Project Evaluation

CEE 1.040 – Project Management

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Introduction

*Project Evaluation* – *Seeing what you need to see instead of what you want to see.*

[http://www.youtube.com/watch?v=dsNjQhyvRnU](http://www.youtube.com/watch?v=dsNjQhyvRnU)
Example Evaluations

1. Meaningful
2. Meaningless
3. What would you like it to mean?
Resistentialism

http://en.wikipedia.org/wiki/Resistentialism

A jocular theory to describe "seemingly spiteful behavior manifested by inanimate objects."


The slogan of Resistentialism is "Les choses sont contre nous" - "Things are against us".
Outline

Outcome from Project planning...a Project Management Plan
Monitoring and Controlling Project Work
Project Review
Project Audit
The project management plan defines how a project is executed, monitored and controlled, and closed. The project management plan is developed through a series of integrated processes until project closure. The project management plan is progressively updated, controlled and approved (through processes in Monitoring and Controlling Process Group).
Flexible Project Plan

Rolling Wave

A form of progressive elaboration planning where the work to be accomplished in the near term is planned in detail and future work is planned at the higher level of WBS. This is useful in the early planning level, where less information about project and resources is known.

For example; if there are 4 milestones planned in the project, then initially work packages only for first milestone might be decomposed into activities. Later, as more details about project are clear, work packages for other milestones could be decomposed into specific activities.
Flexible Project Plan

Agile – Scrum

14 Jan 2011 07:42 AM

“Has anyone applied Agile methodology in Construction Projects. Please share any references available for the same.”


Planning meetings solicit commitments to accomplish tasks over the sprint (7 – 30 days).
Outline

Outcome from Project planning…a Project Management Plan
Monitoring and Controlling Project Work
Project Review
Project Audit
## Monitor and Control Project Work - Inputs

<table>
<thead>
<tr>
<th>Name of the input</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>1. Project management plan</strong></td>
<td>Definition of how project is to be executed – the PM roadmap.</td>
</tr>
<tr>
<td><strong>2. Performance reports</strong></td>
<td>Performance reports can be used to report the key information such as: current project status, accomplishments, scheduled activities, forecasts, and issues.</td>
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<td><strong>3. Enterprise environmental factors</strong></td>
<td>It includes: governmental or industry standards, company work authorization system, stakeholder risk tolerances, and project management information system.</td>
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<tr>
<td><strong>4. Organizational process assets</strong></td>
<td>It includes: organizational communication requirements, financial control procedures, issues and defect management procedures, risk control procedures, process measurement database, and lessons learned.</td>
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</table>
Status and Performance Assessment

How often?
Nyquist-Shannon Sampling Theorem

“If a function \( x(t) \) contains no frequencies higher than \( B \) Hz, it is completely determined by giving its ordinates at a series of points spaced \( 1/(2B) \) seconds apart.”

Nyquist-Shannon Sampling Theorem

Unless you sample at a sufficient frequency, you cannot reconstruct the original phenomenon.

Sample signal twice as fast as signal bandwidth to accurately represent waveform

Otherwise 5 MHz may look like 1 MHz

Nyquist-Shannon Sampling Theorem – PM Analog

Unless you sample-monitor-evaluate the Project at a sufficient frequency, you cannot accurately represent its condition.

“Sufficient” = f(Project)
Outline

Review: Buffers
Review: WBS, Task list
Managing Constraints and Flows
Managing Resources (Queues)
Workflow smoothing
Constraints

Resource constraints
Resource flows
Resource allocation
Resource Constraints

CPM and PERT assume unlimited resources to achieve task in defined time

Organizations have fixed resources shared between projects – as a PM you therefore become a stakeholder in other projects as you share in misfortune (i.e. personnel).

