Lesson 01 – Project Management

Lesson 01
Project Management

planning, preparing, and coordinating efforts to accomplish a specific set of objectives

A Project is a unique one-time operation designed to accomplish a specific set of tasks in a limited time frame.

- Olympic Games
- Producing a movie
- Software development
- Product development
- ERP implementation

Leadership/Participation in a successful project will enhance your opportunities for career advancement!

Typically success is defined by:
- On time
- Within budget

Managers have day-to-day operations as well as routine projects with which to deal. Some typical projects include:

- New product design
- Updating old products
- Marketing and advertising campaigns
- Information system development
- Quality improvement
- Process improvement
- Location selection, etc.

Doing day-to-day activities and routine projects will get you a “met expectations” on your performance review.
Those projects which are non-routine continual improvement projects are usually undertaken as a company initiative. However, no matter what your position in the organization, you have an opportunity to develop projects within your sphere of influence. These non-routine projects which add value to your organization will also add value to your career.

Projects which are undertaken outside of the normal routine day to day activities will set you apart from your peers. It is also what many superiors will use to evaluate you as a person who "exceeds expectations" or "does superior work".

In my opinion, this is the secret to success!

Size - some projects are larger than others and have thousands of complex, large components requiring careful planning and coordination. Projects typically have a specified time-frame and a budget for costs. All projects require:

- Goals
- Priorities
- Activities & tasks
- Time estimates
- Responsibility assignments
- Planning
- Scheduling
- Coordinating
- Resolving conflict
- Monitoring

Project Issues

Project Tasks & Timelines

[Diagram showing project timelines and tasks]

Copyright – Harland E. Hodges, Ph.D
Lesson 01 – Project Management

**Project Phases**

Projects have a life-cycle of phases which may require a different set of skills for each phase or task within phase. The major phases of a project are:

- Concept
- Feasibility
- Planning
- Execution
- Phase out

**Project Life Cycle**

**Key Decisions in Project Management** -

- Which projects are most important? (Pareto)
- Project manager
- Project Team
- Planning and designing the project
- Managing and controlling the project resources (personnel, technology, money, etc.)
- Deciding if and when a project should be terminated

Copyright – Harland E. Hodges, Ph.D
Lesson 01 – Project Management

Project Issues

Projects may be departmental or company wide. In either case selection of the project participants is extremely important.

- Team members
  - Departmental
  - From many departments within the company
- Matrix organization ... because the project member may be assigned to the project effort on a part-time basis and he/she may wind up with two supervisors. Conflicts will have to be resolved.
- Project manager

Project Manager

The project manager is key to the project success. Many hard decisions will have to be made and it will test their leadership abilities.

Many young managers are given projects to test their leadership ability.

Project Issues

Complexity of projects - because large projects usually involve a very large number of activities, project managers and project planners must break down a project into the tasks and sequence them according to priority, timing, task length, and costs. Visual aids are very important for communicating the project tasks to all persons involved and interested in the project.

Two key tools to accomplish this are:
- Work Breakdown Structures
- Gantt Charts (named for Henry Gantt)
A **work breakdown structure** is a hierarchical listing of what must be done during a project.

**Work Breakdown Structure**

**Gantt Chart**

A **Gantt chart** is a simple chart showing major tasks and time lines.

**PERT & CPM**

The simplicity of the Gantt chart is very useful for communication of a project status; however, it does not contain details showing relationships between tasks. Two of the most popular and widely used techniques for planning and coordinating tasks in projects are:

- **Project Evaluation and Review Technique (PERT)**
  - U.S. Navy Special Projects Office (1958)
  - Polaris Missile Project

- **Critical Path Method (CPM)**
  - J. E. Kelly - Remington-Rand & M. R. Walker - Du Pont (1957)
  - Scheduling maintenance of chemical processing plants
These methods show:
- Project network diagrams which are graphical displays of project activities (tasks) indicating preceding and following activities.
- Length of time each activity takes.
- Estimates of how long the project (all activities) will take.
- An indication of which activities are the most critical to timely project completion.
- An indication of how long any activity can be delayed without lengthening the project.

A project network diagram is a precedence relationship showing project activities showing sequential relationships by use of arrows and nodes.

