances:
  - $EAC = AC^C + ((BAC - EV^C) / CPI^C)$
  - Current variances typical of future variances

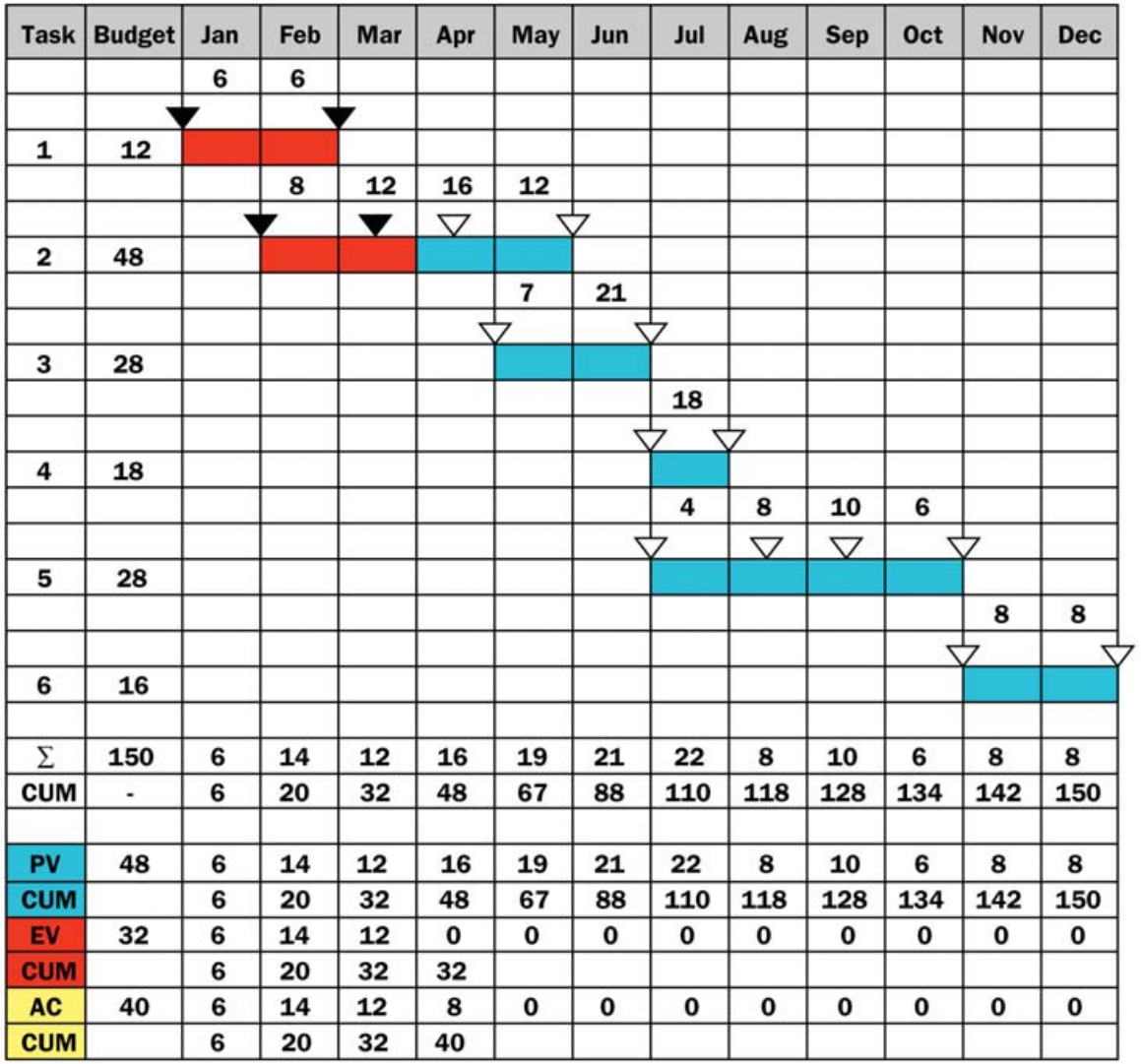
Example



Task	Budget	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		6	6										
1	12												
			8	12	16	12							
2	48												
						7	21						
3	28												
								18					
4	18												
								4	8	10	6		
5	28												
												8	8
6	16												
∑	150	6	14	12	16	19	21	22	8	10	6	8	8
CUM	-	6	20	32	48	67	88	110	118	128	134	142	150

Figure 1-4. Work Plan—Gantt (Bar) Chart

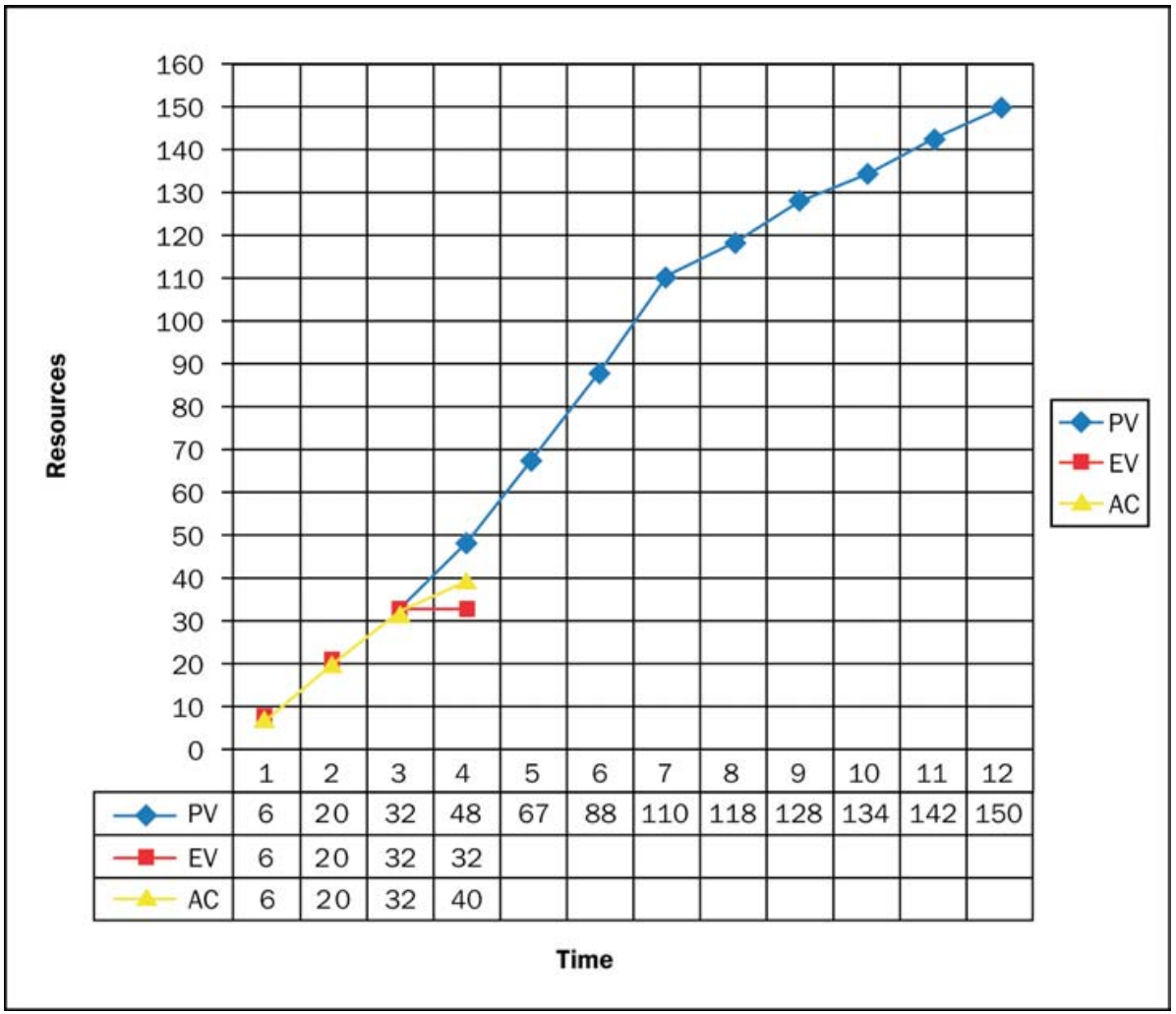
Example



Task	Budget	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		6	6										
1	12												
			8	12	16	12							
2	48												
						7	21						
3	28												
								18					
4	18												
								4	8	10	6		
5	28												
												8	8
6	16												
Σ	150	6	14	12	16	19	21	22	8	10	6	8	8
CUM	-	6	20	32	48	67	88	110	118	128	134	142	150
PV	48	6	14	12	16	19	21	22	8	10	6	8	8
CUM		6	20	32	48	67	88	110	118	128	134	142	150
EV	32	6	14	12	0	0	0	0	0	0	0	0	0
CUM		6	20	32	32								
AC	40	6	14	12	8	0	0	0	0	0	0	0	0
CUM		6	20	32	40								