Resource allocation for large organizations requires computer
Resource Constraints

CPM and PERT assume defined task duration

If task duration = f(resources), then may be able to create a better schedule by reallocating existing project resources (variable-duration)

Task = 40 hours

1 Resource at 50% time → 80 calendar hours = 2 work weeks
2 Resources at 100% time → 20 calendar hours = 0.5 work weeks
Resource Constraints

Holidays, Vacation, Illness, Overtime

Confronted with resource limitations, PM may have to overload existing job personnel – this assumes equal capabilities

To avoid overload (or if lack of capable personnel) PM can use float (slack)

Other alternatives involve Iron Triangle parameters
Mass Balance Approach to Human Resources

Population → Personnel Pool → Population

Hiring → Firing
Mass Balance Approach to Material Resources
Mass Balance Approach to Material Resources

Steel Pipe (S) → Hauling Rate → Pipe (S) Backlog → Pipe Lay Rate → Completed Pipeline

\[ \frac{dS}{dt} = \frac{S_{in}}{t} - \frac{S_{out}}{t} \]
Mass Balance Approach to Material Resources

\[ \dot{S}_{in} = \text{Flow of resources in} \]
\[ \dot{S}_{out} = \text{Flow of resources out} \]

\[ \frac{dS}{dt} = \dot{S}_{in} - \dot{S}_{out} \]

\[ dS = (\dot{S}_{in} - \dot{S}_{out}) \, dt \]

\[ S_t = [(\dot{S}_{in} - \dot{S}_{out}) \, t] + S_{t_0} \]
Personnel $\rightarrow$ Materials

\[ \text{Work Productivity} = f(\text{material, personnel}) \]
Outline

Review: Buffers
Review: WBS, Task list
Managing Constraints and Flows
Managing Resources (Queues)
Workflow smoothing
Resources and Project Management

Project management is a balancing of human and material resources

Must have the right number of people, at the right place, at the right time, with the materials they need, doing the right things

Buffers of excess resources (human, material) provide you with safety and ability to increase rate of production

Buffers of excess resources (human, material) cost money

Need to balance need for security with budget
Outline

Review: Buffers
Review: WBS, Task list
Managing Constraints and Flows
Managing Resources (Queues)
Workflow smoothing
Workflow Smoothing

http://www.flickr.com/photos/shnapthat/6464681311/sizes/l/in/photostream/
Workflow Smoothing

Start Job → Pour Foundation → Frame Building → Install Roof → Install wiring → Sheetrock Interior → Finish Job
Workflow Smoothing

Start Job → Pour Foundation → Frame Building → Install Roof → Install Wiring → Sheetrock Interior → Finish Job

- Start Sheetrock Task
  - 2 Break Rooms
    - 1 worker
    - 4 days
  - 20 Offices
    - 4 workers
    - 15 days
  - 3 Conference Rooms
    - 2 workers
    - 6 days
  - Hallways
    - 3 workers
    - 4 days
  - 3 Closets
    - 1 worker
    - 3 days

Finish Task
# Plan

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**Worker Days**
Reallocate Resources

| Day          | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | Worker Days |
|--------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|-------------|
| Break Rooms  | 1 | 1 | 1 | 1 |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    | 4           |
| Offices      | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4  | 4  | 4  | 4  | 4  | 4  | 4  | 4  | 4  | 4  | 60          |
| Conference Rooms | 2 | 2 | 2 | 2 | 2 |   |   |   |   |    |    |    |    |    |    |    |    |    |    | 12          |
| Hallways     |   |   |   |   |   |   |   |   |   | 3  | 3  | 3  | 3  |    |    |    |    |    |    | 12          |
| Closets      |   |   |   |   |   |   |   |   |   | 1  | 1  | 1  |    |    |    |    |    |    |    | 3           |
| Workers      | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 4 | 4  | 4  | 4  | 4  | 4  | 4  | 4  | 4  | 4  | 4  | 91           |

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Reallocate Resources

![Bar chart showing the number of workers on each day of a work week. The chart is divided into two sections: one for red bars representing a specific scenario and another for blue bars representing another scenario. The x-axis represents the days of the week from 1 to 19, and the y-axis represents the number of workers from 0 to 8. The red bars show a higher number of workers on the first few days compared to the blue bars, which indicate a more consistent number of workers throughout the week.](image-url)
Reallocate Resources

