Project Cost Management

Chapter 7 – Information Technology Project Management

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Roadmap

- Introduction and case study overview
- Principles of cost management
- Estimating costs
- Determining the budget
- Controlling costs
- Software and tools

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- **Introduction and case study overview**
- Principles of cost management
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Case Study

- Modernization of the Fiat 500e
  - Support TCU upgrade
  - Telematics infrastructure

- Cost factors
  - Non-recurring engineering (NRE)
  - Development
  - Integration and testing
  - Post-launch support

- The product
  - http://www.fiatusa.com/en/mobile_apps/fiat-access/

The Problem

- Most projects encounter **overrun**
  - Additional percentage or dollar amount by which actual costs exceed estimates
  - **27%** average overrun for IT projects (Harvard Business Review, 2011)

- Measuring overrun isn't always scientific
  - and neither is management of a project's costs

What Went Wrong

- United States Internal Revenue Service (IRS) is a prime example of how **not** to manage costs

- A series of failures in the 90's cost taxpayers **>$50 billion**

- GAO (2008) reports more than 400 gov't projects suffer from poor planning and underperformance
  - Total cost of those projects: $25 billion

- United Kingdom National Health Service electronic payments system
  - $26 billion overrun over 10 years

Cost

- **Cost** is defined as a "resource sacrificed or foregone to achieve a specific objective" (*Cost Accounting)*
  - Money
  - Time -> Money

- Project managers must understand project cost management in order to effectively control these tangibles
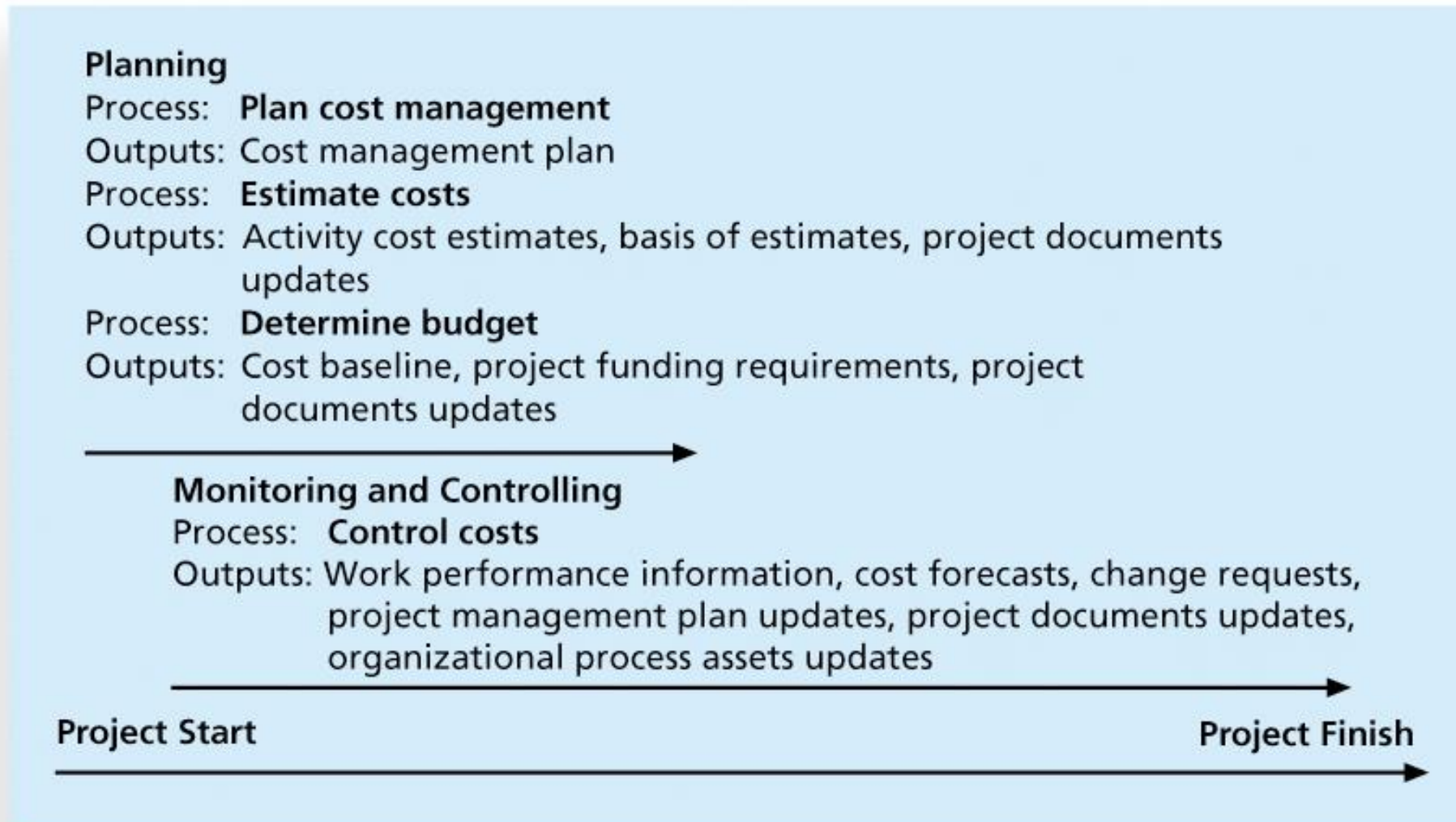
Project Cost Management