Figure 2-6. Work Plan and Status for Project EZ (As of April 30)

Example



	1	2	3	4	5	6	7	8	9	10	11	12
PV	6	20	32	48	67	88	110	118	128	134	142	150
EV	6	20	32	32								
AC	6	20	32	40								

Figure 2-7. Cumulative Planned Value, Earned Value, and Actual Cost for Project EZ (As of April 30)

Example

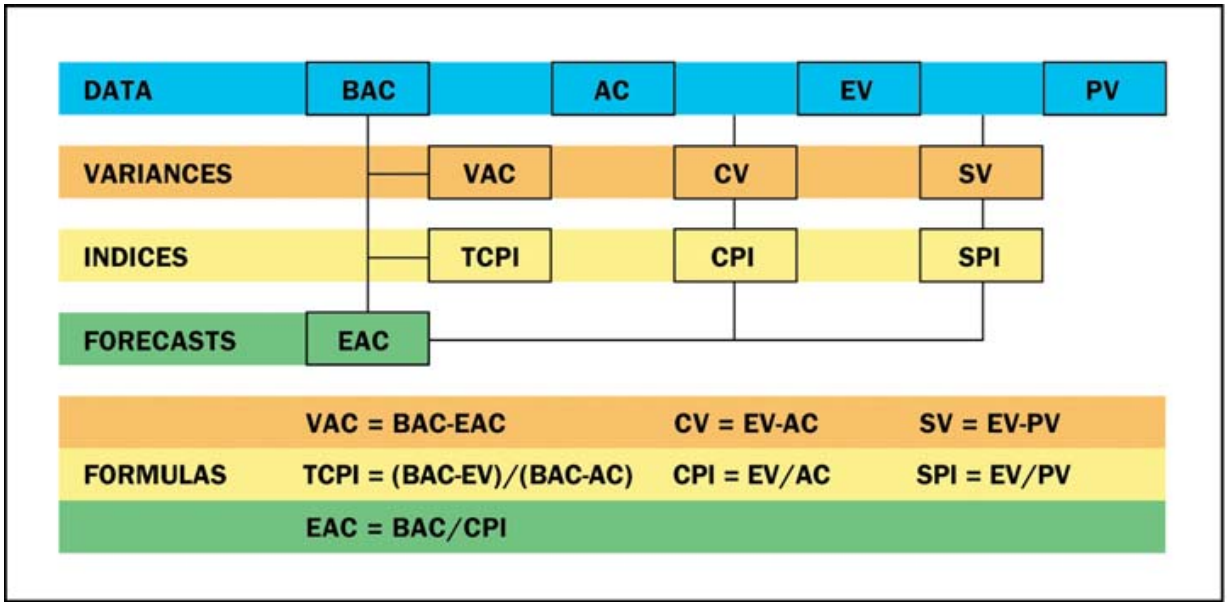


Figure 3-1. EVM Performance Measures

Example

- Schedule Analysis and Forecasting
  - $SV = EV - PV = 32 - 48 = -16\ \{unfavourable\}$
  - $SV\% = \frac{SV}{EV} = -\frac{16}{48} = -33\%\ \{unfavourable\}$
  - $SPI = \frac{EV}{PV} = \frac{32}{48} = 0.67\ \{unfabourable\}$
  - $EAC_t = \frac{(\frac{BAC}{SPI})}{(\frac{BAC}{months})} = \frac{\frac{150}{0.6667}}{\frac{150}{12}} = 18\ months > 12\ months$
- Cost Analysis and Forecasting
  - $CV = EV - AC = 32 - 40 = -8\ \{unfavourable\}$
  - $CV\% = \frac{CV}{EV} = -\frac{8}{32} = -25\%\ \{unfavourable\}$
  - $CPI = \frac{EV}{AC} = \frac{32}{40} = 0.80\ \{unfabourable\}$
  - $EAC = \frac{BAC}{CPI} = \frac{150}{0.80} = 187.50 > 150$
  - $TCPI = \frac{BAC-EV}{BAC-AC} = \frac{150-32}{150-40} = 1.07$ → For the project to achieve the BAC, performance must improve from a CPI of 0.80 to a TCPI (To-Complete PI) of 1.07

Project Control

- Other Approaches to Output Measurement
  - Elapsed time vs. estimated duration
  - Resource usage vs. estimated usage
  - Budget spent to date vs. total budget
- Problems with above approaches?

Project Control: Research Findings

- Cost Performance Index (CPI): Stability - Fact or Fiction
- Christensen, David S., and Kirk Payne. 1992. “CPI Stability – Fact or Fiction?” Journal of Parametrics 10:27-40 (April).
- It has long been asserted that the CPI does not change more than 10 percent once the contract is 50 percent complete.
- Stable CPI:
  - Is evidence that the contractor’s management control systems, particularly the planning, budgeting, and accounting systems, are functioning properly.
  - “Estimated at Completion,” are reliable.
  - Capability of a contractor to recover from a cost overrun by comparing the CPI with other key indicators, such as the To-Complete Performance Index.

Project Control: Research Findings

- Cost Performance Index (CPI): Stability - Fact or Fiction
- Hypothesis Testing
- *Once a contract is 50 percent or more complete, the CPI is stable*.
  - 1. Range of the CPI after 50% complete, if < 0.20 CPI is stable;
  - 2. An interval of plus and minus 10 percent of the CPI at the 50% point, within the interval stable.
  - Sensitivity of the results at earlier points of completion (40, 30, 20, 10, and 0 %) and narrower intervals (7.5 and 5.0 %).
- Data:
  - Database of U.S Air Force Systems Command Aeronautical Systems Division (ASD), and consisted of cost performance data from 26 cost performance reports for seven aircraft procurement programs.

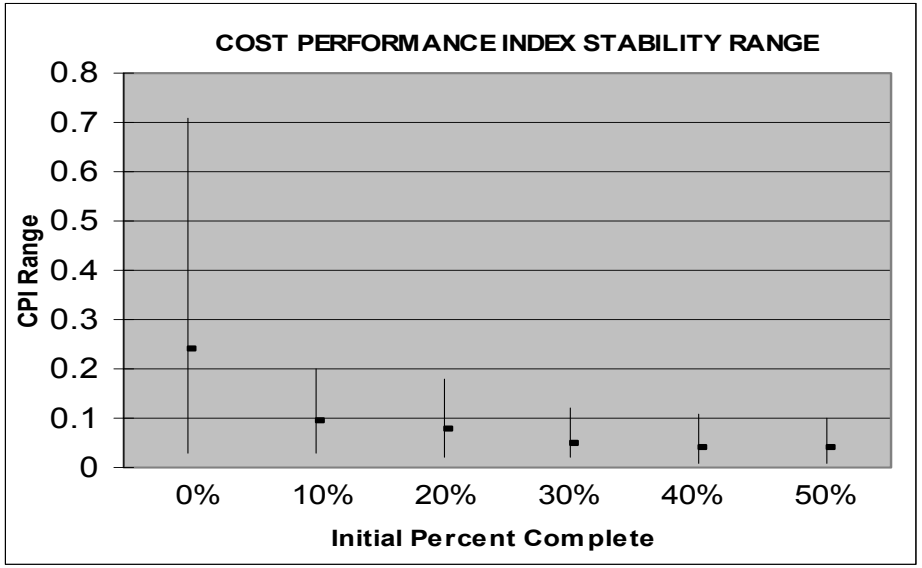
Project Control: Research Findings

- Cost Performance Index (CPI): Stability - Fact or Fiction
- Results
- CPI range was stable from the 50 % completion point

