Chapter 5

Project Management

“...a huge topic.” See Part 6, “Managing People”.

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Project management

- Organizing, planning and scheduling software projects
Objectives

- To introduce software project management and to describe its distinctive characteristics.
- To discuss project planning and the planning process.
- To show how graphical schedule representations are used by project management.
- To discuss the notion of risks and the risk management process.
Topics covered

- Management activities
- Project planning
- Project scheduling
- Risk management
Software project management

- Concerned with activities involved in ensuring that software is delivered on time, within budget and in accordance with the requirements of the organizations developing and procuring the software.

- Project management is needed because software development is always subject to budget and schedule constraints that are set by the organization developing the software.
SE distinctions that make project management particularly difficult

1. The product is *intangible*.
   • In shipbuilding or civil engineering, managers can *SEE* the product being developed.

2. There are *no standard software processes*.
   • Engineering disciplines with a long history have tried and tested processes.

3. Large software projects are often *“one-off”*. (one-of-a-kind)
   • Lessons learned from previous projects may not be transferable to new projects.
Management activities

- Proposal writing (to fund new projects)
- Project planning and scheduling (focus of this Chap)
- Project costing and preparing bids (Chap 26)
- Project monitoring and reviews
- Personnel selection and evaluation (Chap 25)
- Report writing and presentations
- Attending lots and lots of meetings!
  - IBM Santa Teresa study, etc., …
Management commonalities

- These activities are *not* peculiar to software management.
- *Many techniques* of engineering project management are *equally applicable* to software project management.
- Technically complex engineering systems tend to suffer from *most* of the same problems as software systems.
Project staffing

- May not be possible to appoint the *ideal* people to work on a project…
  - Project *budget* may not allow for use of highly-paid staff.
  - Those with appropriate skills / experience *may not be available*.
  - An organization may wish to develop employee skills by assigning *inexperienced* staff.

- *Managers have to work within these constraints especially when there is a shortage of skilled IT staff.*
Project planning

- Probably the most time-consuming project management activity (or at least it should be).
- Continuous activity from initial concept to system delivery. Plans must be regularly revised as new information becomes available.
- Different types of sub-plans may be developed to support a main software project plan concerned with overall schedule and budget.
# Types of project sub-plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality plan (QA)</td>
<td>Describes the quality procedures and standards that will be used in a project.</td>
</tr>
<tr>
<td>Validation plan</td>
<td>Describes the approach, resources and schedule used for system validation.</td>
</tr>
<tr>
<td>Configuration management plan</td>
<td>Describes the configuration management procedures and structures to be used.</td>
</tr>
<tr>
<td>Maintenance plan</td>
<td>Predicts the maintenance requirements of the system, maintenance costs and effort required.</td>
</tr>
<tr>
<td>Staff development plan</td>
<td>Describes how the skills and experience of the project team members will be developed.</td>
</tr>
</tbody>
</table>
Project planning

“The plan is nothing – the planning is everything.”

– Dwight Eisenhower, on the D-Day invasion plan

(a bit of dramatic overstatement to make a point…)
Project planning process

Establish the project constraints
Make initial assessments of the project parameters
Define project milestones and deliverables

while project has not been completed or cancelled loop

Draw up project schedule
Initiate activities according to schedule
Wait (for a while) - not idle time...
Review project progress
Revise estimates of project parameters
Update the project schedule
Re-negotiate project constraints and deliverables

if (problems arise) then
    Initiate technical review and possible revision
end if

end loop
The project plan

- The project plan sets out:
  - The resources available to the project;
  - The work breakdown;
  - A schedule for the work.
Project plan document structure

- Introduction (goals, constraints, etc.)
- Project organization
- Risk analysis
- Hardware and software resource requirements
- Work breakdown
- Project schedule
- Monitoring and reporting mechanisms
Activity organization

- **Activities** in a project should be associated with *tangible outputs* for management to judge progress (i.e., to provide *process visibility*).
- **Milestones** are the *unequivocal* end-points of process activities.

  e.g., “**DR1 complete**” versus “**90% of design complete**”
Activity organization

- **Deliverables** are project results delivered to customers. (There are also *internal* “deliverables”.)

