Software Engineering Project Management (SEPM): ISYS1106/1108

Lecture 04
(26.03.2015)
Project Scheduling-II;
Monitoring and Control

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Assignment 1 Feedback week

- The feedback consultations are on this week
- You were sent an email; an announcement has been made in Blackboard
- Are you attending these sessions?
- They are an excellent forum to bring doubts/queries
- Why not get feedback on your work?

Hour 1

PERT/CPM

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PERT and CPM Networks

- PERT and CPM developed independently in 1950's
- Program Evaluation and Review Technique (PERT)
  - U.S. Navy, Booz-Allen Hamilton, and Lockheed Aircraft
  - Probabilistic activity durations
- Critical Path Method (CPM)
  - Dupont De Nemours Inc.
  - Deterministic activity durations

The Language of PERT/CPM

- Activity
  - A task or set of tasks
  - Uses resources and time
- Event
  - An identifiable state resulting from completion of one or more activities
  - Consumes no resources or time
  - Predecessor activities must be completed
- Milestones
  - Identifiable and noteworthy events that mark significant progress

The Language of PERT/CPM Continued

- Network
  - A diagram of nodes (activities or events) and arrows (directional arcs) that illustrate the technological relationships of activities
- Path
  - A series of connected activities between two events
- Critical path
  - The set of activities on a path that, if delayed, will delay the completion date of the project
- Critical Time
  - The time required to complete all activities on the critical path

Building the Network

- There are two ways of displaying a project network
  1. Activities on arrows (AOA) network
     - The activities are shown as arrows and events as nodes
     - Generally more difficult to draw but depicts the technical relationships of the activities well
  2. Activities on nodes (AON) network
     - Each task is shown as a node and the technological relationship is shown by the arrows
- AON network usually associated with CPM
- AOA network usually associated with PERT

Sample AON Network

Task	Predecessor
A	—
B	—
C	a
D	b
E	b
F	c, d
G	e

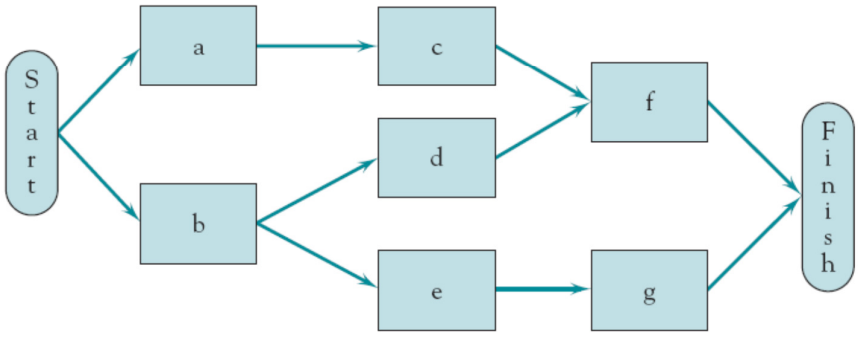


Table 5-1

Figure 5-3

Sample AOA Network

Task	Predecessor
A	—
B	—
C	a
D	b
E	b
F	c, d
G	e

Table 5-1

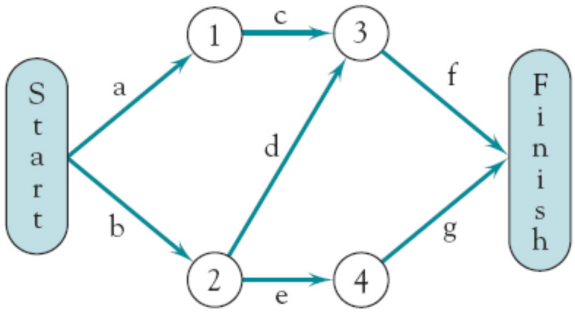


Figure 5-6 (a)

Which to Use?