- Recall the triple-constraint (right)

- **Project cost management** includes the processes required to ensure that a project team completes a project within an approved budget

- Endgame: satisfy stakeholders

Processes of Cost Management

- **Estimating costs** – developing an approximation/estimate of the costs of the resources needed to complete a project

- **Determining the budget** – allocating the overall cost estimate to individual work items to establish a *baseline* for measuring performance

- **Controlling costs** – controlling changes to the project budget

Figure 7-1: Project Cost Management Summary

Planning
Process: **Plan cost management**
Outputs: Cost management plan
Process: **Estimate costs**
Outputs: Activity cost estimates, basis of estimates, project documents updates
Process: **Determine budget**
Outputs: Cost baseline, project funding requirements, project documents updates

Monitoring and Controlling
Process: **Control costs**
Outputs: Work performance information, cost forecasts, change requests, project management plan updates, project documents updates, organizational process assets updates

Project Start   **Project Finish**

Case Study - Processes

- Cost estimation based on empirical data

- Budget determination based on cost of service, hardware, and labor rate

- Cost controlling based on regular level of effort reporting against baseline

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Profits

- **Profits** are revenues minus expenditures

- **Profit margin** is the ratio of revenues to profits
  - Example: $100 revenue generates $2 profit
    - 2% profit margin
    - Deduction: $98 invested

- Executives primarily concerned with profits

Life Cycle Costing

- **Life cycle costing** allows you to see a big-picture view of the cost of a project throughout its life cycle

- Considerations:
  - Total cost of ownership
  - Development plus support costs

- Project managers must make estimates of the costs and benefits of a project throughout its life cycle

- Life cycle cost should emphasize spending **up front** to reduce defect repair costs after implementation

Cost of Downtime for IT Applications

Type of IT Application	Cost/Minute
Securities trading	$73,000
Enterprise Requirements Planning (ERP)	$14,800
Order processing	$13,300
Electronic commerce	$12,600
Supply chain	$11,500
Point of sale (POS)	$ 4,700
Automatic teller machine (ATM)	$ 3,600
E-mail	$ 1,900

Source: The Standish Group International, "Trends in IT Value," www.standishgroup.com (2008).