- The *waterfall model* allows for the straightforward definition of milestones (“*a deliverable oriented model*”).

- **Deliverables are always milestones, but milestones are not necessarily deliverables.**
Milestones in the RE process

MILESTONES

ACTIVITIES

Feasibility study → Requirements analysis → Prototype development → Design study → Requirements specification

Feasibility report → Requirements definition → Evaluation report → Architectural design → Requirements specification

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Project scheduling

- Split project into *tasks* and *estimate time and resources required* to complete each.
- Tasks should not be too small or too large – they should last on the order of *weeks* for projects lasting *months*. (“Models should be as simple as possible, but no simpler.”)
Project scheduling

- Organize tasks as *concurrent* activities to make optimal use of workforce.
- *Minimize task dependencies* to avoid potential delays.
- Dependent on project managers’ *intuition and experience*. (Good management is *not* a science.)
The project scheduling process

1. Identify activities
2. Identify activity dependencies
3. Estimate resources for activities
4. Allocate people to activities
5. Create project charts

Software requirements

Activity charts and bar charts

Review Progress
Scheduling problems

- Estimating the difficulty of problems, and hence the cost of developing solutions, is hard.
- Progress is generally not proportional to the number of people working on a task.
- Adding people to a late project can make it later (due to coordination overhead). (F. Brooks, *The Mythical Man-Month*)
- The unexpected always happens. Always allow for different contingencies in planning. (a.k.a. “Murphy’s Law”)
Bar charts and activity networks

- Graphical notations are often used to illustrate project schedules.
- **Activity charts** (a.k.a. *PERT* charts) show task dependencies, durations, and the critical path.
- **Bar charts** (a.k.a. *Gantt* charts) generally show resource (e.g., people) assignments and calendar time. (Sommerville calls these “staff allocation vs. time” charts.)

* Program Evaluation and Review Technique
## 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>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>15</td>
<td>T1 (M1)</td>
</tr>
<tr>
<td>T4</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>10</td>
<td>T2, T4 (M2)</td>
</tr>
<tr>
<td>T6</td>
<td>5</td>
<td>T1, T2 (M3)</td>
</tr>
<tr>
<td>T7</td>
<td>20</td>
<td>T1 (M1)</td>
</tr>
<tr>
<td>T8</td>
<td>25</td>
<td>T4 (M5)</td>
</tr>
<tr>
<td>T9</td>
<td>15</td>
<td>T3, T6 (M4)</td>
</tr>
<tr>
<td>T10</td>
<td>15</td>
<td>T5, T7 (M7)</td>
</tr>
<tr>
<td>T11</td>
<td>7</td>
<td>T9 (M6)</td>
</tr>
<tr>
<td>T12</td>
<td>10</td>
<td>T11 (M8)</td>
</tr>
</tbody>
</table>
Activity network

\[ |CP| = 55 \]
How much potential “slack time” is associated with Task J?

If J is on the Critical Path, CP, then 0

Else

|CP| - |JL|

where JL is the longest path containing J
Consider Task T4...
Activity timeline

Start: 4/7
Finish: 19/9

Duration calculation:

potential slack time: 55 - 35 = 20 days
Staff allocation (Gantt) Chart

<table>
<thead>
<tr>
<th></th>
<th>4/7</th>
<th>11/7</th>
<th>18/7</th>
<th>25/7</th>
<th>1/8</th>
<th>8/8</th>
<th>15/8</th>
<th>22/8</th>
<th>29/8</th>
<th>5/9</th>
<th>12/9</th>
<th>19/9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred</td>
<td>T4</td>
<td></td>
<td>T8</td>
<td></td>
<td></td>
<td></td>
<td>T11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jane</td>
<td>T1</td>
<td>T3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anne</td>
<td>T2</td>
<td></td>
<td>T6</td>
<td>T9</td>
<td></td>
<td></td>
<td>T10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jim</td>
<td>T7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mary</td>
<td>T5</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Risk management

- Risk management is concerned with identifying risks and drawing up plans to minimize their effect on a project.
Risk management (cont’d)

- A risk exists when there is a probability that some adverse circumstance will occur.
  - Project risks affect schedule or resources.
  - Product risks affect the quality or performance of the software being developed.
  - Business risks affect the organization developing or procuring the software.