- Mostly AON used throughout this textbook
- AON used by most of the popular software
- AON networks are easier to draw by hand
  - Large (20+ activities) AOA networks are difficult to draw
- Software to draw AOA networks is expensive

Finding the Critical Path and Critical Time

- ES: Earliest start time
- EF: Earliest finish time
- LS: Latest start time
- LF: Latest finish time
- Displayed on node as shown
- ES + completion = EF
- LS + completion = LF

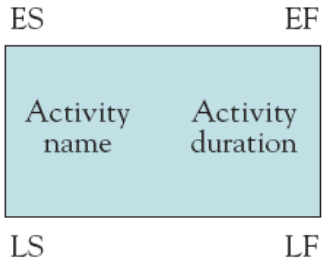


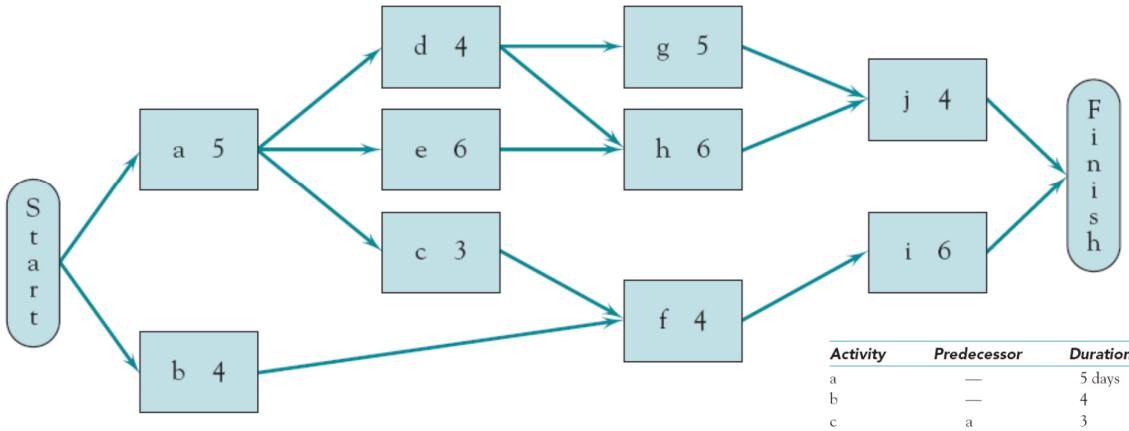
Figure 5-9

A Sample Problem for Finding the Critical Path and Critical Time

Activity	Predecessor	Duration
a	—	5 days
b	—	4
c	a	3
d	a	4
e	a	6
f	b, c	4
g	d	5
h	d, e	6
i	f	6
j	g, h	4

Table 5-2

The Complete Network



Activity	Predecessor	Duration
a	—	5 days
b	—	4
c	a	3
d	a	4
e	a	6
f	b, c	4
g	d	5
h	d, e	6
i	f	6
j	g, h	4

Table 5-2 and Figure 5-8

The Critical Path and Completion Time for Sample Project

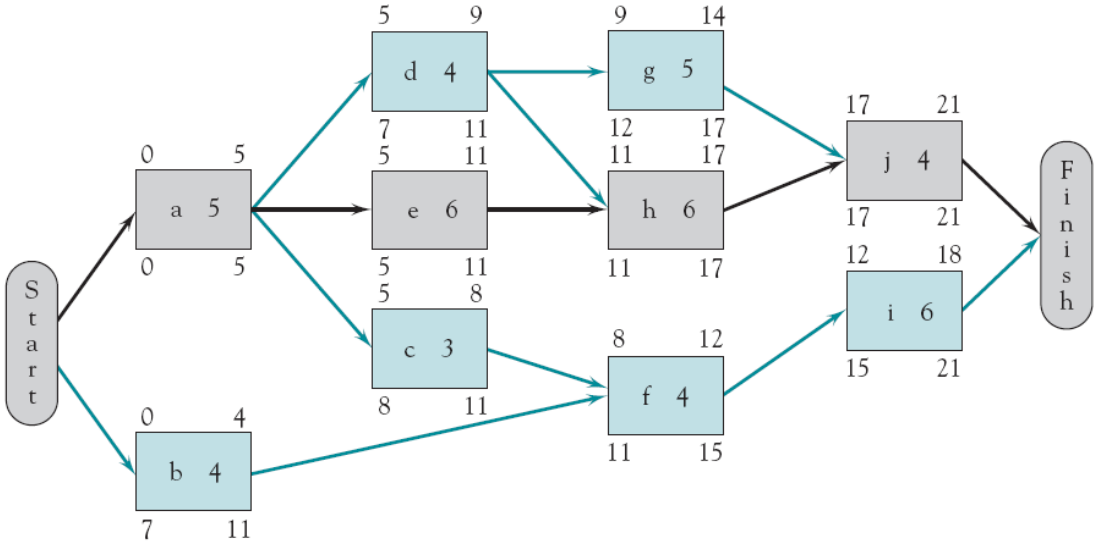
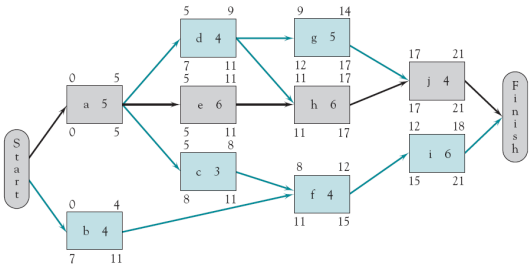


