



Defining the Project Tasks, Cost and Schedule



Cost and Schedule Estimates



- The principal measures of a project are cost, time (schedule), and performance
- For a given project, one or more of these measures may be constrained
 - For LaACES the launch opportunity has a fixed date, and you must have a payload ready by this date
- Initial estimates on cost and schedule are essential to determine if your plan is realistic
 - May need to plan for (or implement) trade-offs according to established priorities
- Cost and schedule need to be monitored throughout the project life-cycle



Determining the project scope



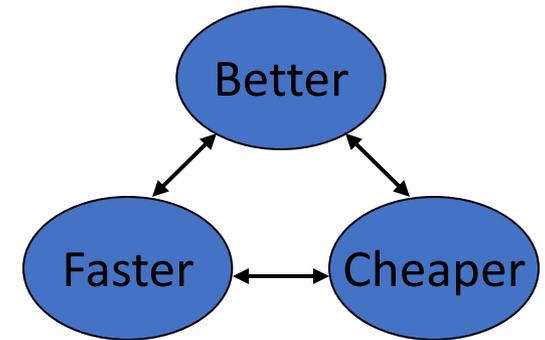
- Defining the project scope is a necessary precursor to developing an effective project plan.
- Determining the scope includes addressing the following questions:
 - What are the major objectives for the project?
 - What are the major deliverables or outputs over the life of the project and when are they due?
 - What are the significant events or milestones that will happen during the project?
 - What technical requirements must be satisfied?
 - What are the project constraints or limits that must be taken into account?
- This effort goes hand-in-hand with development of the system requirements.



Determining the project priorities



- The primary measures of a project are in terms of cost, schedule and performance
- Usually very difficult (impossible ?) to enhance or optimize all three of these measures at the same time
- Establishing the priorities at project start provides guidance for trade-offs
 - Required to stay fixed or constrained? (e.g. fixed budget or schedule)
 - Allowed or desired to be enhanced? (e.g. better or cheaper)
 - Acceptable to exceed? (e.g. increased cost, schedule slip, downsized)
- All three priority types should be used when ranking the primary measures of cost, time and performance
- Priorities can change, so these need to be reviewed at times



Pick two

(ancient engineering wisdom)



Steps to defining the project tasks



- Tasks can be broken down in a similar process to how systems and then subsystems are defined
- Create the Work Breakdown Structure (WBS)
 - Determine the highest level, most general tasks
 - Example “3. Fabricate Flight Payload.”
 - Establish a numbered “tree structure” of lower-level tasks under each task
 - Subtask for 3, “3.1 Fabricate Power System, 3.2 Fabricate Data Archive ...”
 - Repeat until the tasks are small and well defined, where a reasonable cost and time can be estimated
 - Ex. “3.1.1 Assemble 5V regulator circuit(0.5 Hours), 3.1.2 Load Test 5V regulator (2 Hours)”



Organizing the project tasks



- Are tasks focused on producing a tangible result?
 - Project and tasks are structured by concrete products or deliverables (e.g. building a hydroelectric dam)
 - Task definitions breakdown into subdeliverables, further sub-deliverables and work packages
 - Can be run in a highly parallel fashion
- Are tasks focused on processes or phases?
 - Project evolves over time where results from one phase affect tasks in subsequent phases
 - Tasks and “deliverables” defined as outputs needed to move to next phase
- Many aerospace projects are actually a combination of these two structures
 - Phases allow new innovations to be defined and developed
 - Tangible results (e.g. spacecraft) occur during the project



The Work Breakdown Structure



- This numbered list of tasks is called the Work Breakdown Structure (WBS)
- NASA definition of the WBS
 - A family tree subdivision of effort to achieve an end objective
 - Developed by starting with the end objective required and successively subdividing it into manageable components in terms of size and complexity
 - Product or task oriented and should include all the effort necessary to achieve the end objective



Why use a WBS?