**Project Network Diagram Terminology**
- **Activities** - project steps that consume resources and/or time.
- **Path** - a sequence of activities that leads from the starting node to the finishing node.
- **Critical Path** - the longest path determines the expected project duration.
- **Critical Activities** - activities on the critical path.
- **Slack** - allowable slippage for a path (the difference between the length of a path and the length of a critical path).
- **Deterministic time estimates** - estimates that can be made with a high degree of certainty.
- **Probabilistic time estimates** - estimates of times that allow for probable variation.
Both activities a and b have to be completed before activity c can begin. Activities a and b are independent of each other.

Activity a must precede activities b and c. Activities b and c are independent of each other.
Both activities a and b have to be completed before activity c or d can begin. Activities a, b, c, and d are independent of each other.

Independent activities a and b both have the same ending node. To preserve the independence a dummy node and activity must be created. The time allocated to a dummy activity is 0.

---

**AON Network**

<table>
<thead>
<tr>
<th>Immediate Activity Predecessor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>J</td>
</tr>
<tr>
<td>K</td>
</tr>
</tbody>
</table>
Lesson 01 – Project Management

AON Network

Immediate Activity Predecessor(s)
A —
B —
C A
D B
E C
F A
G B
H D
I A
J E,G,H
K F,J,J

AOA Network

Immediate Activity Predecessor(s)
A —
B —
C A
D B
E B
F A
G C
H D
I A
J E,G,H
K F,J,J

AOA Network

Immediate Activity Predecessor(s)
A —
B —
C A
D B
E B
F A
G C
H D
I A
J E,G,H
K F,J,J
Lesson 01 – Project Management

AOA Network

Immediate Activity Predecessor(s)
A —
B
C A
D B
E
F A
G C
H D
I A
J E, G, H
K F, J, J

AOA Network

Immediate Activity Predecessor(s)
A —
B —
C A
D B
E
F A
G C
H D
I A
J E, G, H
K F, J, J

AOA Network

Immediate Activity Predecessor(s)
A —
B —
C A
D B
E
F A
G C
H D
I A
J E, G, H
K F, J, J

Copyright – Harland E. Hodges, Ph.D
Immediate Activity Predecessor(s)

AOA Network

Fixed (Deterministic) Time Estimates
Lesson 01 – Project Management

<table>
<thead>
<tr>
<th>&quot;Predecessors&quot;</th>
<th>Duration Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Task&quot;</td>
<td>Start</td>
</tr>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>G</td>
<td>E</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>B</td>
</tr>
</tbody>
</table>

Draw the AOA network diagram

A: Locate facilities (8 weeks)

G: Furniture setup (3 weeks)

B: Interview (4 weeks)

D: Remodel (11 weeks)

F: Hire and train (9 weeks)

Move in (1 week)

Draw the AON network diagram

A: Locate facilities (8 weeks)

C: Order furniture (6 weeks)

E: Furniture setup (3 weeks)

B: Interview (4 weeks)

D: Remodel (11 weeks)

F: Hire and train (9 weeks)

Move in (1 week)
Lesson 01 – Project Management

A. Locate facilities 8 Weeks
B. Interview 4 Weeks
C. Order furniture 6 Weeks
D. Remodel 11 Weeks
E. Furniture setup 3 Weeks
F. Hire and train 9 Weeks
G. Move in 1 Week

Determine the length of each path.
Lesson 01 – Project Management

Determine the critical path and project duration.

A) Locate facilities 8 Weeks
B) Interview 4 Weeks
C) Order furniture 6 Weeks
D) Remodel 11 Weeks
E) Furniture setup 3 Weeks
F) Hire and train 9 Weeks
G) Move in 1 Week

Determine the slack for each path.
Determine the earliest start time and the earliest finish time for each activity.

Forward Pass

ES = max(preceding tasks)
EF = ES + Time

Start
Task
Finish

A
Locate facilities
6 Weeks
8 Weeks

B
Interview
4 Weeks
8 Weeks

C
Order furniture
6 Weeks
9 Weeks

D
Remodel
11 Weeks
14 Weeks

E
Furniture setup
3 Weeks
8 Weeks

F
Hire and train
9 Weeks
8 Weeks

G
Move in
1 Week
9 Weeks

Determine the latest start time and the latest finish time for each activity.