Figure 5-10

Notes on Sample Project

- All activities, and thus all paths, must be completed to finish the project
- The shortest time for completion of the network is equal to the *longest* path through the network
  - In this case a-e-h-j
- If any activity on this path is even slightly delayed, the project will be delayed



Calculating Activity Slack

- ES: Earliest start time
- EF: Earliest finish time
- LS: Latest start time
- LF: Latest finish time
- Slack = LS – ES
- Slack = LF – EF
- Either method of calculating slack gives the same results

Managerial Implications

- The primary attention of the project manager must be to activities on the critical path
- If anything delays one of these activities, the project will be late
- Projects are easier to manage when there is *project slack*

Going back to resources

- Projects compete with each other for resources
  1. If resource is used but not consumed, which project must wait to use resource
  2. If resource is consumed during use, may not be available for other projects or other projects must wait for replacement
- In either case, one project must wait
  - One project is delayed
- Likewise, different activities on the same project may compete for resources
- Trade-offs must be made

Project Management Lifecycle and Software Development Lifecycle (SDLC)

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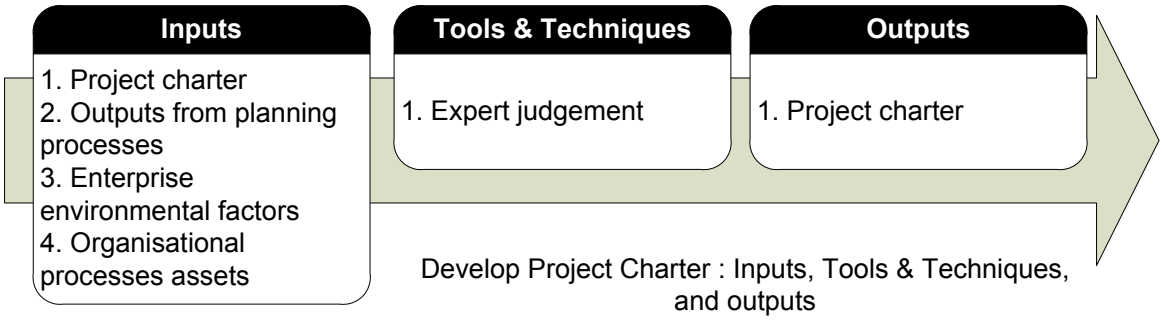
Project Management Lifecycle

- **As covered during lecture 1, PMBOK suggests the following *five* phases in Project Management lifecycle:**
  1. Initiate – *we have already talked about this during lecture 2, also see slide 21*
  2. Plan – *we have already talked about this during lecture 2, also see slide 22*
  3. Executing – we also talked about it briefly in lecture 2. in fact in an information technology (IT) project, this would include the development of the software code.
  4. Controlling – we will talk about this today
  5. Closing- we will talk about this at the end of the course

1- Project Initiation

- PM process are described in terms of Inputs, Tools & Techniques, and Outputs
- Inputs: documents, plans, designs
- Tools & Techniques: mechanisms applied to inputs
- Outputs: documents, products, services



Develop Project Charter : Inputs, Tools & Techniques, and outputs

2- Project Planning

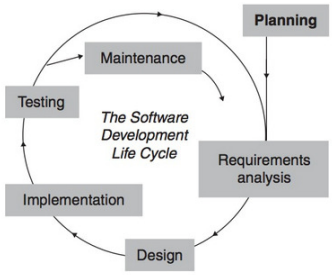
Outputs:

1. **Project Management Plan – integrates and consolidates all subsidiary management plans and baselines from the planning process, including but not limited to:**
   - **Lifecycle selected for the project and processes to be applied**
   - **Results of tailoring by the PM team of PM processes selected, level of implementation of each process, description of tools and techniques, and how selected processes will be used to manage the project**
   - **How work will be executed to accomplish the project objectives**
   - **A change management plan to document, monitor and control changes**
   - **Note project baselines includes but not limited to Schedule baseline, Cost performance baseline and Scope baseline**
   - **Subsidiary plans include a Requirements Management Plan and a Process improvement plan in addition to management plans for each one of the remaining knowledge areas**

3- Project Execution

SDLC

This is only a part of the project management lifecycle (although a very big and substantial part)



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Requirements engineering

- How to get the requirements from the client
  - Gathering requirements can be very difficult
    - The client may not have a clear idea of what they want
    - The problem may be very large and take a long time to fully understand
    - The requirements may be rapidly changing.
    - The client may not be fully committed to the project and will not spend the time with you that you need.
    - They may not understand what you need to complete the task.
    - They may have unreal expectations of what can be achieved.

Requirements Engineering

- Requirements engineering involves:
  - Requirements elicitation
  - Requirements analysis and negotiation
  - Requirements specification/documentation
  - Requirements validation

Analysis

- Eliciting (vs. gathering) information - what the customer needs (vs. wants)
- understanding the customer's business context and constraints
- functions the product must perform
- performance levels
- external systems it must be compatible with
- Techniques used : customer interviews, use cases, and "shopping lists" of software features
- OUTPUT - formal requirements specification

Design

- defining the hardware and software architecture
- satisfy specified requirements
- specifying performance and security parameters (NFRs)
- strategies to deal with issues such as exception handling, resource management and interface connectivity
- navigation and accessibility
- OUTPUT - one or more design specifications

Implementation

- constructing the product as per the design
- built according to a pre-defined coding standard and debugged
- tested and integrated
- satisfy the system architecture requirements
- OUTPUT - one or more working product components

Testing

- individual components and the integrated whole are methodically verified
- fully meet the requirements
- Three types of testing:

  unit testing
  system / integration testing

  performance / load / stress testing
  acceptance testing

  post implementation testing (data migrations)

OUTPUT – Defects – logged

known defects communicated (guide)

Installation / Maintenance

- installation and use at the customer site
- delivery may take place via the Internet or physical media
- formal revision numbers – version control

- Maintenance: modifications to the system
- due to change requests initiated by the customer
- defects uncovered during live use of the system
- OUTPUT - "maintenance release"

Requirements Engineering SDLC

- Requirements Engineering is a systematic approach to requirements analysis.
- Requirements analysis typically includes:
  - Eliciting requirements: communicating with client and users to determine what is required of the system to be developed.
  - Analysing requirements: resolving issues related to unclear, incomplete, ambiguous or contradictory requirements.
  - Documenting requirements: eg. English documents, use cases, user stories or process specifications.

Hour 2

4- Project Monitoring and Controlling

Monitoring and Controlling in a project

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Monitoring and Control

- Monitoring is the collection, recording, and reporting of project information
- Control uses the monitored data to bring actual performance into agreement with the plan
- Monitoring and control are the opposite sides of project selection and planning
  - Project selection dictates what to monitor
  - Project planning identifies the elements to be controlled

Plan-Monitor-Control Cycle

- The plan–monitor-control cycle constitutes a "closed loop" process
  - Continues until the project is completed
- With complex projects, there is a temptation to minimize the planning–monitoring–controlling effort so that "real work" can be done
  - It is these projects that need the planning–monitoring–controlling process the most