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| Workers | 7 | 7 | 7 | 7 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 |
Reallocate Resources

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Outline

Outcome from Project planning...a Project Management Plan
Monitoring and Controlling Project Work

Project Review

Project Audit
Project Review

Goals of Review
1. Are there problems?
2. What is the nature of the problems?
3. When did they occur?
4. How severe are they

Areas of Review
1. Status
2. Design
3. Process
Project Review

Status

Monitoring Iron Triangle (P, C, T, S) status

- Are performance criteria being met?
- Is project within budget?
- Is project on schedule?
- Is project scope correct?
Project Review

Design

Monitoring Design Process

Does design meet sponsor/customer specifications?
It design user friendly?
Can design be manufactured?
Is there still a market demand for design?
Are ROI and other product design justifications still valid?
Project Review

Process

Monitoring Project Process (“Lessons Learned”)

What is going well?

What needs to be improved?
Project Review

QA - QC
Example: Taking an Exam (Preparation and Execution)

Study before examination, get sufficient rest.

Bring pencil and calculator to examination.

Turn off cell phone to eliminate possible distraction.

During examination occasionally check clock to gauge your time.
Project Review
Quality Control (QC)

Example: Taking an Exam (Post-Exam Review)

Check each answer for order of magnitude reality check.

Be sure dimensions of numerical answer are present and correct.

Review all answers before end of examination time.

In construction, QC is usually carried out by the Contractor during construction and subsequent to completion with a report to owner documenting construction meets with contract specifications.
Outline

Outcome from Project planning…a Project Management Plan
Monitoring and Controlling Project Work
Project Review
Project Audit
Project
Review vs. Audit

**Goals of Review**
1. Determine whether there are problems
2. If there are problems, identify the nature of the problems
3. Determine when problems occurred
4. Determine how severe problems are

**Goals of Audit (Formal)**
1. If there are problems, identify why problems occurred
2. If there are not problems, identify project success against defined metrics for future learning
3. Documentation of positive/negative experience(s)
4. Formal learning for future projects
Universe of Audit

Figure 2: Interaction/cause and chart showing which systems are most vulnerable to system accident.

Scope
Cost
Performance
Time

Internal to Organization
Strengths
Weaknesses

External to Organization
Opportunities
Threats

Probability
1-Very Low
2-Moderate
3-High
4-More Likely
5-Ultimately

Consequences
1-Very Low
2-Moderate
3-High
4-More Likely
5-Ultimately

Owner
Contractor
Surety (Bonding) Company

Massachusetts Institute of Technology

Build Team

ABC Construction, Board of Directors
President

Secretary-Treasurer

Assistant

Purchasing Agent

Operations Manager

Assistant, PA

Accountant

Surety (Bonding) Company

Project Manager

Namespace

Cost, Clerk

Project Costs, contracts

Technical

Project Manager

Scheduling, budget, projects

Assistant, PA

Surety (Bonding) Company

Surety (Bonding) Company

Surety (Bonding) Company

Surety (Bonding) Company
Formative vs. Summative Evaluations
NSF (page 5)

Formative evaluation: assess initial and ongoing project activities.

Summative evaluation: assess the quality and impact of a fully implemented project.

According to evaluation theorist Bob Stake, “When the cook tastes the soup, that’s formative; when the guests taste the soup, that’s summative.” (page 5)
Summary
Engage in project evaluation with eyes wide open

Absence of evidence is not evidence of absence
Construction-Phase Rework

Can result in 10%-15% increase in construction costs over the contract price.

Josephson, P., Causes and costs of defects in construction a study of seven building Projects, Automation in Construction, 1999, (8) 681-687

Love, P., L. Heng, Quantifying the causes and costs of rework in construction, Construction Management and Economics, 2000, (18) 479-490
Change vs. Rework

A Change Request can result in:

1. **Change Order (CO)**
   A bilateral (or trilateral) agreement to modify the contract terms. CO defining change(s) in the contracted work, cost, time, requires signatures of all parties (i.e. owner, A/E).