CPI RANGE STABILITY

Percent Complete	0%	10%	20%	30%	40%	50%
Total Contracts	19	25	25	25	25	26
Contracts w/ stable CPI	10	24	25	25	25	26
Percent stable	53%	96%	100%	100%	100%	100%
Maximum Range	0.719	0.206	0.163	0.123	0.108	0.093
Minimum Range	0.031	0.030	0.016	0.015	0.015	0.015
Mean Range	0.236	0.092	0.076	0.060	0.052	0.044
Standard Deviation	0.152	0.047	0.042	0.027	0.023	0.019

FIGURE 1 CPI RANGE STABILITY



Project Control: Research Findings

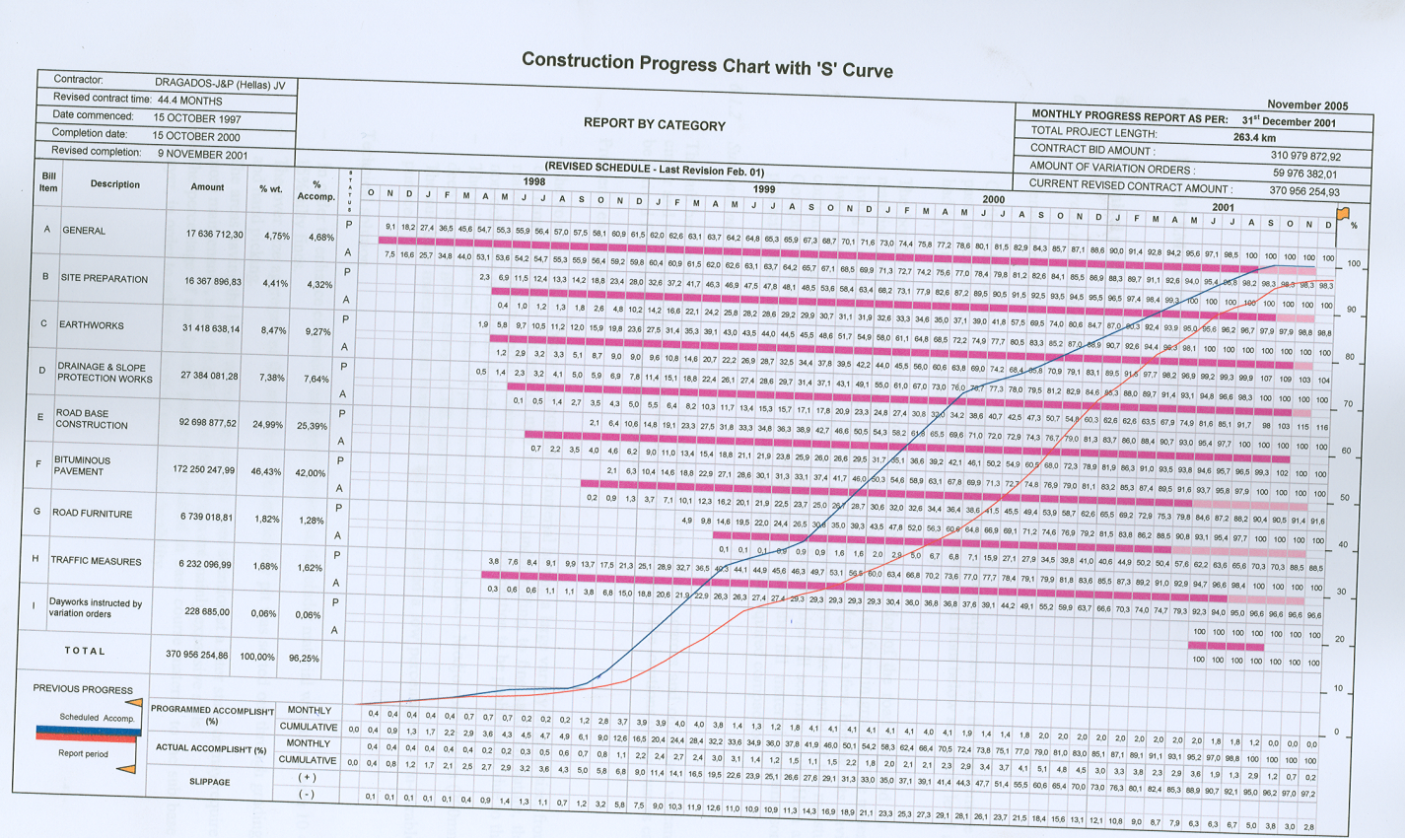
- CPI interval did not change by more than 10% from the CPI measured at the 50 % complete point

CPI INTERVAL STABILITY

	Based on CPI at 50% complete		
Percentage Interval	10.00%	7.50%	5.00%
Number of Contracts	26	26	26
Number of Contracts with Stable CPI	26	25	21
Percent of Contracts with Stable CPI	100%	96%	81%
	Based on CPI at 40% complete		
Percentage Interval	10.00%	7.50%	5.00%
Number of Contracts	25	25	25
Number of Contracts with Stable CPI	24	23	16
Percent of Contracts with Stable CPI	96%	92%	64%
	Based on CPI at 30% complete		
Percentage Interval	10.00%	7.50%	5.00%
Number of Contracts	25	25	25
Number of Contracts with Stable CPI	23	20	14
Percent of Contracts with Stable CPI	92%	80%	56%
	Based on CPI at 20% complete		
Percentage Interval	10.00%	7.50%	5.00%
Number of Contracts	25	25	25
Number of Contracts with Stable CPI	21	17	15
Percent of Contracts with Stable CPI	84%	68%	60%
	Based on CPI at 10 % complete		
Percentage Interval	10.00%	7.50%	5.00%
Number of Contracts	25	25	25
Number of Contracts with Stable CPI	17	15	7
Percent of Contracts with Stable CPI	68%	60%	28%
	Based on CPI at 0% complete		
Percentage Interval	10.00%	7.50%	5.00%
Number of Contracts	19	19	19
Number of Contracts with Stable CPI	7	4	3
Percent of Contracts with Stable CPI	37%	21%	16%

Project Control: Research Findings

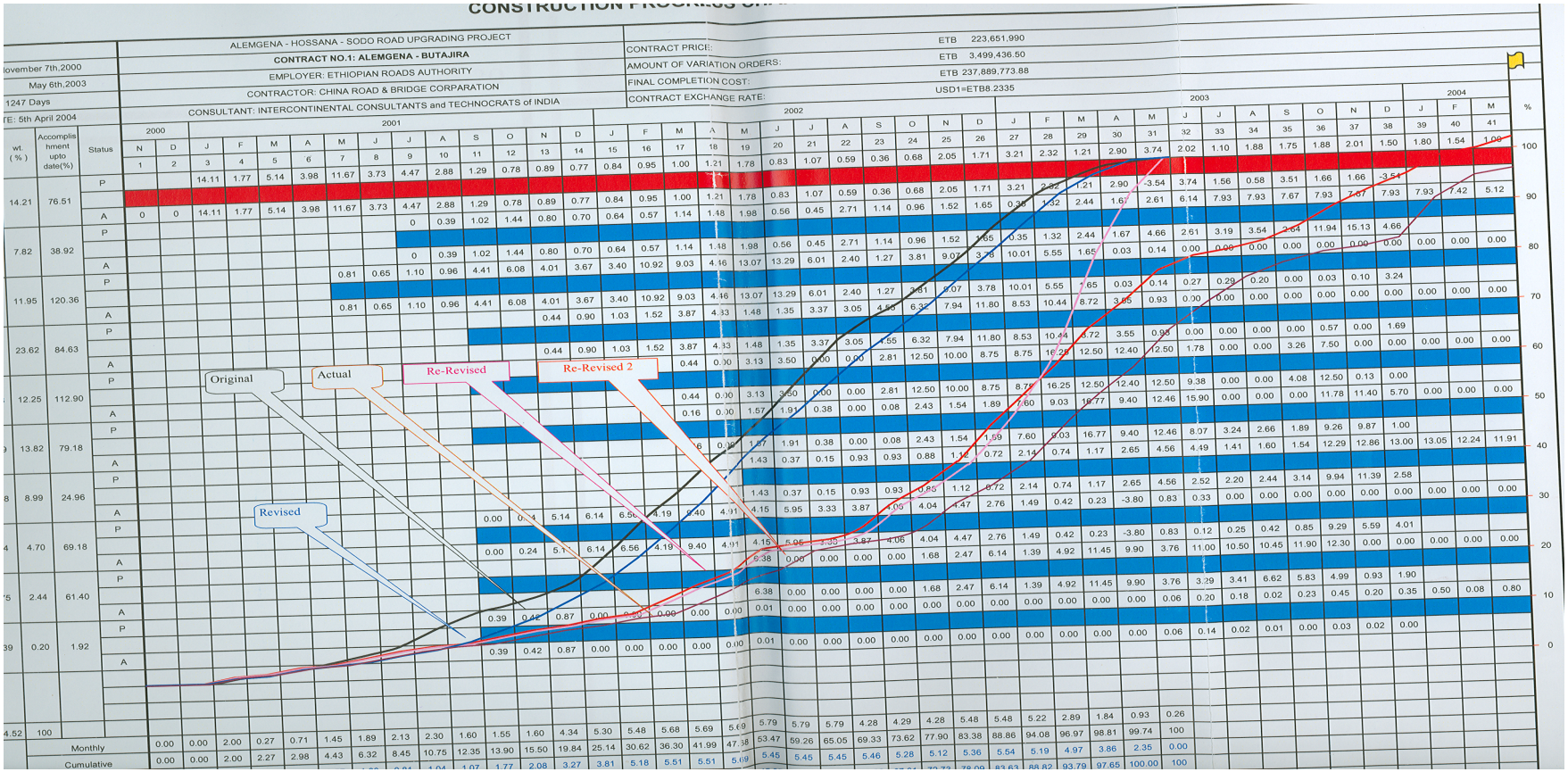
- Shall Ethiopian Road Authority Use S-Curves?
- Abraham. A. Tsehayae. 2008. “Time-Cost Relationship of Ethiopian Road Construction Projects” MSc Thesis, AAU.