Project Authorization and Expenditure Control System Information Flow

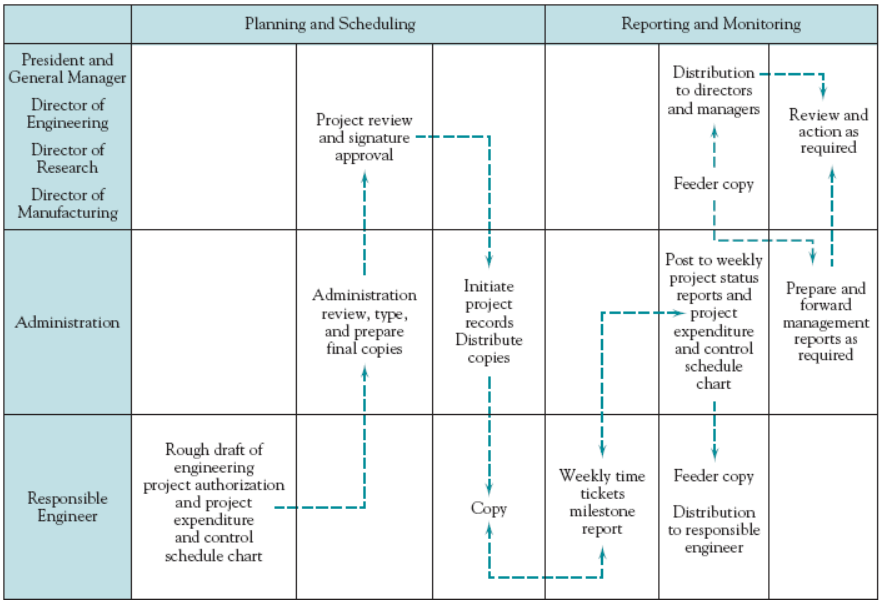


Figure 7-1

Designing the Monitoring System 246

- Identify special characteristics of scope, cost, and time that need to be controlled
  - Specific performance characteristics should be set for each level of detail in the project
- Real-time data must be identified to measure achievement against the plan
- It is important to avoid the tendency to focus on easily collected data

Data Collection and Reporting

- Once data to monitor has been decided, mechanisms to collect this data must be designed
- Analysis is used to transform data into information
- A number of questions come up:
  - Should we use special forms?
  - Should data be collected before/after milestones?
  - Should time and cost data be collected at the same time?

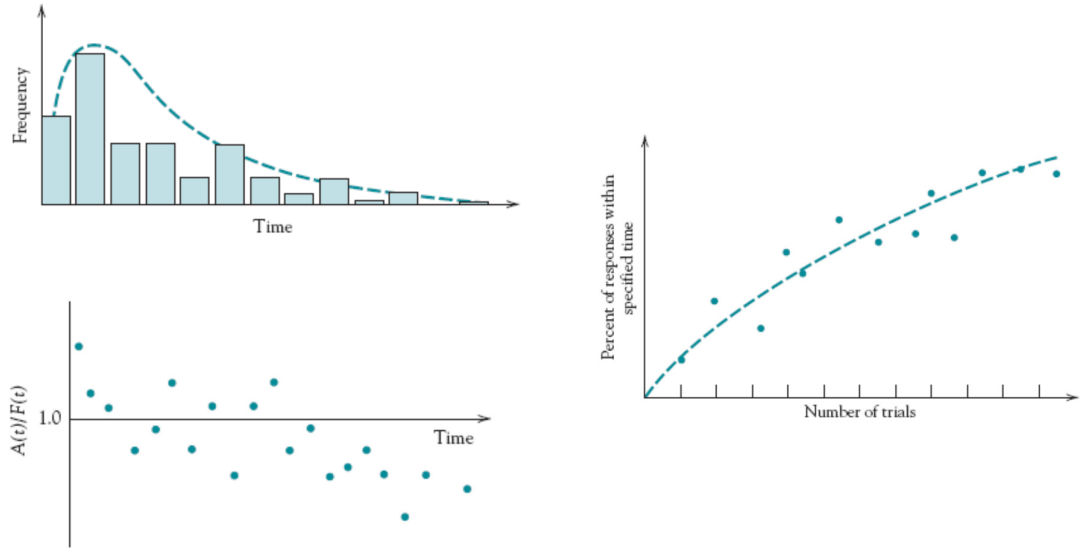
Data Collecting 247

1. Frequency counts
2. Raw numbers
3. Subjective numeric ratings
4. Indicators and surrogates
5. Verbal characterizations

Data Analysis

- Data analysis techniques
  - Simple aggregation
    - Averaging, for example
  - Fitting statistical distribution functions to the data
  - Curve fitting
- Significant differences from the plan should be flagged