2. **Construction Change Directive (CCD)**
   A unilateral contract modification in the absence of complete agreement that affects cost/schedule/scope. If (e.g.) the owner and architect change contract work, cost, time, the contractor proceeds immediately with change(s), the specific costs etc. associated with change(s) to be determined at a later time by the architect.
   CCD must identify necessary change and justification (e.g. change in site conditions, change in owner needs). CCD can include addition, deletion. Used in lieu of CO (e.g. when time is of essence).
CHANGE ORDER

DATE  Click here to enter a date.

CHANGE ORDER NO. ______  WORK ORDER NO. ______  ______  ______

PROJECT NAME: ______
SPECIFICATION NO. ______
CONTRACTOR: ______
ADDRESS: ______

You are hereby directed to make the herein described changes from the Specifications and/or Drawings, or do the following described work not included in the Specifications and/or Drawings on this Contract.
(This Change Order is not effective until signed by the District and the Contractor)

DESCRIPTION OF CHANGE ORDER:

Firm ______, Estimated ______, Cost Decrease $ ______, Increase $ ______
Including ______, Not Including ______, an amount payable by the District for California Sales and Use Taxes.

By reason of this Change Order the Time of Completion will be adjusted as follows: ______

Approval:  Signature:  Title:  Date:
Recommended By:  Project Manager
Approved By:  Select GM or AGM

We, the undersigned Contractor, have given careful consideration to the change proposed and hereby agree, if the Change Order is accepted, that we shall provide all equipment, furnish all labor and materials, except as may otherwise be noted above, and perform all services necessary for the work above specified, and will accept as full payment therefore the price(s) shown above. We understand that the execution of this Change Order constitutes a binding accord and satisfaction that fully satisfies, waives, and releases the District from all claims, demands, costs and liabilities, in Contract, law or equity, arising out of or related to the subject of the change and indirect costs and/or damages for delay, disruption, acceleration, loss of productivity, and any and all consequential damages.

ACCEPTED: Date ______  Contractor ______
By ______  Title ______

REMARKS:
Original Contract Amount: ______
Total of Prior Change Orders: $ ______
#DIV/0!
Total of This Change Order: ______
#DIV/0!
Total of All Change Orders: $ ______
#DIV/0!
Total Adjusted Contract: $ ______
Start Here

Owner or engineer initiates change order proposal

Owner or engineer prepares initiator change order

Or Here

Resident project representative reviews request and submits to project manager

Construction manager reviews and recommends to the engineer

Project design engineer reviews merits of the proposed change order

Change Recommended?

Yes

Contract administrators prepare change order and cost estimates

Change order price proposal requested from contractor

No

Initiator change order form returned to contractor with authorization denied

Contract administrators review time/cost proposal and negotiates term

Contractor estimates time and cost and submits signed change order proposal to owner

Agree on Time/Cost?

Yes

Owner signs change order

Contractor begins change order work

No

"Attempt re-negotiation, otherwise proceed..." under terms for "Extra Work" or "Disputed Work" as applicable

Formal Protest!

Figure by MIT OCW.
Start Here

Owner or engineer initiates change order proposal

Owner or engineer prepares initiator change order

Or Here

Resident project representative reviews request and submits to project manager

Construction manager reviews and recommends to the engineer

Project design engineer reviews merits of the proposed change order

Change Recommended?

Yes

Figure by MIT OCW.

No

Contractor-initiated change order proposal

Contractor prepares initiator change order request form
Contract administrators prepare change order and cost estimates

Change order price proposal requested from contractor

Contractor estimates time and cost and submits signed change order proposal to owner

Agree on Time/Cost?

Yes

Owner signs change order

Contractor begins change order work

No

Initiator change order form returned to contractor with authorization denied

Contract administrators review time/cost proposal and negotiates term

Formal Protest!