Cash Flow Analysis

- **Cash flow analysis** is a method for determining the estimated annual costs and benefits for a project and the resulting annual cash flow.
    - Used to determine NPV (net present value)

- Cannot have too many concurrent projects with high cash flow needs
    - Example: Network Vision
    - Capital expenses

Tangibles vs Intangibles

- **Tangible costs/benefits** are those costs or benefits that an organization can easily measure in dollars
  - Example: it costs $100,000 to perform internal labor on a project versus $75,000 to outsource

- **Intangible costs/benefits** are costs or benefits that are difficult to measure in monetary terms
  - Examples: goodwill, political capital, prestige

Costs

- **Direct costs** are costs that can be directly related to producing the products and services of a project

- **Indirect costs** are costs that are not directly related to the products or services of the project

- **Sunk cost** is money that has been spent in the past

Learning Curve Theory

- **Learning curve theory** states that when many items are produced repetitively, the unit cost of those items decreases in a regular pattern as more units are produces.
- **Factors:**
  - Domain knowledge
  - Relationships
  - Lessons learned

Case Study – Costs and Curve

- **Direct costs:** NRE for modem manufacturing, interface adapter development

- **Indirect costs:** travel to Detroit for testing

- **Sunk costs:** interface for previous generation, T-Mobile integration

- **Learning curve:** already tested and integrated once before

Reserves

- **Reserves** are dollars included in a cost estimate to mitigate cost risk by allowing for future situations that are difficult to predict
- **Contingency reserves** allow for future situations that may be *partially* planned for
  - AKA "known unknowns"
  - Examples: employee vacations, employee turnover
- **Management reserves** allow for future situations that are unpredictable
  - AKA "unknown unknowns"
  - Examples: illness, natural disasters, weather

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Planning Cost Management

- Developing a cost management plan requires the following inputs:
    - Expert judgment
    - Analytical techniques
    - Meetings

- These will drive a **cost estimation** – a variety of techniques for predicting how many resources will be required to complete an activity or collection of activities (project)

Types of Cost Estimates

- **Rough order of magnitude (ROM)** is an estimate of what a project will cost
  - AKA swag, ballpark estimate, or guesstimate
  - Accuracy is typically -50% to +100%, though may be much wider
  - Some IT professionals automatically **double** estimates for software development

Types of Cost Estimates (cont)

- A **budgetary estimate** is used to allocate money into an organizations budget
  - Many organizations develop budgets at least two years into the future
  - More accurate than ROM -10% to +25%

- A **definitive estimate** provides an "accurate" estimate of project costs
  - Made closer to project completion
  - Accuracy -5% to +10%
  - Based on hard facts, such as cost of hardware

Table 7-2: Types of Cost Estimates

TYPE OF ESTIMATE	WHEN DONE	WHY DONE	HOW ACCURATE
Rough Order of Magnitude (ROM)	Very early in the project life cycle, often 3–5 years before project completion	Provides estimate of cost for selection decisions	−50% to +100%
Budgetary	Early, 1–2 years out	Puts dollars in the budget plans	−10% to +25%
Definitive	Later in the project, less than 1 year out	Provides details for purchases, estimates actual costs	−5% to +10%

Case Study – Cost Estimates

- At project inception, provided a ROM estimate for project costs for all impacted systems
  - Level of effort

- Later, provided definitive cost based on level of effort plus
  - Tools
  - Travel

Cost Management Plan

- A **cost management plan** is a document that describes how the organization will manage cost variances on the project
  - Based on estimation, but acted on through monitoring and controlling

- Labor costs are a large percentage of total project cost (time = money)
  - Note that labor cost per resource (run rate) is often much higher for contractors than full time employees
  - Example: $45/hr FTE, $75/hr contract

Sample Headcount (Table 7-3)

Department	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Information systems	24	31	35	13	13	116
Marketing systems	3	3	3	3	3	15
Reservations	12	29	33	9	7	90
Contractors	2	3	1	0	0	6
Totals	41	66	72	25	23	227

Maximum departmental headcounts by year for ResNet (Northwest Airlines)

Cost Estimation Tools & Techniques

- Developing a cost estimate is difficult, but can be made easier with tools and processes
- Will discuss:
  - Analagous cost estimating
  - Bottom-up estimating
  - Parametric modeling
  - Cost of quality
  - Software
  - Vendor bid analysis
  - Reserve analysis

Estimation Techniques

- **Analogous estimates** use the actual cost of a previous, similar project as the basis for estimating the cost of the current project
  - AKA **top-down estimate**
  - Less costly than other techniques, but may be less accurate

- **Bottom-up estimates** involve estimating individual work items (activities) and summing to the project total
  - Preferred if there is a detailed WBS available

Estimation Techniques (cont)

- **Parametric modeling** uses project characteristics (parameters) in a mathematical model to estimate project costs
  - Example: cost per line of code based on difficulty, talent, and size
  - Most reliable when model has empirical input for parameters
  - Downside: can be more inaccurate than other models if executed incorrectly (lack of experience)

- **COCOMO II** is a well-known example of a parametric model for development costs
  - **http://csse.usc.edu/tools/COCOMOII.php**

Case Study – Estimation Techniques

- **Question:** what type of modeling would be most effective for the 500e project? What was actually used?

