Software Development Project Management

Part 1
Software Development Process?

1) Announce availability.
2) Order the T-shirts for the Development team.
3) Write the code.
4) Write the manual.
5) Hire a Product Manager.
6) Spec the software (Writing the specs after the code helps to ensure that the software meets the specifications).
7) Ship.
8) Test (the customers are a big help here).
9) Identify bugs as potential enhancements.
10) Announce the upgrade program.
Cynical Views or Reality?

- Projects progress quickly until they are 90% complete. Then they remain at 90% complete forever.

- When things are going well, something will go wrong. When things just can’t get worse, they will. When things appear to be going better, you have overlooked something.

- If project content is allowed to change freely, the rate of change will exceed the rate of progress.

- Project teams detest progress reporting because it manifests their lack of progress.
Project Management Terms
(not universal)

- **Tasks**: Small units of work
- **Activities**: Major work units
- **Milestones**: When activities are completed
- **Functions**: Pervasive, on-going management activities
Tasks: Small units of work

- **Smallest** unit of management accountability
  - Atomic unit of planning and tracking
  - Finite duration, need resources, produce tangible result (documents, code)

- Specification of a task: Work package
  - Name, description of work to be done
  - **Preconditions** for starting, duration, required **resources**
  - Work product to be produced, acceptance criteria for it
  - Risk involved

- Completion criteria
  - Includes the acceptance criteria for the work products (deliverables) produced by the task.
Activities: Major Units of Work

- Culminates in major project milestone:
  - Internal checkpoint should not be externally visible
  - Scheduled event used to measure progress
- Milestone often produces baseline:
  - Formally reviewed work product
  - Under change control (change requires formal procedures)
- Activities may be grouped into larger activities:
  - Establishes hierarchical structure for project (phase, step, ...)
  - Allows separation of concerns
  - Precedence relations often exist among activities (PERT Chart)
Examples of Activities

- **Major Activities:**
  - Planning
  - Requirements Elicitation
  - Requirements Analysis
  - System Design
  - Object Design
  - Implementation
  - System Testing
  - Delivery

- **Activities during requirements analysis:**
  - Refine scenarios
  - Define Use Case model
  - Define object model
  - Define dynamic model
  - Design User Interface
Project “Functions”

- **Examples:**
  - Project management
  - Configuration Management
  - Documentation
  - Quality Control (Verification and validation)
  - Training

- Project Functions in the IEEE 1058 standard are called *Integral processes* in the IEEE 1074 standard.
Organizational Diagrams

- Work breakdown structure (WBS): Shows hierarchy of work products

- PERT chart: Shows the order in which activities must be done (a partial order)

- Gantt Chart or Schedule: Shows scheduling of work products as a function of time
Creating Work Packages

- Work Breakdown Structure (WBS)
  - Break up project into activities (phases, steps) and tasks.
  - The work breakdown structure does not show the interdependence of the tasks
Work Breakdown Structure (WBS) Diagram

Source: Pleeger, ch. 3
WBS Tradeoffs

- Work breakdown structure influences cost and schedule
- Determination of work breakdown structure may be incremental and iterative
PERT Chart

- “Program Evaluation and Review Technique”
- U.S. Navy, 1957
PERT chart
(Similar to UML Activity Diagram)
To Build a PERT chart

- List all the tasks.
- For each task:
  - List the tasks that must (immediately) precede that task
  - Remove *implied* dependencies (called the "transitive reduction" of the graph)
Tasks in Building a House: What are likely required orders?

- Install roofing
- Install interior electrical
- Buy materials
- Excavate
- Build outside wall
- Install interior plumbing
- Install exterior siding
- Paint interior
- Install flooring
- Lay foundation
- Obtain permits
- Install exterior electrical
- Install exterior doors and fixtures
- Paint exterior
- Survey land
- Install interior doors and fixtures
- Install wallboard
- Install exterior plumbing
## Task durations and dependencies

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration (days)</th>
<th>Dependencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>8</td>
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<tr>
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<td>T3</td>
<td>15</td>
<td>T1</td>
</tr>
<tr>
<td>T4</td>
<td>10</td>
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<tr>
<td>T5</td>
<td>10</td>
<td>T2, T4</td>
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<td>T6</td>
<td>5</td>
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<td>T9</td>
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<td>T10</td>
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<td>T5, T7</td>
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<tr>
<td>T11</td>
<td>7</td>
<td>T9</td>
</tr>
<tr>
<td>T12</td>
<td>10</td>
<td>T11</td>
</tr>
</tbody>
</table>

source: Ian Sommerville, Software Engineering, 5th Ed.
Task network with Milestones (ovals)

Precedence (rightward implied)

source: Ian Sommerville, Software Engineering, 5th Ed.
As we saw, PERT enforces certain **precedence** constraints.