Project Control: Research Findings

- Shall Ethiopian Road Authority Use S-Curves

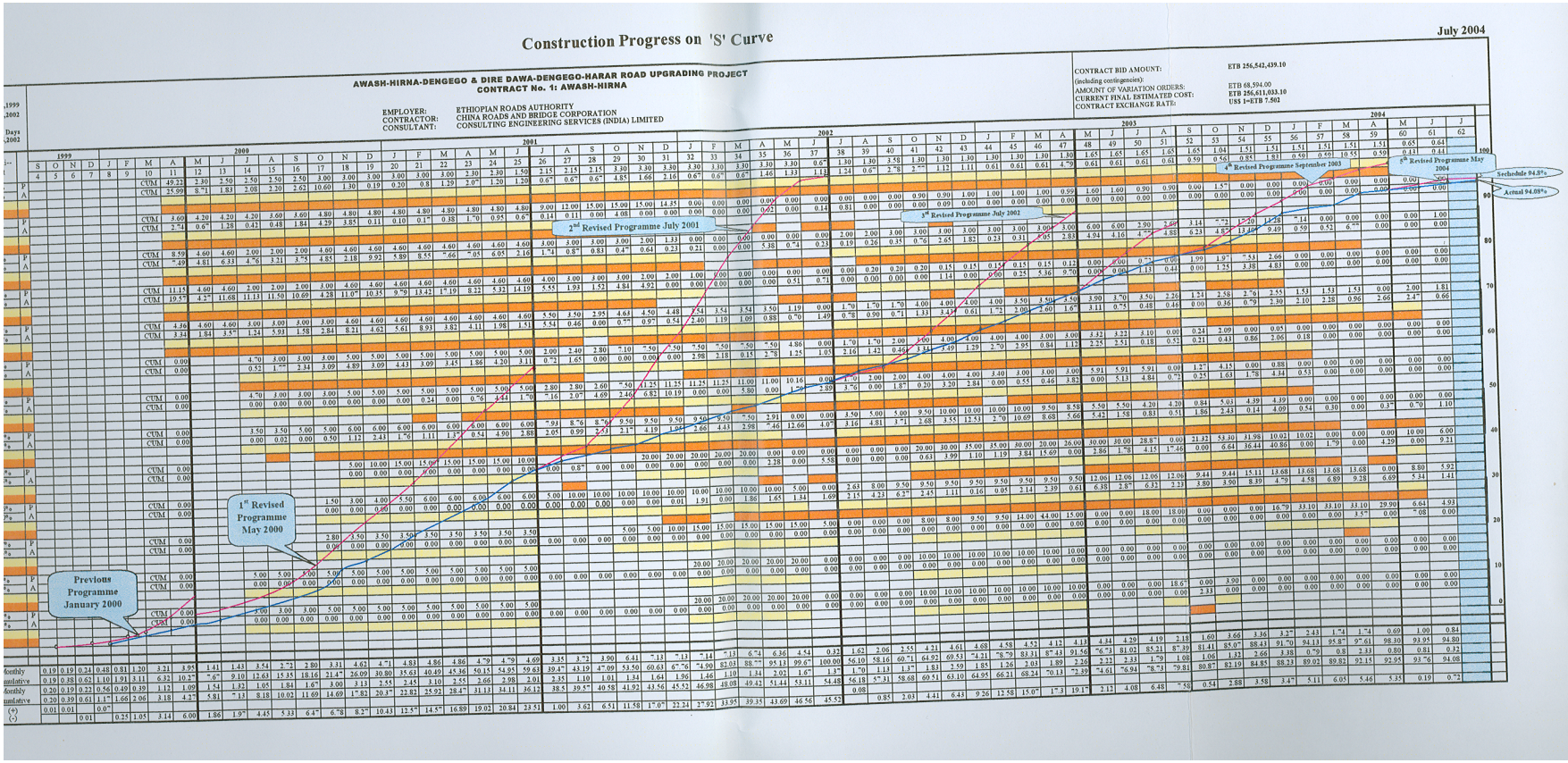
Almgena - Butajira



Project Control: Research Findings

- Shall Ethiopian Road Authority Use S-Curves

Awash - Hirna



Project Control: Research Findings

- Problems and Pitfalls of EVM (Baldwin and Bordoli, 2014):
- Requirements for the system are not clearly identified and documented
- Progress is not monitored against updated schedules
- Progress of the construction work is incorrectly assessed
- Cost analysis is performed with inaccurately allocated cost data
- There is no agreed understanding of what comprises the PV of the work
- Failure to prepare a fully completed WBS integrated with cost estimate and time schedule

Project Control

- Critical Chain Project Management (CCPM)
  - CCPM is based on the concept of a project buffer and argues that managers should manage production by monitoring the buffer time available and allocating resources to critical chain tasks.
  - CCPM was presented by Goldratt, 1997. Since then, CCPM has been used successfully across different industries including the construction industry.
  - Goldratt argued that resource dependencies determine the critical chain as much as activity dependencies.
  - Defines the constraint for multiple projects as the constraining company resource. It links projects through this resource, using buffers to account for activity duration variability.
- Control: buffers as an immediate and direct measurement tool to control the project schedule.