"Attempt re-negotiation, otherwise proceed..." under terms for "Extra Work" or "Disputed Work" as applicable

Figure by MIT OCW.
Project Iteration Dynamics

**Unplanned Iteration**
Unforeseen, unfortunate
Pure failure
Minimize using QA, RM

**Planned Iteration**
Part of engineering design
Prototype – test – implement
Intelligent fast failure
Known Process step
Unknown duration
Outline

Project Dynamics
Project Dynamics and Project Failure
System Dynamics
Rework and Iterations
Managing Project Dynamics - Rules for Survival
Rules for Survival

1. **Perceive and Believe**
   Don't fall into the deadly trap of denial or of immobilizing fear.

2. **Stay Calm**
   Use your anger in the initial crisis, survivors are not ruled by fear; instead, they make use of it. Their fear often feels like (and turns into) anger, which motivates them and makes them feel sharper.

3. **Think, Analyze, and Plan**
   Survivors quickly organize, set up routines, and institute discipline.

4. **Take Correct, Decisive Action.**
   Survivors are willing to take risks to save themselves and others. But they are simultaneously bold and cautious in what they will do. They handle what is within their power to deal with from moment to moment, hour to hour, day to day.

5. **Celebrate your success.** Survivors take great joy from even their smallest successes. This helps keep motivation high and prevents a lethal plunge into hopelessness. Viktor Frankl put it this way: “Don’t aim at success—the more you aim at it and make it a target, the more you are going to miss it.”

6. **Enjoy the Survival Journey.** It may seem counterintuitive, but even in the worst circumstances, survivors find something to enjoy, some way to play and laugh. Survival can be tedious, and waiting itself is an art.

7. **See the Beauty.** Survivors are attuned to the wonder of their world, especially in the face of mortal danger. The appreciation of beauty, the feeling of awe, opens the senses to the environment.

8. **Believe that you will succeed.** It is at this point, following what I call “the vision,” that the survivor’s will to live becomes firmly fixed.

9. **Surrender.** Yes you might die. In fact, you will die—we all do. But perhaps it doesn’t have to be today. Don’t let it worry you.

10. **Do Whatever Is Necessary.**
    If you’re still alive, there is always one more thing that you can do.
Managing Project Dynamics

1. Awareness
2. Recognition
3. Appropriate response
4. Monitoring effect(s)
5. Celebration
6. Learning
Why do Projects Fail?

External forces clearly can affect project dynamics; however, often it is our inability to manage change in the midst of turbulence and uncertainty.

Managing project dynamics requires:
(1) Perceiving – be aware of the project environment and sensitive to changes
(2) Believing – be open to experience
(3) Staying calm – panic is a waste of energy and is contagious
(4) Thinking, analyzing, and re-planning – “ready, aim fire”
(5) Taking correct, decisive action – sometimes your “best” is not enough…you must do what is necessary
(6) Monitoring change – feedback is critical
(7) Never giving up – persevere in the face of a zombie army
Recipe for Failure

Be unaware of the project environment, ignore changes when you see them, panic (or give up) when problems arise, act indecisively without thinking things through, and don’t follow up to measure effect(s) of actions.
Example: Recognition and Response

You are the PM on an 18-month construction project of a small (6 million gallons per day) potable water treatment plant. Schedule is your prime priority and cost secondary. The construction is ~30% complete (according to the original plan), but scope creep and unexpected weather events have placed you ~20% behind the contract schedule.

What do you do?

1. Work your team overtime?
2. Add personnel (crash)?
3. Stay within contract but ease up on quality?
4. Slip the schedule?
5. Adjust the scope?
6. ?
The Challenge of Project Acceleration

1. Multiple shift work
   a. Health
   b. Safety
   c. Neighbors

2. Overtime
   a. Fatigue
   b. Morale
   c. Errors, rework

3. Increased personnel
   a. HR – hiring time
   b. Training by on-site personnel
   c. Space (e.g. offshore platform)