(Taxonomy based on Effect)
<table>
<thead>
<tr>
<th>Risk</th>
<th>Risk type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff turnover</td>
<td>Project</td>
<td>Experienced staff will leave the project before it is finished.</td>
</tr>
<tr>
<td>Management change</td>
<td>Project</td>
<td>There will be a change of organisational management with different priorities.</td>
</tr>
<tr>
<td>Hardware unavailability</td>
<td>Project</td>
<td>Hardware which is essential for the project will not be delivered on schedule.</td>
</tr>
<tr>
<td>Requirements change</td>
<td>Project and product</td>
<td>There will be a larger number of changes to the requirements than anticipated.</td>
</tr>
<tr>
<td>Specification delays</td>
<td>Project and product</td>
<td>Specifications of essential interfaces are not available on schedule</td>
</tr>
<tr>
<td>Size underestimate</td>
<td>Project and product</td>
<td>The size of the system has been underestimated.</td>
</tr>
<tr>
<td>CASE tool under-performance</td>
<td>Product</td>
<td>CASE tools which support the project do not perform as anticipated</td>
</tr>
<tr>
<td>Technology change</td>
<td>Business</td>
<td>The underlying technology on which the system is built is superseded by new technology.</td>
</tr>
<tr>
<td>Product competition</td>
<td>Business</td>
<td>A competitive product is marketed before the system is completed.</td>
</tr>
</tbody>
</table>
The risk management process

- **Risk identification** – identify project, product and business risks
- **Risk analysis** – assess the *likelihood* and *consequences* of these risks
- **Risk planning** – draw up *plans to avoid or minimise* the effects of the risk
- **Risk monitoring** – *monitor* the risks throughout the project

We consider each of these activities in turn...
The risk management process

Risk identification
- List of potential risks

Risk analysis
- Prioritised risk list

Risk planning
- Risk avoidance and contingency plans

Risk monitoring
- Risk assessment
Risk identification

- Types
  - Technology risks
  - People risks
  - Organizational risks
  - Tools risks
  - Requirements risks
  - Estimation risks

(Taxonomy based on Source)
# Risks and risk types

<table>
<thead>
<tr>
<th>Risk type</th>
<th>Possible risks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>The database used in the system cannot process as many transactions per second as expected. Software components which should be reused contain defects which limit their functionality.</td>
</tr>
<tr>
<td><strong>People</strong></td>
<td>It is impossible to recruit staff with the skills required. Key staff are ill and unavailable at critical times. Required training for staff is not available.</td>
</tr>
<tr>
<td><strong>Organisational</strong></td>
<td>The organisation is restructured so that different management are responsible for the project. Organisational financial problems force reductions in the project budget.</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td>The code generated by CASE tools is inefficient. CASE tools cannot be integrated.</td>
</tr>
<tr>
<td><strong>Requirements</strong></td>
<td>Changes to requirements which require major design rework are proposed. Customers fail to understand the impact of requirements changes.</td>
</tr>
<tr>
<td><strong>Estimation</strong></td>
<td>The time required to develop the software is underestimated. The rate of defect repair is underestimated. The size of the software is underestimated.</td>
</tr>
</tbody>
</table>
Risk analysis

- Assess *probability* and *seriousness* of each risk.
- Probability may be very low, low, moderate, high or very high.
- Risk effects might be *catastrophic, serious, tolerable* or insignificant.
## Risk analysis