- **Answer:** bottom-up estimation was used, and was probably the best choice

Estimation Challenges

- Estimates are often done too quickly

- Many people asked to do estimation lack experience

- Human beings are biased towards underestimation -> overrun

- Most challenging to balance, management wants accuracy

Sample Cost Estimate

- Task: create a cost estimate to upgrade the telematics unit in the next generation of Fiat 500e electric vehicles

- Overview:
  - Upgrade modem from 2G T-Mobile to 4G LTE Sprint
  - Change interface from legacy NGTP to lightweight messaging
  - All changes must be fully qualified before VP-A build date

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Sample Cost Estimate Assumptions

- Work breakdown structure (WBS) exists
- Testing is 10% of development costs
- Risk and overhead is 10% of development costs
  - Reserves, project management, architecture
- An inventory of required tools will be generated and quoted
- Three weeks of on-site work in Detroit will be required

Sample Cost Estimate (cont)

- **Development costs**
  - WBS contains four development activities:
    - **TCU client re-write**
      - 3 contract resources for 3 weeks
    - **Adapt provisioning portal to support new embedded SIM provider**
      - 1 full time resource for 1 week
    - Write service adapter for current production units (sunsetting existing dispatcher)
      - 5 contract resources for 8 weeks
    - **Add components to rights management for new model support**
      - 1 contract resource for 1 week
  - Contract run rate is $75/hr
  - Full time run rate is $45/hr

Sample Cost Estimate (cont)

- Tool support:
  - Develop new simulations for new vehicle (testing)
    - Outsourced for $15,000
  - Vehicle diagnostic tool for logging vehicle messages
    - Licensing cost of $10,000
  - Benchtop fabrication (for testing TCU client prior to vehicle integration)
    - Outsourced for $7,000
- Travel costs:
  - 3 round trips flights to Detroit and 15 hotel nights
    - $5,000

WBS Items	#Units/hrs	Cost per	Subtotals	Level 2 Totals	% of Total
1. Development				$151,800	61%
TCU Client	360	$75	$27,000		
Provisioning	40	$45	$1,800		
Legacy adapter	1600	$75	$120,000		
Rights management	40	$75	$3,000		
2. Tools				$32,000	13%
Simulation	1	$15,000	$15,000		
Diagnostic tool	1	$10,000	$10,000		
Benchtop	1	$7,000	$7,000		
3. Travel				$5,475	2%
Flights (roundtrip)	3	$800	$2,400		
Hotel nights	15	$130	$1,950		
Per diem	15	$75	$1,125		
4. Testing				$18,928	8%
10% of development	N/A	N/A	$18,928		
5. Project management				$18,928	8%
10% of development	N/A	N/A	$18,928		
6. Reserves				$22,713	9%
10% of other estimates	N/A	N/A	$22,713		
TOTAL COST ESTIMATE				$249,843	

What could be improved?

- Estimation assumed 40 hours work weeks for contract labor

- Break out design and architecture from project management

- No hard datapoints based on previous experience
  - Dependent on learning curve

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Project Budget Overview

- Determining the project budget involves allocating the project cost estimate to individual work items over time (WBS)

- Budgeting generally includes:
  - Headcount (FTE + Contract)
  - Supplier costs
  - Travel
  - Deprecation
  - Rent/leases

Cost Baseline

- A **cost baseline** is a time-phased budget that project managers use to measure and monitor cost performance

- Use cost estimates for major activities to create

- Cost budgeting may result in updates to the cost management plan (monitor and controlling)