Backward Pass

LS = min(following tasks)
LF = LS - Time

Start
Task
Finish

A
Locate facilities
6 Weeks
8 Weeks

B
Interview
4 Weeks
8 Weeks

C
Order furniture
6 Weeks
9 Weeks

D
Remodel
11 Weeks
14 Weeks

E
Furniture setup
3 Weeks
8 Weeks

F
Hire and train
9 Weeks
8 Weeks

G
Move in
1 Week
9 Weeks

Early Finish
Task
Start
Finish

A
0.0
8.0

B
0.0
4.0

C
5.0
14.0

D
0.0
19.0

E
14.0
17.0

F
4.0
13.0

G
19.0
20.0

Copyright – Harland E. Hodges, Ph.D
Lesson 01 – Project Management

Determine the slack for each task

<table>
<thead>
<tr>
<th>Task</th>
<th>Start</th>
<th>Finish</th>
<th>Late Start</th>
<th>Late Finish</th>
<th>Slack</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9.0</td>
<td>19.0</td>
<td>9.0</td>
<td>19.0</td>
<td>0.0</td>
</tr>
<tr>
<td>C</td>
<td>13.0</td>
<td>16.0</td>
<td>13.0</td>
<td>16.0</td>
<td>0.0</td>
</tr>
<tr>
<td>D</td>
<td>8.0</td>
<td>18.0</td>
<td>8.0</td>
<td>18.0</td>
<td>0.0</td>
</tr>
<tr>
<td>E</td>
<td>16.0</td>
<td>19.0</td>
<td>16.0</td>
<td>19.0</td>
<td>0.0</td>
</tr>
<tr>
<td>G</td>
<td>19.0</td>
<td>20.0</td>
<td>19.0</td>
<td>20.0</td>
<td>0.0</td>
</tr>
<tr>
<td>B</td>
<td>4.0</td>
<td>10.0</td>
<td>4.0</td>
<td>10.0</td>
<td>6.0</td>
</tr>
<tr>
<td>F</td>
<td>10.0</td>
<td>19.0</td>
<td>10.0</td>
<td>19.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Variable (Probabilistic) Time Estimates
Lesson 01 – Project Management

Task Times - Beta (β) Distribution

Path Times
Determine the expected time, variance and standard deviation for each task

<table>
<thead>
<tr>
<th>Task</th>
<th>Task</th>
<th>μ</th>
<th>σ²</th>
<th>σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Locate facilities</td>
<td>7.7</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>B</td>
<td>Interview</td>
<td>4.0</td>
<td>0.4</td>
<td>0.7</td>
</tr>
<tr>
<td>C</td>
<td>Order furniture</td>
<td>5.8</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>D</td>
<td>Remodel</td>
<td>10.8</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>E</td>
<td>Furniture setup</td>
<td>3.0</td>
<td>0.4</td>
<td>0.7</td>
</tr>
<tr>
<td>F</td>
<td>Hire and train</td>
<td>9.2</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>G</td>
<td>Move in</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Refer to β distribution formulae

Determine the expected duration (time) for each path

Refer to path times formulae

Determine the critical path and expected project duration

Choose longest path time
Determine the standard deviation for each path

Refer to path times formulae

\[ \sigma_{path} = \sqrt{\sum_{task} \sigma_{task}^2} \]

\[ \mu_{path} = \sum_{task} \mu_{task} \]

Path Probabilities

The probability that a path can be completed in less than a specified time (ST)

\[ P(\text{< ST}) = \frac{\mu_{path} - \text{ST}}{\sigma_{path}} \]

The probability under the normal path distribution less than the specified time

\[ P(\text{< ST}) = \text{NORMDIST}(\text{ST}, \mu_{path}, \sigma_{path}, \text{TRUE}) \]

Determine the probability that Path – A C E G can be completed in

. less than 20 weeks
. more than 20 weeks

\[ P(\text{< 20}) = \text{NORMDIST}(20, \mu_{path}, \sigma_{path}, \text{TRUE}) \]

\[ P(\text{> 20}) = 1 - P(\text{< 20}) \]