Project Control

Critical Chain Project Management (CCPM)

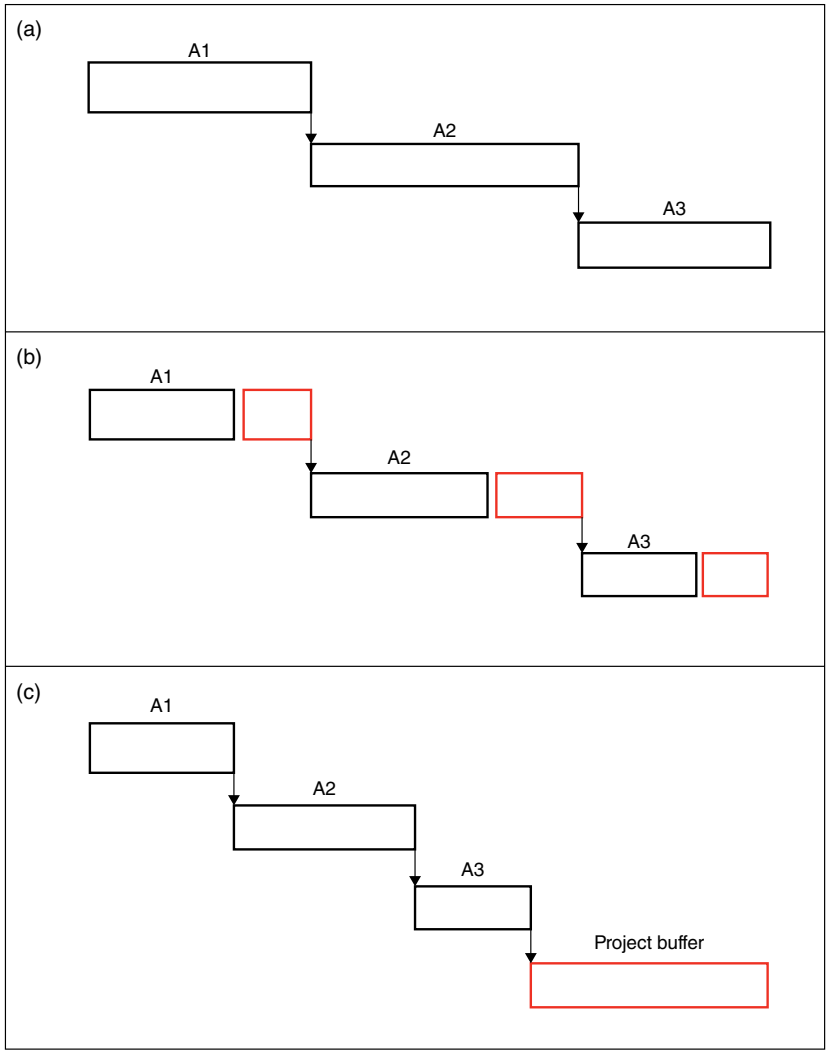


Figure 5.1 The critical chain project buffer. (a) Critical path activities with original duration. (b) Critical path activities with best estimate duration. (c) Revised critical path with the project buffer.

Variance Analysis

- Variance Analysis
- Variance analysis conducted for labour and material
- Variance can result from variation in actual vs. planned: (1) unit cost = cost/price variance (2) quantity consumed = usage variance
- Quantity and cost variance differ depending on order of calculation (net variance is same)
- Can result in owner-contractor and contractor-subcontractor disputes

Variance Analysis

Adapted from:
Construction Cost Analysis and Estimating, Ostwald, 2001, Prentice Hall

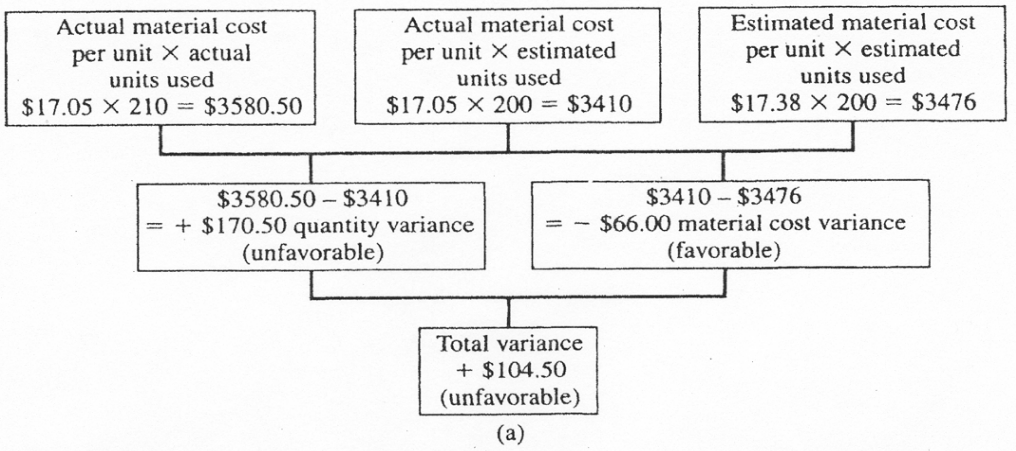


Figure 9.7 Finding material cost variance: (a) quantity first, and (b) unit cost first.

Suggested Method for Variance Analysis

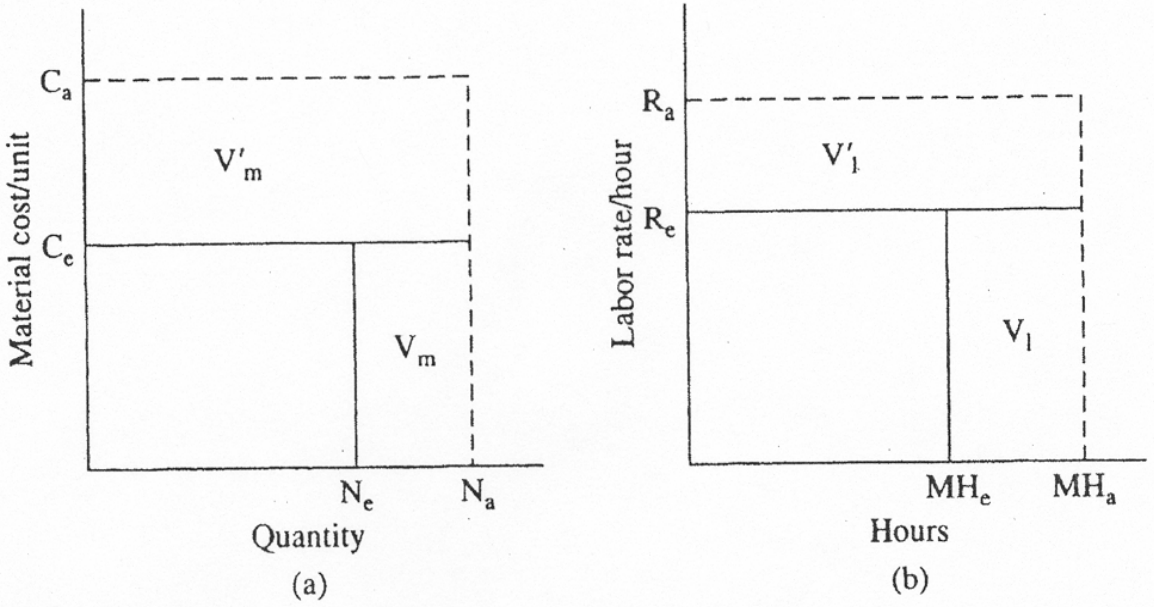


Figure 9.8 (a) Variance for material; and (b) variance for labor.

$$V_m = (N_a - N_e)C_e \tag{9.9}$$

$$V'_m = (C_a - C_e)N_a$$

$$\text{net material variance} = V_m + V'_m$$

where
V_m = variance for material due to quantity change, dollars
V'_m = variance for material due to cost-per-unit change, dollars
N_a = actual quantity, number
N_e = estimated quantity, number
C_e = estimated material dollars per unit
C_a = actual material dollars per unit

	Number of Units	$/Unit	Total
Estimate	200	17.38	$3476.00
Actual	210	17.05	3580.50

Material Variance

V_m = (210-200) units * $17.38/unit = $173.80 overrun

V'_m = ($17.05/unit - $17.38/unit) * 210 units = -$69.30 underrun

$V_{m_{net}} = V_m + V'_m$ = $173.80 - $69.30 = $104.50 overrun

$$V_l = (MH_a - MH_e)R_e \tag{9.10}$$

$$V_l' = (R_a - R_e)MH_a$$

$$\text{net labor variance} = V_l + V_l'$$

where
- V_l = variance for labor due to difference from estimated man hours, dollars
- V_l' = variance for labor due to difference from estimated hourly labor rate, dollars
- MH_a = actual total hours for job
- MH_e = estimated total hours for job
- R_a = actual labor hourly rate, dollars per hour
- R_e = estimated labor hourly rate, dollars per hour

	Wage Rate, $/hr	*Hours*	*Total*
Estimate	$18.67	283	$5,283.61
Actual	17.32	325	5,629.00