WBS Items	1	2	3	4	5	6	7	8	9	10	11	12	Totals
1. Development													**$151,800**
TCU Client	$3,462.50	$6,925	$3,462.50	$3,463	$3,463	$3,463	$3,463	$3,463	$3,463	$3,463	$3,463	$3,463	$27,700
Provisioning	$1,800												$1,800
Legacy adapter	$15,000	$30,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$120,000
Rights management		$3,000											$3,000
2. Tools													**$32,000**
Simulation	$15,000												$15,000
Diagnostic tool	$10,000												$10,000
Benchtop	$7,000												$7,000
3. Travel													**$5,475**
Flights (roundtrip)							$2,400						$2,400
Hotel nights							$1,950						$1,950
Per diem							$1,125						$1,125
4. Testing													**$18,928**
10% of development							$4,732	$9,464	$4,732				$18,928
5. Project management													**$18,928**
10% of development	$1,577	$1,577	$1,577	$1,577	$1,577	$1,577	$1,577	$1,577	$1,577	$1,577	$1,577	$1,577	$18,928
6. Reserves													**$22,713**
10% of other estimates	$1,893	$1,893	$1,893	$1,893	$1,893	$1,893	$1,893	$1,893	$1,893	$1,893	$1,893	$1,893	$22,713
													$249,844

Sample Baseline

Surveyor Pro Project Cost Baseline Created October 10*

WBS Items	1	2	3	4	5	6	7	8	9	10	11	12	Totals
1. Project Management													
1.1 Project manager	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	96,000
1.2 Project team members	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
1.3 Contractors		6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	66,300
2. Hardware													
2.1 Handheld devices				30,000	30,000								60,000
2.2 Servers				8,000	8,000								16,000
3. Software													
3.1 Licensed software				10,000	10,000								20,000
3.2 Software development		60,000	60,000	80,000	127,000	127,000	90,000	50,000					594,000
4. Testing			6,000	8,000	12,000	15,000	15,000	13,000					69,000
5. Training and Support													
5.1 Trainee cost									50,000				50,000
5.2 Travel cost									8,400				8,400
5.3 Project team members							24,000	24,000	24,000	24,000	24,000	24,000	144,000
6. Reserves				10,000	10,000	30,000	30,000	60,000	40,000	40,000	30,000	3,540	253,540
Totals	20,000	86,027	92,027	172,027	223,027	198,027	185,027	173,027	148,427	90,027	80,027	53,567	1,521,240

*See the lecture slides for this chapter on the companion Web site for a larger view of this and other figures in this chapter. Numbers are rounded, so some totals appear to be off.

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Project Cost Controlling

- Controlling project costs includes monitoring cost performance, cost impact of changes, and stakeholder communication.

- Outputs include:
  - Work performance measurements
  - Budget forecasts
  - Organizational process asset updates
  - Change requests
  - Project management plan updates
  - Product document updates

Earned Value Management

- **Earned value management (EVM)** is a project performance measurement technique that integrates scope, time, and cost data
  - In short: actuals vs forecast
  - Uses baselines as input

- A **baseline** is the original project plan plus approved changes

Key EVM Components

- **Planned value (PV)** is the portion of approved total cost estimate planned to be spent on an activity during a given period
  - AKA budget
- **Actual cost (AC)** is the total direct and indirect costs incurred in accomplishing work on an activity during a given period
  - AKA actuals
- **Earned value (EV)** is an estimate of the value of the physical work actually completed
  - Essentially a monetary representation of all work complete to date
  - **Ratio of performance (RP)** is the ratio of actual work completed to the percentage of work planned

EVM Components (cont)

- **Cost variance (CV)** is the earned value minus the actual cost
- **Schedule variance (SV)** is the earned value minus the planned value
- **Cost performance index (CPI)** is the ratio of earned value to actual cost
  - Used to estimate the projected cost of completing the project
- **Schedule performance index (SPI)** is the ratio of earned value to planned value
  - Used to estimate the projected time to complete the project
- **Estimate at completion (EAC)** is an estimate of what it will cost to complete the project based on performance to date
 - Can be done for schedule as well