<table>
<thead>
<tr>
<th>Task</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Path</th>
<th>( \sigma_{path} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7.7</td>
<td>1.9</td>
<td>1.0</td>
<td>1.46</td>
</tr>
<tr>
<td>B</td>
<td>5.8</td>
<td>1.5</td>
<td>0.7</td>
<td>0.91</td>
</tr>
<tr>
<td>C</td>
<td>3.2</td>
<td>1.5</td>
<td>0.4</td>
<td>1.46</td>
</tr>
<tr>
<td>E</td>
<td>5.5</td>
<td>1.5</td>
<td>0.0</td>
<td>1.87</td>
</tr>
<tr>
<td>G</td>
<td>17.5</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \sigma_{path} = \sqrt{\sum_{task} \sigma_{task}^2} = \sqrt{(1.46^2 + 0.91^2 + 1.46^2 + 1.87^2)} = 2.1 \]

\[ \mu_{path} = \sum_{task} \mu_{task} = 7.7 + 5.8 + 3.2 + 5.5 + 17.5 = 40 \]

\[ P(\text{< 20}) = \text{NORMDIST}(20, 40, 2.1, \text{TRUE}) = 0.9565 \]

\[ P(\text{< 20}) = 1 - P(\text{< 20}) = 1 - 0.9565 = 0.0435 \]
Lesson 01 – Project Management

Determine the probability that Path – A D G can be completed in
. less than 20 weeks
. more than 20 weeks

\[
\begin{array}{c|c|c|c|c}
A & D & G & \phi \\
\hline
7.7 & 10.8 & 19.5 & \\
\end{array}
\]

\[
\begin{array}{c|c|c|c|c}
1 & Path & & & \\
2 & Mean & 19.5 & & \\
3 & Std Dev & 1.12 & & \\
4 & (ST) Specified Time & 20 & & \\
5 & P < ST & 0.6724 & =NORMDIST(B5,B2,B3,TRUE) & \\
6 & P > ST & 0.3276 & =1-B7 & \\
\end{array}
\]

Determine the probability that Path – B F G can be completed in
. less than 20 weeks
. more than 20 weeks

\[
\begin{array}{c|c|c|c|c}
B & F & G & \mu \\
\hline
4.0 & 9.2 & 14.2 & \\
\end{array}
\]

\[
\begin{array}{c|c|c|c|c}
1 & Path & & & \\
2 & Mean & 14.2 & & \\
3 & Std Dev & 1.07 & & \\
4 & (ST) Specified Time & 20 & & \\
5 & P < ST & 1.0000 & =NORMDIST(B5,B2,B3,TRUE) & \\
6 & P > ST & 0.0000 & =1-B7 & \\
\end{array}
\]

Project Probabilities

There is a possibility that the variation on the critical path is not the largest or the variation on another path may extend to the right of the critical path variation; therefore, we must consider the other paths when determining project probability.
The project probability discussion relies on path independence (i.e., path duration times are independent of each other). The assumption of independent paths is considered to be met if only a few activities in a large project are on multiple paths.

If the paths are determined to be independent then,

\[
P(\text{project can be completed in less than a specified time (ST)}) = \text{The product of all path probabilities less than the specified time}
\]

Determine the probability that the project can be completed in less than 20 weeks, more than 20 weeks

\[
P(\text{Project < 20}) = P(A \rightarrow C \rightarrow E \rightarrow G < 20) \times P(A \rightarrow D \rightarrow G < 20) \times P(B \rightarrow F \rightarrow G < 20)
\]

\[
= .9566 \times .6724 \times 1
\]

\[
P(\text{Project < 20}) = .6432
\]

\[
P(\text{Project > 20}) = 1 - P(\text{Project < 20})
\]

\[
P(\text{Project > 20}) = .3568
\]

Since there is only 1 task which overlaps paths we will determine that the paths are independent; therefore,

\[
P(\text{Project < 20}) = P(A \rightarrow C \rightarrow E \rightarrow G < 20) \times P(A \rightarrow D \rightarrow G < 20) \times P(B \rightarrow F \rightarrow G < 20)
\]

\[
= .9566 \times .6724 \times 1
\]

\[
P(\text{Project > 20}) = 1 - P(\text{Project < 20})
\]

\[
P(\text{Project > 20}) = .3568
\]

To be 99% sure that complete the project in the scheduled amount of time, how many days should be scheduled?