Labour Variance

V_l = (325-283) mhrs * $18.67/mhr = $784.14 overrun

V'_l = ($17.32/mhr - $18.67/mhr) * 325 mhrs = -$438.75 underrun

$V_{lnet} = V_l + V'_l$ = $784.14 - $438.75 = $345.39 overrun

Project Control

Factors Influencing Original Plan

- Changes in time or cost objectives for completion
- Changes in operating policies
- Changes in technical specifications
- Changes in construction methods
- Changes in owner's needs
- Revised activity time estimates
- Inaccurate planning of activity relationships
- Failure of suppliers or contractors to deliver on time
- Reassessment of resource requirements and usage
- Unexpected technical difficulties, environmental conditions, market fluctuations

Project Control

Maintain Site Records

- Maintain daily site diary
- Lost time per day due to exceptional rain, cold or heat
- Labour on site
- Issued instructions, drawings
- Material and Equipment on site
- Daywork record

- Daily Report_CBE_HQB21112017 .pdf

Project Control

Key Performance Indicators (KPIs): Used to measure the overall performance on projects

- Client satisfaction
- Defects
- Safety
- Time and cost predictability
- Productivity and Production
- Profitability

Meetings: Part of the Control Process

- Weekly progress meetings
- Monthly site meetings
- Subcontract coordination meetings

Project Control

Monthly Site Meeting Agenda

Personnel attending and apologies for absence	Confirmation of minutes of previous meeting	Matters arising from minutes	Confirmation of matters raised at intermediate site visits
Weather report - record of inclement weather to date	Progress report	Drawings and information requirements	Construction queries - related to materials or design
Design issues - anticipate future requirements	Subcontractor and specialist supplier report	Health and safety report	Variation orders and dayworks
Financial review	Project completion date review	Any other business	Date and time of next meeting

Source: Cooke and Williams (2009)

Project Control

Change Control

- Changes required to: (1) correct errors or omissions (2) changes in scope due to economic or functional reasons
- Project manager must establish formal procedure for control of changes
- Authorization of changes required → becomes a change order
- Risky for contractor to implement changes prior to obtaining written authorization

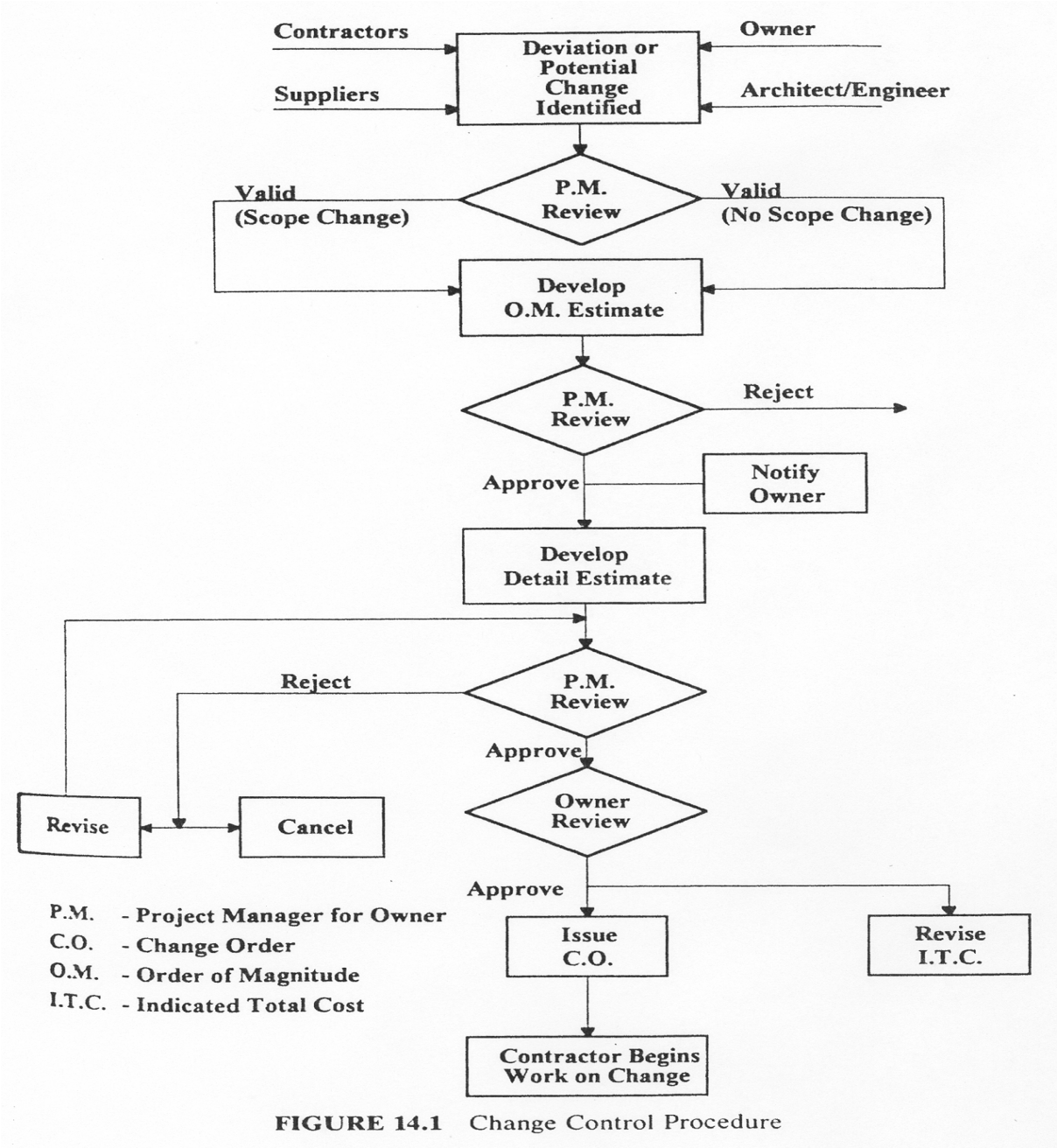


FIGURE 14.1 Change Control Procedure

JONES AND SMITH
PROJECT MANAGERS
GANDER, NFLD.

CONTRACT CHANGE ORDER

Project: *Airport Terminal Building*
For: *Dept. of Transportation*
To: *The Labrador Construction Co., Ltd.*
Churchill, NFLD.

Change Order No. *1*
Date July 27, 19 __

Revised Contract Amount	
Previous contract amount	*5,762,634.00*
Amount of this order ~~(decrease)~~ (increase)	*5,478.00*
Revised Contract Amount	*5,768,112.00*

An ~~(increase)~~ ~~(decrease)~~ (no change) of _____ days in the contract time is hereby authorized.

This order covers the contract modification hereunder described:

Providing and installing 50mm dia. copper pipe as shown and described by Supplemental Drawing GB 25 attached hereto

The work covered by this order shall be performed under the same terms and conditions as included in the original construction contract.

Changes Approved

_____
(Owner)

by _____

_____
(Contractor)

by _____

Jones and Smith, Project Managers

by _____

FIGURE 14.2 Contract Change Order

Updating the Schedule

Why do it?

- To reflect current project status
  - To implement corrective action
  - To revise plan for future activities
  - To develop recovery plan
- To restore its usefulness as a forecasting and communication tool
  - To reflect current status
  - To plan resource requirements
  - To communicate with the client
  - To coordinate subs, materials, procurement
  - For progress payments
- To explain and quantify delays
  - For damages/bonuses
  - For potential claims

Updating the Schedule

How to do it?

- Walk the site – record actual start/finish times, % complete for each activity
- Mark project status on bar chart or network diagram
- Revise activity durations on partially completed activities
- Revise activity logic if necessary
- Recalculate the schedule
- Develop a recovery plan, if necessary

Always keep a baseline copy of the original project plan, schedule, and progress curves.