Table 7-5: Earned Value Formulas

Term	Formula
Earned value (EV)	$EV = PV \text{ to date} * RP$
Cost variance (CV)	$CV = EV - AC$
Schedule variance (SV)	$SV = EV - PV$
Cost performance index (CPI)	$CPI = EV/AC$
Schedule performance index (SPI)	$SPI = EV/PV$
Estimate at completion (EAC)	$EAC = BAC/CPI$
Estimated time to complete	Original time estimate/SPI

Table 7-4: Earned Value Calculations

Activity	Week 1
Earned Value (EV)	5,000
Planned Value (PV)	10,000
Actual Cost (AC)	15,000
Cost Variance (CV)	−10,000
Schedule Variance (SV)	−5,000
Cost Performance Index (CPI)	33%
Schedule Performance Index (SPI)	50%

Figure 7-5: Earned Value Chart (Five Months)
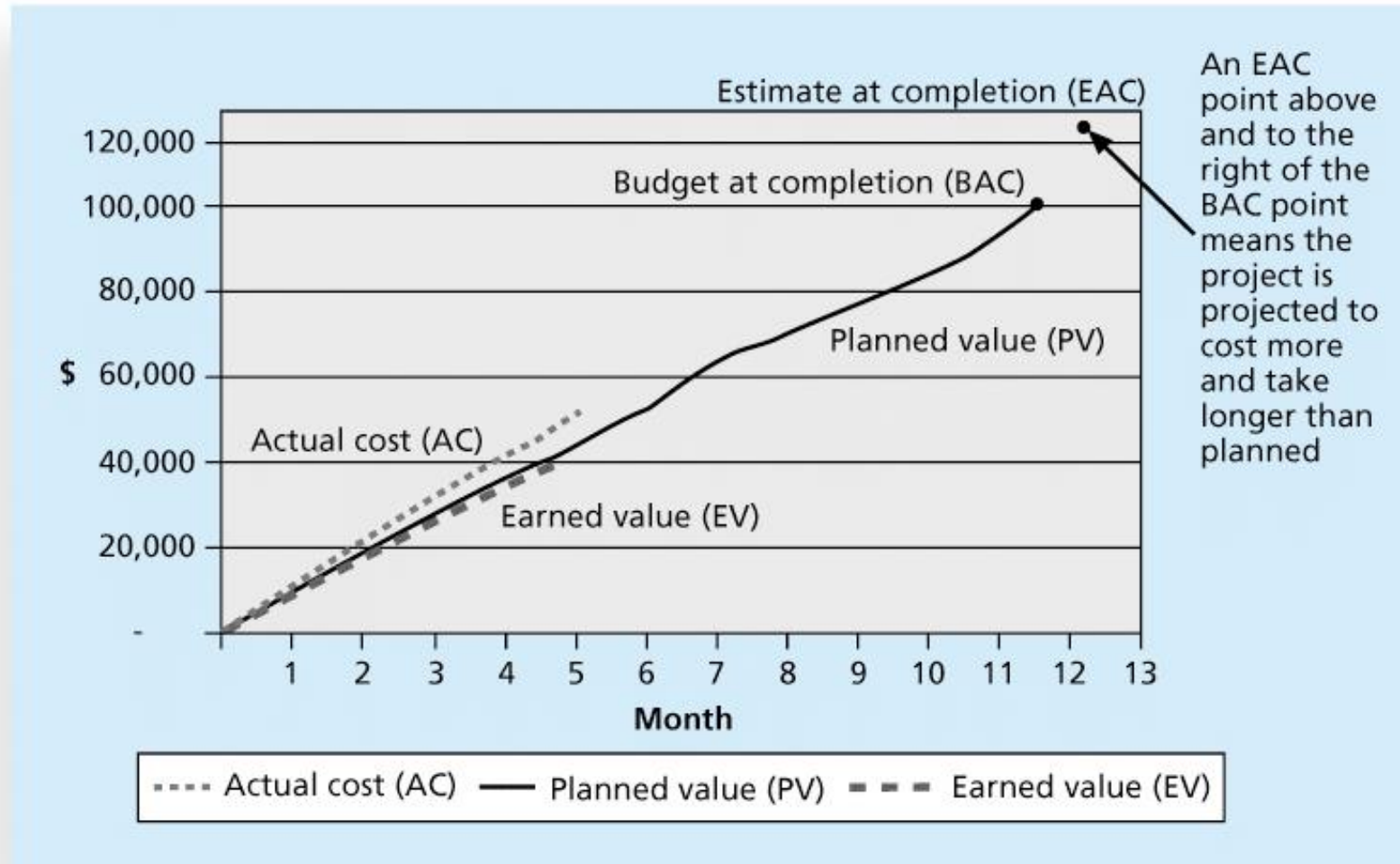
Global Issues