<table>
<thead>
<tr>
<th>Risk</th>
<th>Probability</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisational financial problems force reductions in the project budget.</td>
<td>Low</td>
<td>Catastrophic</td>
</tr>
<tr>
<td>It is impossible to recruit staff with the skills required for the project.</td>
<td>High</td>
<td>Catastrophic</td>
</tr>
<tr>
<td>Key staff are ill at critical times in the project.</td>
<td>Moderate</td>
<td>Serious</td>
</tr>
<tr>
<td>Software components which should be reused contain defects which limit their functionality.</td>
<td>Moderate</td>
<td>Serious</td>
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<td>The database used in the system cannot process as many transactions per second as expected.</td>
<td>Moderate</td>
<td>Serious</td>
</tr>
<tr>
<td>The time required to develop the software is underestimated.</td>
<td>High</td>
<td>Serious</td>
</tr>
<tr>
<td>CASE tools cannot be integrated.</td>
<td>High</td>
<td>Tolerable</td>
</tr>
<tr>
<td>Customers fail to understand the impact of requirements changes.</td>
<td>Moderate</td>
<td>Tolerable</td>
</tr>
<tr>
<td>Required training for staff is not available.</td>
<td>Moderate</td>
<td>Tolerable</td>
</tr>
<tr>
<td>The rate of defect repair is underestimated.</td>
<td>Moderate</td>
<td>Tolerable</td>
</tr>
<tr>
<td>The size of the software is underestimated.</td>
<td>High</td>
<td>Tolerable</td>
</tr>
<tr>
<td>The code generated by CASE tools is inefficient.</td>
<td>Moderate</td>
<td>Insignificant</td>
</tr>
</tbody>
</table>
Risk planning

- Consider each risk and develop a strategy to manage that risk.
- **Avoidance strategies** – the *probability* that the risk will arise *is reduced*.
- **Minimisation strategies** – the *impact* of the risk on the project or product *is reduced*.
- **Contingency plans** – if the risk arises, contingency plans are plans to deal with that risk. *(to effect the minimisation strategy)*
## Risk management strategies

<table>
<thead>
<tr>
<th>Risk</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisational financial problems</td>
<td>Prepare a briefing document for senior management showing how the project is making a very important contribution to the goals of the business.</td>
</tr>
<tr>
<td>Recruitment problems</td>
<td>Alert customer of potential difficulties and the possibility of delays, investigate buying-in components.</td>
</tr>
<tr>
<td>Staff illness</td>
<td>Reorganise team so that there is more overlap of work and people therefore understand each other’s jobs.</td>
</tr>
<tr>
<td>Defective components</td>
<td>Replace potentially defective components with bought-in components of known reliability.</td>
</tr>
<tr>
<td>Requirements changes</td>
<td>Derive traceability information to assess requirements change impact, maximise information hiding in the design.</td>
</tr>
<tr>
<td>Organisational restructuring</td>
<td>Prepare a briefing document for senior management showing how the project is making a very important contribution to the goals of the business.</td>
</tr>
<tr>
<td>Database performance</td>
<td>Investigate the possibility of buying a higher-performance database.</td>
</tr>
<tr>
<td>Underestimated development time</td>
<td>Investigate buying in components, investigate use of a program generator.</td>
</tr>
</tbody>
</table>
Risk monitoring

- Assess each identified risk regularly to decide whether or not it is becoming less or more *probable*.
- Also assess whether the *effects* of the risk have changed.
- Each key risk should be discussed at management progress meetings.
### Risk factors

*(≈warning signs)*

<table>
<thead>
<tr>
<th>Risk type</th>
<th>Potential indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Late delivery of hardware or support software, many reported technology problems</td>
</tr>
<tr>
<td>People</td>
<td>Poor staff morale, poor relationships amongst team member, job availability</td>
</tr>
<tr>
<td>Organisational</td>
<td>Organisational gossip, lack of action by senior management</td>
</tr>
<tr>
<td>Tools</td>
<td>Reluctance by team members to use tools, complaints about CASE tools, demands for higher-powered workstations</td>
</tr>
<tr>
<td>Requirements</td>
<td>Many requirements change requests, customer complaints</td>
</tr>
<tr>
<td>Estimation</td>
<td>Failure to meet agreed schedule, failure to clear reported defects</td>
</tr>
</tbody>
</table>
Key points

- Good project management is essential for project success. (Necessary, but not sufficient…)
- The intangible nature of software causes problems for management.
- Managers have diverse roles, but their most significant activities are planning, estimating, and scheduling.
- Planning and estimating are iterative processes which continue throughout the course of a project.
Key points (cont’d)

- A project *milestone* is a predictable state where some formal report of progress is presented to management.

- Risks may be *project* risks, *product* risks or *business* risks. (and: technology, people, organisational, tools, requirements, or estimation risks)

- Risk management is concerned with *identifying risks* which may affect the project, and *planning* to ensure that these risks do not develop into major threats.
Chapter 5

Project Management

“...a huge topic.” See Part 6, “Managing People”.