Data Analysis Examples 248



Figures 7-2, 7-3, 7-4

Reporting and Report Types 249

- Routine performance reports
  - Project status reports
  - Time/Cost reports
  - Variance reports
- Avoid periodic or routine reports
- Not all stakeholders need to receive same information
- Electronic media makes it possible to customize information for difference audiences
- Reports should be timed to allow control to be exercised before completion of the task in question

Report Types

1. **Routine**
   - Status, progress, and forecast reports
2. **Exception**
   - A report used for special decisions or unexpected situations where affected team members need to be made aware, and the change itself documented
3. **Special analysis**
   - The results of a special study which documents a particular opportunity or problem within the project itself

Additional Report Benefits

- They provide the mutual understanding between stakeholders in a project
- They help communicate the need for coordination among those working on project
- They establish and maintain a communication network for global projects
- Reports can communicate information about changes to a project
- They help maintain the visibility of the project
- They improve motivation

Meetings

- Many reports are delivered at meetings
- Meetings range from regular, highly formalized and structured sessions to informal, off-the-cuff get-togethers
  - Presentations
  - Question and answer sessions
- Meetings must be well run to be effective

Meeting Guidelines

- Meetings should be used primarily for group decision making, not for mere progress reports
- Distribute written agenda in advance of meeting to ensure that all attendees are properly prepared for the meeting
- For a crisis meeting, restrict discussion to that issue
- Meeting should take minutes
  - Avoid attributing remarks to individuals in the minutes
- Avoid excessive formality
- If meeting is held to address specific crisis, restrict meeting to this issue alone

Virtual Reports, Meetings, and Project Management

- The Internet can be used to communicate and report about the project's status
  - Irrespective of the location of the project team members
- Software programs allow the project manager to utilize the organization' local area network or intranet
- Virtual project teams have members spread worldwide

Earned Value

- The earned value (EV) of a task or project is the budgeted cost of the work actually done
  - It is calculated by multiplying the budgeted cost of the task by the percentage completion of the task
  - Process is more difficult than it sounds
    - Budgeted cost of a task is clear
    - Percentage of completion is not
- The percent of a task's budget actually spent is not good indicator of percent completion

Conventions Used to Estimate Progress on Tasks

- 50-50
  - Task is listed as 50% complete when initiated and the remaining 50% added when task is completed
- 100%
  - The task is 100% complete when finished … and zero percent before that
  - projects will always appear to be "behind schedule"
- Ratio of cost (or time) expended to cost (or time) budgeted
  - Neither is an accurate estimator of percentage completion
- These conventions are meant for application only to individual tasks on a project, not to the project as a whole

Earned Value Chart 255, video

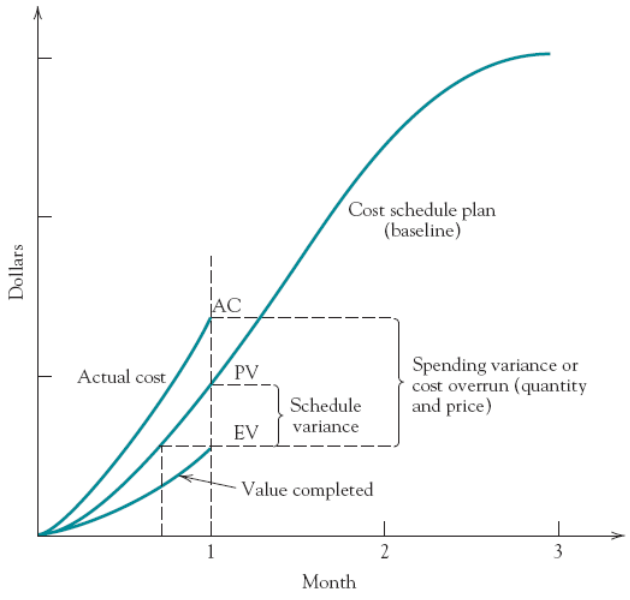


Figure 7-5

Two Simple Rules for Variances

1. A negative variance is bad and a positive variance is good
2. The spending and schedule variances are calculated as the earned value minus some other measure