- EVM is used worldwide, and it is particularly popular in the Middle East, South Asia, Canada, and Europe

- Most countries require EVM for large defense or government projects

- EVM is also used in such private-industry sectors as IT, construction, energy, and manufacturing.

- However, most private companies have not yet applied EVM to their projects because management does not require it, feeling it is too complex and not cost effective

Project Portfolio Management

- Utilizing a portfolio for related projects enhances cost management by providing historical data
- The five levels of portfolio management:
  - Put all your projects in one database
  - Prioritize the projects in the database
  - Divide projects into two or three budgets based on type of investment
  - Automate the repository
  - Apply modern portfolio theory including risk-return tools that map project risk on a curve

Case Study – Portfolio Management

- The Fiat 500e upgrade project is actually a relatively small project in connected vehicle portfolio

- Other major projects:
  - Infotainment variant support
  - Remote diagnostics
  - Model support (Chrysler, Dodge, Jeep, RAM, SRT, Fiat)
  - Platform modernization

- Draw from all to enhance cost estimation accuracy

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Cost Controlling Software

- Microsoft Project 2007
  - Assign cost to resources
  - Track actuals to forecast (EVM)

- Spreadsheets

- Using software empirically has benefits (2008 Gantry Group study)
  - Improved project timeliness by 45.2%
  - Reduced time spent on status reporting by 43%
  - Reduced time spent on labor capitalization reporting by 55% (3.6 hrs/report)
  - Decreased time to sign-off for new projects by 20.4% (8 days)

PRESTO

ID	Code	Description	Impact	Done	SOX	Chargeable	LOE (Hr)	Hardware($)	Software($)	Other/Vendor($)
657831	0LB	CVP CARE AGENT TOOL (CAT)	S - Support	Y	N	Y	100			
658506	1OT	CVP-MDP - Master Database	S - Support	Y	N	Y	0			
657062	21L	RISE - Reporting Integrated Subscriber Engine	C - Code	Y	Y	Y	350			
654392	4KV	CVP Master Transaction Server	C - Code	Y	N	Y	1,300			
731729	4UC	CVP Connected Vehicle Head Unit Apps	S - Support	Y	N	Y	100			
657817	6RL	SAIL - Integrated Service Level Activity Engine	N - None	Y	N	Y	0			
657064	76S	Datapower Enterprise Service Bus	S - Support	Y	N	Y	141			
657065	81N	Integrated Wireless Billed Revenue Reporting	C - Code	Y	N	Y	300			
657059	9AN	Tax Reporting	C - Code	Y	N	Y	180			
657061	9MN	Traffic Management System (TMS)	C - Code	Y	Y	Y	100			
657820	E6P	MAP (Multi-dimensional Analysis of Performance)	T - Test	Y	N	Y	150			
657795	H6P	PeopleSoft Billing	T - Test	Y	Y	Y	40			
657063	IDS	IMPACT - Interactive Map Pricing Activation and Coverage Tool	S - Support	Y	N	Y	30			
654393	LME	CVP DW REPORTING	C - Code	Y	N	Y	750			
657818	LPS	Customer Churn Management Data Warehouse	N - None	Y	N	Y	0			

Chapter Summary

- Project cost management is a traditionally weak area of IT projects, and project managers must work to improve their ability to deliver projects within approved budgets

- Main processes include
  - Plan cost management
  - Estimate costs
  - Determine the budget
  - Control costs