Other kinds of constraints:

- **Staff assignment** (task -> person) and loading constrains number of activities that can go on concurrently.
- **Resource availability** further constrains time at which various activities can happen.

The **Gantt chart** (or schedule) shows a particular scheduling of the tasks, subject to all of the constraints.
Gray bars show \textit{slack} in activity.

source: Ian Sommerville, Software Engineering, 5th Ed.
## Real-life Gantt Chart

*(source: http://www.kidasa.com/information/examples/aerospace/aerospace2.html)*

### Master Schedule

<table>
<thead>
<tr>
<th>WBS</th>
<th>ACTIVITY</th>
<th>FY99</th>
<th>FY00</th>
<th>FY01</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>1.1</td>
<td>MODEM</td>
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<tr>
<td>1.2</td>
<td>TRANSMITTER</td>
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<tr>
<td>1.3</td>
<td>RECEIVER</td>
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</tr>
<tr>
<td>1.4</td>
<td>BASEBAND EQUIP</td>
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<tr>
<td>1.5</td>
<td>ANTENNA SUBSYSTEM</td>
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<td>2</td>
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<tr>
<td>3</td>
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<td>3.2</td>
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<tr>
<td>3.3</td>
<td>MANAGEMENT DATA</td>
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</table>

<table>
<thead>
<tr>
<th>SCHEDULED EVENT</th>
<th>COMPLETED EVENT</th>
<th>CRITICAL MILESTONE</th>
<th>SUMMARY SCHEDULE</th>
</tr>
</thead>
</table>

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*Legend:*
- ▲ SCHEDULED EVENT
- ▼ COMPLETED EVENT
- ◇ CRITICAL MILESTONE
- ← SUMMARY SCHEDULE
Henry L. Gantt (1861-1919)
(http://accel-team.com/scientific/scientific_04.html)

- well-known pioneer in the early days of scientific management
- remembered for his humanizing influence on management, emphasizing the conditions that have favorable psychological effects on the worker
- “The Gantt chart for which he will be remembered, is a visual display chart used for scheduling, which is based on time, rather than quantity, volume or weight.”
A “critical path” on a PERT chart is one in which the *sum of durations* of the tasks on the path equals the *shortest* overall project-completion time.

The critical path is shaded on the preceding diagram.

PERT is also called *CPM* (Critical Path Method)
What is the Critical Path in Building your House, given the number of days required as shown?

- Install roofing (4)
- Install interior electrical (2)
- Buy materials (5)
- Excavate (7)
- Build outside wall (5)
- Install interior plumbing (4)
- Install exterior siding (3)
- Paint interior (2)
- Install flooring (2)
- Lay foundation (2)

- Obtain permits (24)
- Install exterior electrical (3)
- Install exterior doors and fixtures (2)
- Paint exterior (1)
- Survey land (1)
- Install interior doors and fixtures (2)
- Install wallboard (2)
- Install exterior plumbing (1)
Exercise

• List as many ways you can for shortening the critical path in a set of tasks.
Staff Loading & Resources

- Staff loading and resource constraints are two aspects of scheduling not represented directly on PERT charts.
- Generally they have the effect of providing added sequencing, and therefore lengthening overall project time.
Staff Loading & Resources

- Staff loading refers to:
  - Some tasks can be assigned only to certain staff members, based on specialized skills.
  - A given staff member can only do so much at a time.
  - Staff members differ in their productivity on a given task.
Staff loading

source: Ian Sommerville, Software Engineering, 5th Ed.
Resource constraints refers to certain resources being needed for certain tasks, but being limited in the number of tasks they can support concurrently.

Resources include:
- Machines, workstations, storage units
- Rooms, offices
Exercise

- How Do Constraints Differ from Precedence Relationships?