The solution requires that a schedule time (ST) should be such that the product of the path probabilities is < .99.

The answer is 23 days.
Project Management Software

Specialized software used to help manage projects
- Assign resources
- Compare project plan versions
- Evaluate changes
- Track performance

Advantages:
- Imposes a methodology and common project management terminology
- Provides a logical planning structure
- May enhance communication among team members
- Can flag the occurrence of constraint violations
- Automatically formats reports
- Can generate multiple levels of summary and detail reports
- Enables "what if" scenarios
- Can generate a variety of chart types
Lesson 01 – Project Management

**ED (Enter Tasks and Times) Worksheet**

Options
- Clear Data
- 1. Enter/Modify Tasks
- 2. Enter/Modify Preceding Tasks

Data can also be entered directly in cells B through P and T. Cells Q, R, and S are locked.

*or*

using option 1 then 2 (follow the dialogue boxes)

<table>
<thead>
<tr>
<th>Task</th>
<th>Start</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>&quot;Opt&quot;</th>
<th>&quot;M&quot;</th>
<th>&quot;P&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>4</td>
<td>8</td>
<td>10</td>
<td>Locate facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>Order furniture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>A</td>
<td>8</td>
<td>11</td>
<td>12</td>
<td>Remodel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>C</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>Furniture Setup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>E</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>Interview</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>D</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>Site and Data</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Completed ED Worksheet*

If all three times (optimistic, most likely, and pessimistic) are entered then the Beta Distribution calculations are made; otherwise, the Beta Distribution calculations are blank.
Select the time estimate for the analysis you wish to perform from the drop down box at the upper left.

All paths in the project network diagram are automatically calculated showing the expected duration, variance, slack and tasks for each path. The Critical Path is also identified. Here, we see there are 3 paths, 1 critical path, and 7 tasks in the project.

If the "Expected" time estimate was chosen, the Project Summary shows the expected project duration (same as critical path), and provides a warning of whether the critical path variance is maximum.

The "Expected" time estimate was chosen, the Project Summary also shows project probability estimates. Here, we see that the probability of completion in less than a specified time of 20 days is 64.33%. The slider increments can be used to change the specified time.
SF Worksheet

Shows each task early and late start finish times, slack, and whether or not the task is a Critical Task.

For each path (selected by the slider increment in the upper left corner), it also show a GANTT Chart with the early start – early finish (bright green) and late start – late finish (bright orange) on the same graph. The slider increments at the graph upper right can be used to adjust spacing in the graph.

PERT Worksheet

Shows the AON project network diagram which may need to be adjusted (Adjust Task Y Plot Points) to minimize the overlapping lines. You can also scroll (select path increment slider in upper left corner) through each of the paths in the project.
Adjusted AON project network diagram showing Path (A C E G) in highlighted (green).

GANTT Worksheet.
Can be used to track the project status by path task (Update Task Status). The project day (slider increment below paths) to the current project day. Here we see task A can start (CS in yellow above task).

Here we see for Project Day 5, Path (A C E G) that Task A has started at time 0 (yellow) and 5 days have been completed (blue). None of the other tasks on this path can start because preceding tasks have not been completed.
Lesson 01 – Project Management

Here we see for Project Day 5, Path (A D G) that Task A has started at time 0 (yellow) and 5 days have been completed (blue). None of the other tasks on this path can start because preceding tasks have not been completed.

Here we see for Project Day 5, Path (B F G) that Task B is complete (blue). It started at time 0 (yellow) and 4 days have been completed (blue). We also see that Task F started at time 4 (yellow) and 1 day (blue) has been completed. None of the other tasks on this path can start because preceding tasks have not been completed.

Homework
Read and understand all material in the chapter.
Discussion and Review Questions
Do not begin the homework until you have recreated and understand all the examples in this presentation.
Exercises on chapter web page

Copyright – Harland E. Hodges, Ph.D