Session 4: Cross-Cutting Activities
Learning Outcomes

- List key project management activities
- State role of configuration management
- Explain why change control is important
- List elements of risk management
Crosscutting Activities and The “V”
1) Project Management
   a) Project Planning
   b) Project Monitoring and Control
2) Configuration Management
3) Traceability
4) Risk Management
Project Planning

- Project Plan defines
  - Scope of Work
    - Tasks
    - Deliverables
  - Resources and budget
  - Schedule

- Systems Engineering Management Plan
  - How SE will be applied on your project
### Project Plan for Small, Low-Risk Project
Can Be a Simple Table

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Task Activities</th>
<th>Results / Decisions</th>
<th>Start Date</th>
<th>End Date</th>
<th>Budget</th>
<th>Task Staffing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Project Mgmt.</td>
<td>a. Write PMP</td>
<td>a. PMP</td>
<td>Jan. 2008</td>
<td>Dec. 2008</td>
<td>$10,000</td>
<td>John is PM; does it all</td>
</tr>
<tr>
<td></td>
<td>b. Prog. Rpts</td>
<td>b. Prog. Rpt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example Outline:

1. Purpose of document
2. Scope of project
3. Project tasks
4. Work Breakdown Structure and task budgets
5. Schedule constraints (external, internal)
6. Deliverable Requirements List
7. Referenced documents

Template and Checklist in CA SEGB, Sec. 8.4.1
Project Planning - Work Breakdown Structure (WBS)

- Divides project into manageable pieces
- Requires focus on deliverables
  - Output needed for all WBS elements
- Schedule, budget and resources tied to WBS for planning and monitoring
- Well defined work packages
<table>
<thead>
<tr>
<th>WBS No.</th>
<th>Activity</th>
<th>Output(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Planning</td>
<td>Grocery List</td>
</tr>
<tr>
<td>1.1</td>
<td>Check food supply</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Prepare grocery list</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>Purchase groceries</td>
<td>Groceries</td>
</tr>
<tr>
<td>2.1</td>
<td>Purchase fruit</td>
<td></td>
</tr>
<tr>
<td>2.1.1</td>
<td>Select fruit</td>
<td></td>
</tr>
<tr>
<td>2.1.2</td>
<td>Weigh &amp; bag fruits</td>
<td>Fruit in cart</td>
</tr>
<tr>
<td>2.2</td>
<td>Purchase meat</td>
<td>Meat in cart</td>
</tr>
<tr>
<td>2.3</td>
<td>Check out</td>
<td>Register receipt</td>
</tr>
</tbody>
</table>
WBS is the Basis for Scheduling
Progress can only be tracked if it can be measured.

Many types of metrics
- Miles of roadway paved
- No. of detectors installed
- No. of stakeholders contacted
- No. of buses equipped

Dollars/hours spent is not a measure of progress!
Two Types of Metrics

1. Metrics used to determine whether the system objectives are met. i.e. Changes in incident response times.

2. Metrics used to track design and development progress. i.e. Pages of documentation completed.
Examples of Development Metrics

- Number of requirements defined
- % of data elements entered in DB
- Number of software modules completed
- Number of field sites installed
- Number of acceptance tests passed
Characteristics of Good Metrics

- The metrics should not divert development resources. They should be:
  - Easy to obtain and/or measure
  - Limited in number
- Metrics should be a true representation of progress
Earned Value Analysis (EVA)

- Technique for quantifying project status
  - Are you on schedule and budget
  - How much time and money is needed for completion

- Assumes that you have:
  - Allocated resources to each task
  - Calculated costs for each task
  - Defined a metric for each task
Calculating Earned Value (EV)

EV = (Task Budget) x (Physical % Complete)

- Task defined by WBS
- Budget developed during project planning
- Physical % Complete based on metrics
Earned Value is the Starting Point

How much will it cost to finish this task?

Cost at Completion = \( \frac{\text{Actual Cost}}{\text{Physical % Complete}} \)

Is the project on-budget?