Variances 255

- Cost/Spending variance
  - Earned value (EV) – actual cost (AC)
- Schedule variance
  - Earned value (EV) – planned cost (PV)
- CPI (cost performance index)
  - Earned value (EV)/actual cost (AC)
- SPI (schedule performance index)
  - Earned value (EV)/planned cost (PV)

Example

- Work on a project was expected to cost $1,500
- Workers were originally scheduled to finish today
- However, as of today…
  - Actually spent $1,350
  - About 2/3 finsished

Calculations for Example

$$\begin{aligned}
\text{Cost/spending variance} &= \text{EV} - \text{AC} = 1500(2/3) - 1350 = -350 \\
\text{Schedule variance} &= \text{EV} - \text{PV} = 1500(2/3) - 1500 = -500 \\
\text{CPI} &= \text{EV}/\text{AC} = 1500(2/3)/1350 = .74 \\
\text{SPI} &= \text{EV}/\text{PV} = 1500(2/3)/1500 = .67
\end{aligned}$$

Additional Items of Interest

- Estimated remaining cost to completion
  - ETC = (BAC – EV) / CPI
    - ETC: estimated cost to completion
    - BAC: budget at completion
    - EV: earned value
    - CPI: cost performance index
- Estimated total cost at completion
  - EAC = ETC + AC
    - EAC: estimated at completion
    - ETC: estimated cost to completion
    - AC: actual cost

Additional Calculations for Example

- BAC = 1500
- EV = 1500 (2/3) = 1000
- CPI = .74 (calculated earlier)
- AC = 1350
- ETC = (BAC – EV) / CPI
  = (1500 – 1000) / .74
  = 676
- EAC = ETC + AC
  = 676 + 1350 = 2026

Project Control

- Control, the act of reducing differences between the plan and actuality
- It is the final element in the planning-monitoring-controlling cycle
- It is to no avail if actions are not taken when reality deviates significantly from what was planned
- Control is a difficult task
  - It involves human behavior
  - Problems are rarely clear cut so the need for change and redirection is also fuzzy

Purposes of Control

1. Stewardship of organizational assets
   - Physical asset control
   - Human resources management
   - Financial control through the use of accounting tools
2. Regulation of results through the alteration of activities
   - This step involves taking action when reality deviates from plan
   - It includes both mechanistic and human elements

Purposes of a Control System 266

- Primary purpose is to correct errors
  - Not to identify and punish the guilty
  - Managers must realize that the past cannot be changed
- Control the investment, subject to diminishing returns
- Consider impact on creativity and innovation
- The control system should employ the lowest degree of hassle consistent with accomplishing its goals

Primary Mechanisms by which Project Manager Exerts Control

1. **Process reviews**
   - An analysis of the process of reaching the project objectives
2. **Personnel assignment**
   - Control can also be exercised through personnel assignments based on past productivity
3. **Resource allocation**
   - Resources are usually allocated to the more productive or important tasks and this can significantly influence the attainment of project results

Common Mistakes

- Emphasizing short-run results at the expense of long-run objectives
- Excessive control directed to specific objectives can result in sacrificing other project objectives
- Across-the-board cuts in resource allocations tend to reward those who have already overspent or over hired while penalizing the frugal and efficient
- Focusing on certain items for control can distract the attention of team members from other, equally important items

Control System Components 264

- Sensor
  - Its purpose is to measure any aspect that one wishes to control
- Standard
  - The control system must have a standard of items to measure against
- Comparator
  - Compares the output of the sensor with the standard
- Decision maker
  - To decide if the difference between what is measured and the standard is large enough to warrant attention.
- Effector
  - If some action is required to reduced the difference, the effector must then take action

Types of Control Systems

- Cybernetic control systems
  - A control system that uses all five components of a control system
  - Also known as steering controls
- Go/no-go controls
  - A predetermined standard must be met for permission to be granted to continue
- Post-control (post-performance reviews)
  - Applied after the project has been completed
  - Purpose is to allow future projects to learn from past project experience