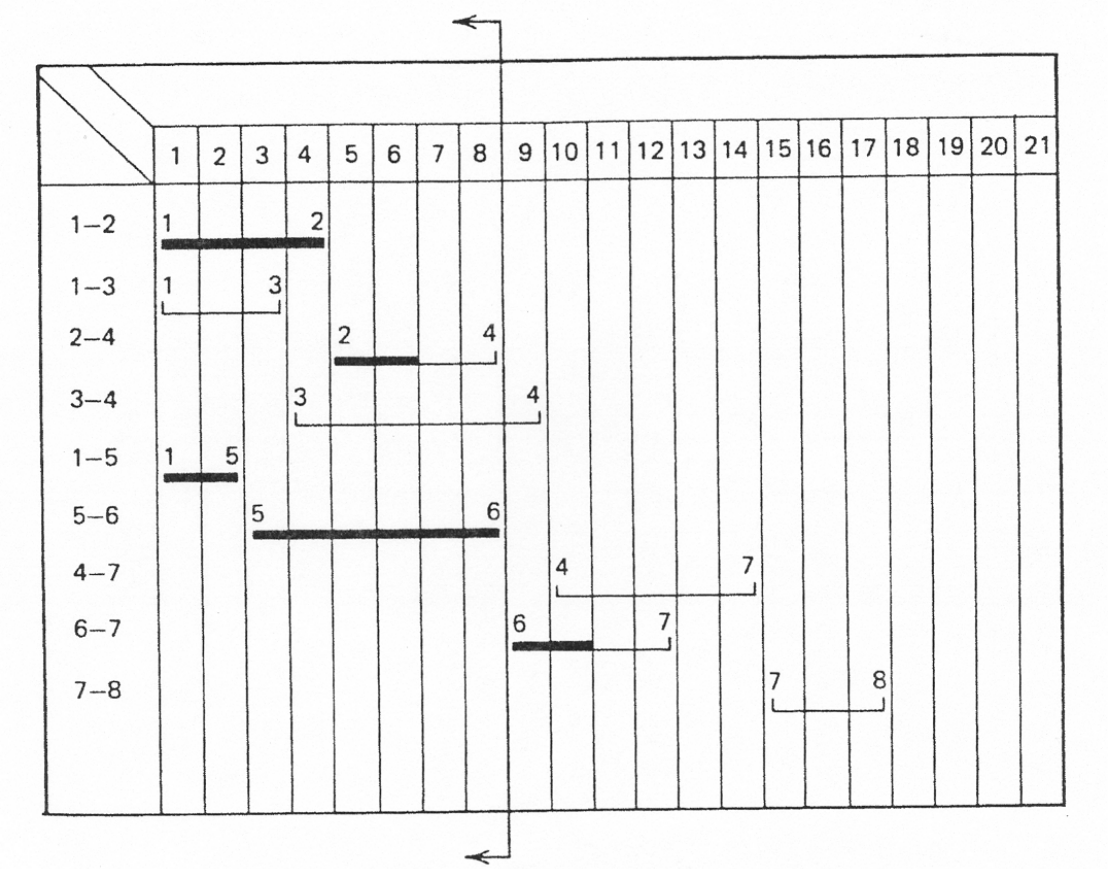
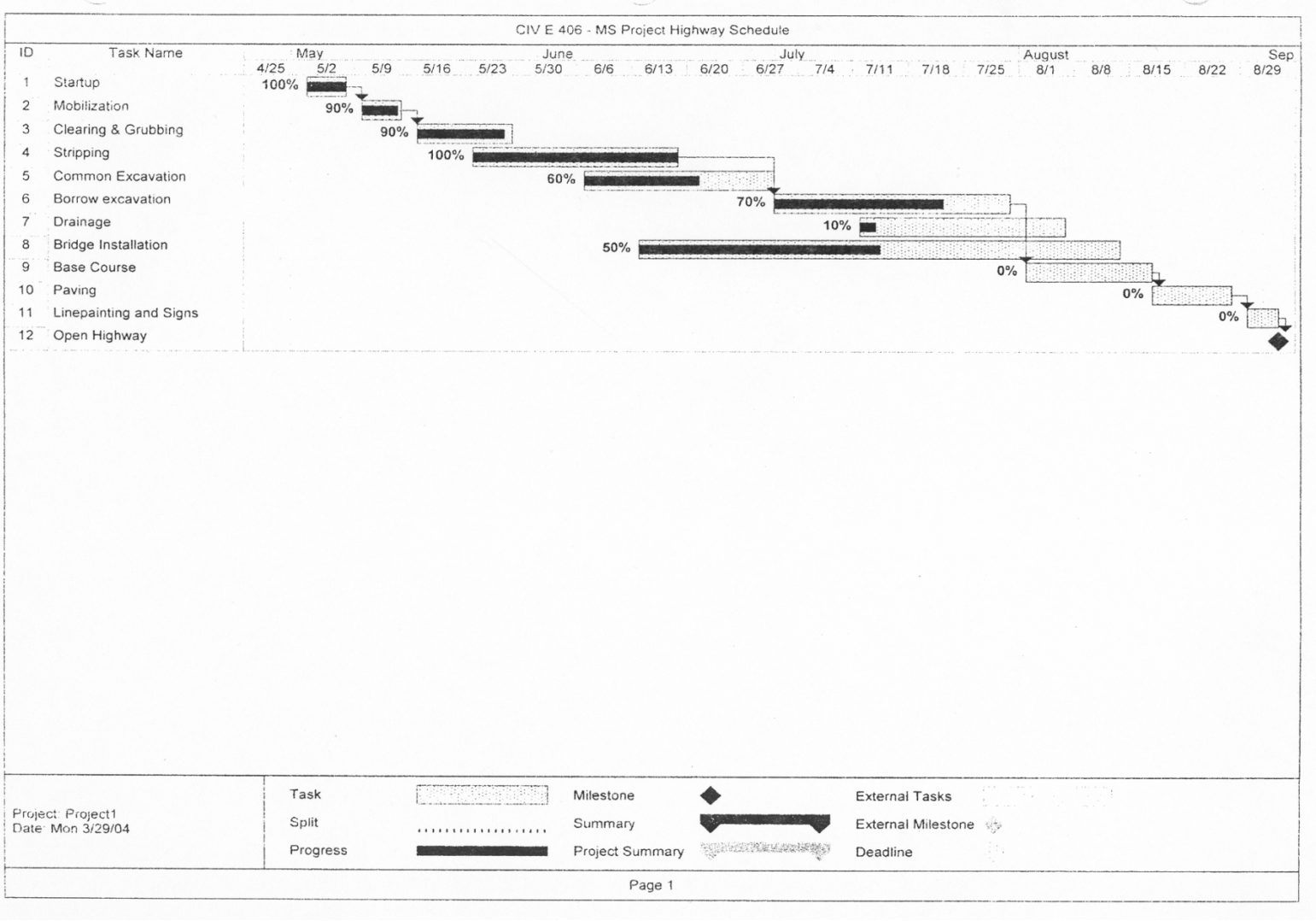


FIGURE 14.3 Bar Chart Displaying Progress


CIV E 406 - MS Project Highway Schedule
ID
Task Name
May
June
July
August
Sep
4/25
5/2
5/9
5/16
5/23
5/30
6/6
6/13
6/20
6/27
7/4
7/11
7/18
7/25
8/1
8/8
8/15
8/22
8/29
1 Startup 100%
2 Mobilization 90%
3 Clearing & Grubbing 90%
4 Stripping 100%
5 Common Excavation 60%
6 Borrow excavation 70%
7 Drainage 10%
8 Bridge Installation 50%
9 Base Course 0%
10 Paving 0%
11 Linepainting and Signs 0%
12 Open Highway
Project: Project1
Date: Mon 3/29/04
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 1