Performance Ratio = \( \frac{\text{Earned Value}}{\text{Actual Cost}} \)
Solve the following problem

The Facts:
A requirements task has been budgeted to cost $100,000
150 of 500 anticipated requirements have been defined
Expenditures to date are $45,000

The Questions:
1) What is the earned value? i.e. The value of work performed so far.
2) What is the cost at completion? i.e. The estimated amount of money to finish the work.
3) What is the performance ratio? i.e. How are we doing?
Earned Value is an Extrapolation
Corrective Action - Schedule

BAD

- Add staff
- Reduce schedule for later tasks
- Work overtime
- Abandon testing

GOOD

- Extend schedule
- Reduce functionality
Corrective Action - Budget

BAD
- Squeeze contractor
- Add lower cost labor
- Abandon project controls/testing

GOOD
- Extend schedule
- Reduce functionality
“Adding manpower to a late software (based) project makes it later.”

— Brooks, 1975
Project Monitoring and Control - Tying It All Together

The Project

WBS

Task 1
Task 2
Task 3
Other Tasks

Task 1 Metrics
Task 2 Metrics
Task 3 Metrics

Task 1 EV
Task 2 EV
Task 3 EV

Project Status

Actual Task 1 progress
Actual Task 2 progress
Actual Task 3 progress

Actual Task 1 progress
Actual Task 2 progress
Actual Task 3 progress
Project Reviews

- Keep all parties informed
- Provide visibility into the “true” progress of the project
- Control decision to proceed with next project phase.
- Validate that the product being produced is the one that is intended
- Recognize problems quickly

DON’T SHOOT THE MESSENGER!!!
Project Reviews

- Technical Reviews
  - Project planning
  - System requirements
  - Design
  - Readiness (system, documentation and test)

- Programmatic Reviews
  - Budget, Schedule, Resources
1) Project Management

2) Configuration Management
   a) Why CM?
   b) Configuration Identification
   c) Change Management

3) Traceability

4) Risk Management
Why Configuration Management?

- Change is inevitable
- Even “small” changes, if not controlled, can have major effects
- Essential for an efficient development process
- Essential for maintenance
Configuration Management (CM)

- Controls design as system moves through its life cycle
- Establishes system baselines
- Controls how changes are made
- Communicates all approved changes
Configuration Management Activities

CM Planning

Configuration Identification

Change Management

Status Accounting

Configuration Audits

CM Plan/Process

Product & Document Identification

Approved Changes

Status Of Configuration Item Information

Product Confidence
Configuration Identification: Hardware

- Hardware configuration can be tracked at the Part, Subassembly, Assembly, and Unit levels
- Pick the level of control best suited to your project
Traffic Signal Controller Example

- Part
- Subassembly
- Assembly
- Unit
- Processor chip
- Printed circuit board
- Traffic signal controller
- Controller cabinet
Configuration Identification: Software

- Source code for application programs
- Executable application code
- Test cases
- Third-party software
- Development environment
- Documentation
Change Management is Important

Causes of Change Requests

- Errors in system specifications
- External factors (e.g., legislation)
- Advances in technology
- Upgrades
- Additional capabilities requested by users
  - Justified
  - Unjustified
- “Improved” solutions proposed by technical team
Configuration Control Board (CCB)

- Reviews all proposed changes for impact on budget and schedule
- Prioritizes changes – identifies changes that can be postponed to future
- Limits “Scope Creep”
CCB Members

- Agency’s and contractor’s project managers
- At least one key user representative
- Senior manager with funding responsibility
- Configuration manager
- Quality control manager
- Systems engineer
Change Control Process

1. Submit change request
2. Assess impact and prepare recommendation
3. Submit report to CCB
4. CCB deliberates and decides
5. Document approved changes
6. Update traceability matrices
Traceability

1) Project Management
2) Configuration Management
3) Traceability
4) Risk Management
It is important to have unique project references to:

- User Needs and Scenarios
- Requirements
- Design elements
- Software and Hardware items
- Test Plans and Procedures

<table>
<thead>
<tr>
<th></th>
<th>Unique references</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The system shall generate …</td>
</tr>
<tr>
<td>1.2</td>
<td>The system shall provide …</td>
</tr>
<tr>
<td>2.1</td>
<td>The system shall collect…</td>
</tr>
<tr>
<td>2.2</td>
<td>The system shall store…</td>
</tr>
</tbody>
</table>
...in Order to Have Traceability

- **Both** forward traceability
  - Needs and requirements are satisfied by the design and implementation
  - Requirements are verified by tests

- **And** backward traceability
  - Every design and implementation item has corresponding user needs and requirements
  - Each test verifies one or more requirements
Requirements:
2.0 The system shall have the ability to monitor traffic
   2.1 The system shall measure traffic volumes

Specification:
3.83 System processing of volume data shall be performed by summing the actuations of each detector …

Implementation (software modules):
17.6.1 Detector data input module
18.3.4 Volume summation module
2.4.5 Volume storage (DBMS interface)

Test:
8.0 Compare calculated volume with actual volume
### Traceability Matrix Illustration

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Specifications</th>
<th>Implementations</th>
<th>Verification (Acceptance Tests)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>1.1, 2.6</td>
<td>2.0, 3.4, 5.1.1</td>
<td>1.0</td>
</tr>
<tr>
<td>1.2</td>
<td>1.2</td>
<td>6.8</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>2.1</strong></td>
<td><strong>3.83</strong></td>
<td><strong>17.6.1, 18.3.4, 2.4.5</strong></td>
<td><strong>8.0</strong></td>
</tr>
<tr>
<td>2.2</td>
<td>4.9</td>
<td>12.2, 17.10</td>
<td>2.0</td>
</tr>
<tr>
<td>2.3</td>
<td>3.5</td>
<td>6.6</td>
<td>9.0</td>
</tr>
</tbody>
</table>
Risk Management

1) Project Management
2) Configuration Management
3) Traceability
4) Risk Management
   a) Sources of Risk
   b) Risk Planning
   c) Risk Control
Sources of Risks

- Technology
- People
- Physical environment
- Political environment
- Contract issues

*Increased risk = Increased costs and delays*
Top 10 Generic Risks

1. Personnel shortfalls
2. Unrealistic schedules and budgets
3. Functions not right
4. User interface not right
5. “Gold-plating”

Source: Kemerer
Top 10 Generic Risks, continued

6. Requirements changes (scope creep)
7. Component shortcomings
8. External dependencies (subcontractors, government-furnished equipment, etc.)
9. Real-time performance shortfalls
10. Unrealistic technical requirements

Source: Kemerer
Elements of Risk Management

Risk Management
- Risk Planning
  - Risk Identification
  - Risk Analysis
  - Risk Prioritization
- Risk Control
  - Risk Monitoring
  - Risk Resolution
Sample Qualitative Risk Planning Process

1. List Risks
2. Determine Risk Likelihood
3. Determine Risk Impact
4. Plan for Top 10

Experts

Project Participants
Sample Risk Control Strategy

- Periodically check the Top 10 risks
  - Include health/status as agenda item on project progress meetings
- Take risk resolution actions if needed
Let’s Practice – A Real Life Example

- **Risk:** Contractors worry that agencies will not review documentation. When final system does not meet expectations, contractor is required to revise the final product – at great cost!

- How would you avoid the risk?
- What is your mitigation strategy?
Risk Example – Some Answers

- Include submissions and review times in schedule
- Discuss impacts and schedule of review slippages at monthly review meetings.
- Agree that contractor will NEVER proceed on their own with work dependent on review
- Compensate contractor for missed reviews
Learning Outcomes

- List key project management activities
- State role of configuration management
- Explain why change control is important
- List elements of risk management