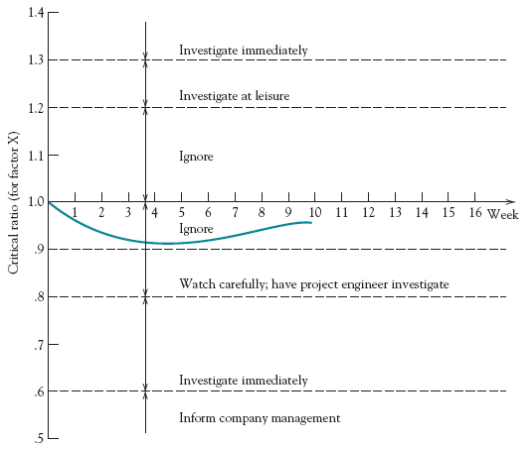
Tools for Control

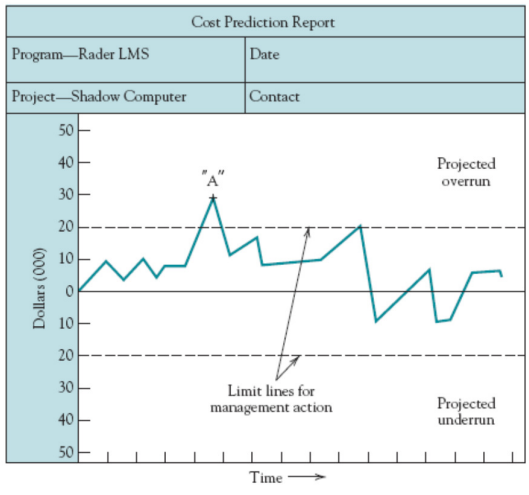
- Some already covered
  - Variance analysis
  - Trend projections
  - Earned value
- Critical ratio
  - Indicates when a task is becoming unacceptable
    - When the ratio drops below one
  - CR = (actual progress/scheduled progress) × (budgeted cost/actual cost)

More Tools for Control

- Control chart
  - Any measure can be plotted and tracked on a control chart
  - Control limits set by project manager
- Benchmarking
  - Make comparisons to “best in class” practices across organizations, or divisions, or even departments within an organization

Two Sample Control Charts 267





Figures 7-9 and 7-10

Scope Creep and Change Control

- Midcourse changes to a project must be controlled
  - Called *scope creep*
- The later changes are made to a project, the more difficult and costly they become
- All projects face change
- The best approach is a well-controlled, formal process for change

Purpose of Change Control System

- Review all requested changes
- Identify all impacts
- Translate impacts into performance, schedule, and cost
- Evaluate the benefits and disadvantages
- Have appropriate person accept or reject
- Communicate accepted changes
- Ensure changes are implemented properly
- Prepare report

Rules for Controlling Scope Creep

- Include a change control system in every project contract
- Require all changes be introduced by a change order
- Require approval in writing by the client's agent and senior management
- Consult with project manager prior to preparation of change order
- Amend master plan to reflect changes

Project Control techniques - nutshell

- Here is an interesting website:

http://www.projectmanagementguru.com/controlling

Assignment 1 deadline reminder

- The deadline is fast approaching- Sunday 12.04.2015 (11:59 pm)
- The group creator (in Portedu) must submit on behalf of the group via Portedu
- Only 1 PDF submission- no zipped archives!! Or any other format!!
- Marking will take 2 weeks- you will receive your marks around April 27, 2015

Lesson Number 4

- Project planning is crucial!!
  - [http://www.youtube.com/watch?v=9LSnINgIkQA]
- Avoid Scope creep!!
  - [http://www.youtube.com/watch?v=AHSjpFUKQR4]

References

- Project Management in Practice 5th Edition, Wiley Inc.
- http://www.unce.unr.edu/publications/files/cd/other/fs9726.pdf
- http://www.gantt.com/creating-gantt-charts.htm
- http://www.pmhut.com/advantages-and-disadvantages-of-gantt-charts

And now it is..

- Quiz time!!

Reading from textbook

- Chapter 5: Scheduling the project
  - Pages 151, 181-188
- Chapter 7: Monitoring and Controlling the Project
  - Pages 244-271

Next week (Easter break)

- Week 5 is divided by the Easter break (02.04- 08.04, 2015)
- Monday, Tue and Wednesday tute/labs will run as usual next week (30/3, 31/3 and 01/04)
- Lecture will NOT run next week
- Thursday, Friday tute, labs will NOT run next week
- Lecture 5 will be held on Thursday April 09, 2015
- Thursday, Friday tute/labs will take place on 09/04 and 10/04