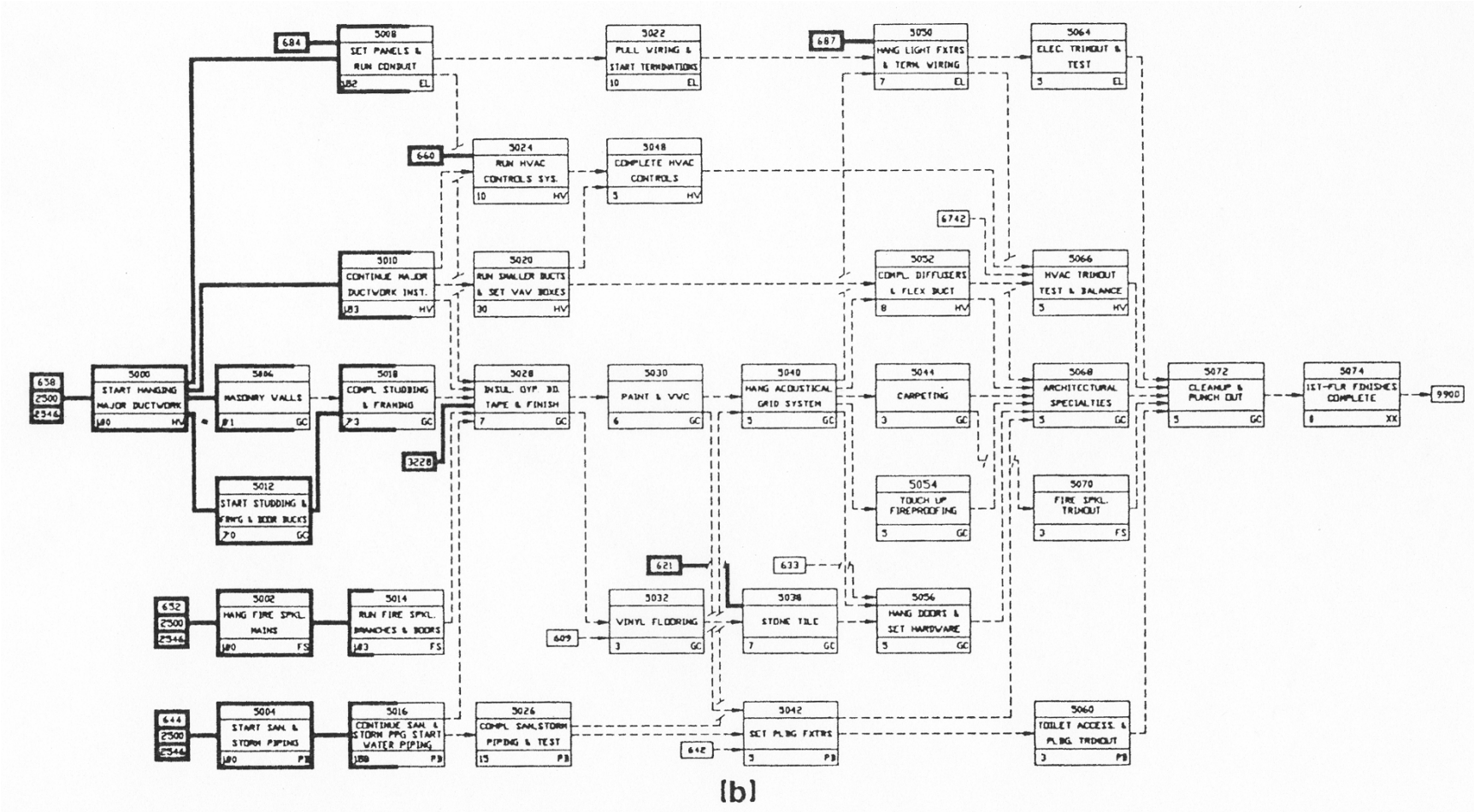
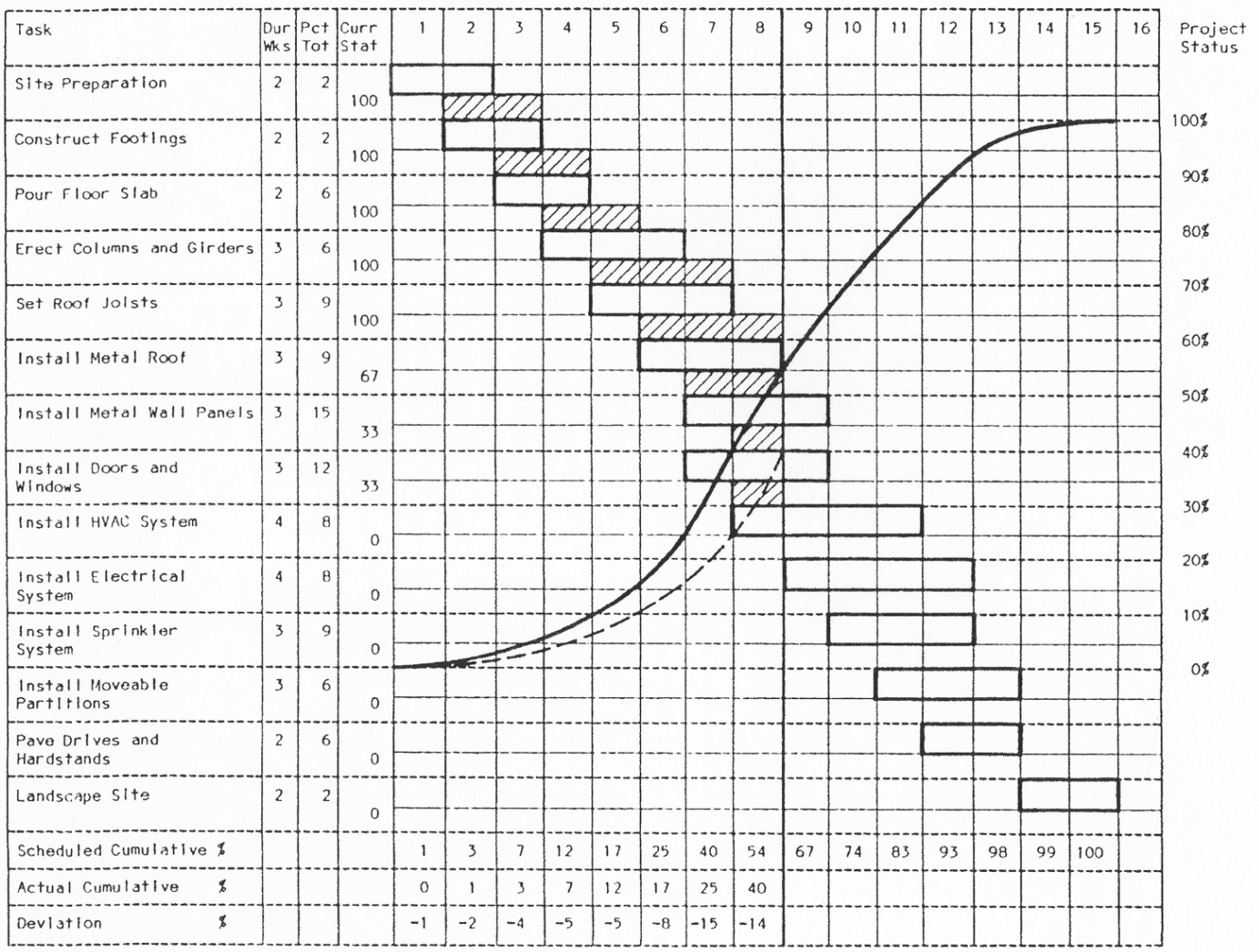


FIGURE 8-4b Updated rough-in and finish subnetwork in procedure format.

FIGURE 12.3
UPDATED BAR CHART FOR WAREHOUSE PROJECT

PROJECT: ACME Warehouse Project Updated As Of: End of 8 th Week



Task	Dur Wks	Pct Tot	Curr Stat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Site Preparation	2	2	100																
Construct Footings	2	2	100																
Pour Floor Slab	2	6	100																
Erect Columns and Girders	3	6	100																
Set Roof Joists	3	9	100																
Install Metal Roof	3	9	67																
Install Metal Wall Panels	3	15	33																
Install Doors and Windows	3	12	33																
Install HVAC System	4	8	0																
Install Electrical System	4	8	0																
Install Sprinkler System	3	9	0																
Install Moveable Partitions	3	6	0																
Pave Drives and Hardstands	2	6	0																
Landscape Site	2	2	0																
Scheduled Cumulative %				1	3	7	12	17	25	40	54	67	74	83	93	98	99	100	
Actual Cumulative %				0	1	3	7	12	17	25	40								
Deviation %				-1	-2	-4	-5	-5	-8	-15	-14								

Project Closeout

Data to Collect at Project Closeout

- "As-built" CPM network from design to construction
- Crew composition, mhrs per unit measure
- Equipment usage per unit measure
- Materials consumed per unit measure
- Overhead expenditure as % total job cost
- Learning curve effects
- Progress at different stages in project
- Special difficulties, problems encountered
- Effective techniques and corrective actions
- Evaluation of consultants', contractors', subcontractors' performance
- Comparison of sub-element cost in design estimates with actual costs at completion
- Actual vs. estimated contingency and profit

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