- Identifies the tasks, subtasks and units of work necessary to complete the project
- Identifies the relationships between tasks
- Increases the probability that every requirement will be accounted
- Organize areas of responsibility and authority
- Used to estimate project cost and schedule
- Can be used to track the costs of each element
- Can be used to monitor progress by completion of tasks



WBS Structure



- The WBS has a hierarchical structure
 - Most general units at the highest level
 - Most specific units at the lowest level
 - Use a “tree structure” to provide task details
- 1.0 Major Task A
 - 1.1 Sub Task A
 - 1.2 Sub Task B
 - 1.2.1 Sub Unit A
 - 1.2.2 Sub Unit B
 - 2.0 Major Task B
 - 3.0 Major Task C
- For most projects, it is unlikely to need to split subunits to below level 4
 - Each unit should have an identifier code representing the hierarchical tree structure (e.g. see figure)
 - You also need to identify which task are prerequisites of other tasks



WBS Subunits



- Each WBS subunit is a deliverable of some kind
 - May be documentation such as system requirements, ICD documents, test results, etc.
 - Concrete products such as power system, real-time clock software module, sensor readout system, etc.
- Lowest WBS level is defined by Work Packages
- The contents of a Work Package include:
 - Description of the work to be done, including a time schedule
 - The resources needed and the cost of the work (time and money)
 - The person responsible for assuring the work is completed
- A sum or “roll up” of the Work Packages yields a cost and time estimate for the unit



Example WBS (Incomplete)



- Example takes one subunit down to level 4
- Many times level 3 is sufficient and level 4 defines the work package
- Each major unit has a similar level 2 list of subunits
- Each level 2 subunit has a similar level 3 list of subunits

- 1.0 Power System
 - 1.1 Power Source
 - 1.2 FCU Supply
 - 1.3 DAU HD Supply
 - 1.4 DAU Supply
 - 1.5 CubeSat Supply
 - 1.5.1 Interface to power source
 - 1.5.2 FCU Control Interface
 - 1.5.2.1 Establish control requirements
 - 1.5.2.2 Design control interface
 - 1.5.2.3 Prototype & test design
 - 1.5.2.4 Complete design
 - 1.5.2.5 Implement & test design
 - 1.5.3 DC/DC Converters
 - 1.5.4 FCU Monitoring Interface
 - 1.6 Integrate & test power system
- 2.0 Flight Control Unit
- 3.0 Data Archive Unit
- 4.0 Data Archive Disk
- 5.0 Auxiliary Transmitter
- 6.0 Mechanical Structure
- 7.0 Thermal Control
- 8.0 System Integration & Testing
- 9.0 Management



Steps to developing the estimates



- Develop the general project definition and set of tasks
- Perform a rough cost and time estimate
- Develop the detailed project definition, tasks and WBS
- Estimate the cost and time for each individual, lowest level element of the WBS
- Roll-up (add) the cost and time for each low level WBS elements to obtain the estimates for higher level elements
- Establish the project schedules
- Reconcile differences between the macro and micro estimates



Estimating Techniques



- **Scaling:** Given a cost for a previous project then an estimate for a new project can be scaled from the known cost. E.g NASA, at times, uses spacecraft weight to estimate total cost.
- **Ratio:** Costs for subunits of the new project would be proportional to similar subunits in a previous project. For example, if it takes 1 day to build & test a particular sensor unit, then an instrument with 10 sensors would take 2 technicians, 5 days to complete.
- **Learning Curve:** If the same task is repeated a number of times there will be a cost / time savings relative to the first time the task is done.
- **WBS Roll-up:** Times and costs associated with the lowest level WBS work packages are estimated and then these are added or rolled-up to yield the costs for higher level units.



Guidelines for Estimates



- Estimates should be done by the person most familiar with the task
- Base the estimates upon normal conditions
- Use consistent units when estimating task time
- Work package estimates should not include contingencies
- Use a separate risk assessment for estimating the effect of abnormal conditions and contingencies
- If possible, obtain estimates from several people and use the variance for risk assessment



Example WBS Cost Roll-up



WBS Element

Estimated Time and Dollar Costs

1.0 Power System					155.0d	\$7560
1.1 Power Source				25.0d	\$1340	
1.2 FCU Supply				20.0d	\$970	
1.3 DAU HD Supply				15.0d	\$530	
1.4 DAU Supply				20.0d	\$970	
1.5 CubeSat Supply				45.0d	\$2450	
1.5.1 Interface to power source			10.0d	\$300		
1.5.2 FCU Control Interface			14.0d	\$970		
1.5.2.1 Establish requirements	0.5d	\$20				
1.5.2.2 Design control interface	1.5d	\$50				
1.5.2.3 Prototype & test design	5.0d	\$300				
1.5.2.4 Complete design	2.0d	\$100				
1.5.2.5 Implement & test design	5.0d	\$500				
1.5.3 DC/DC Converters			8.5d	\$730		
1.5.4 FCU Monitoring Interface			12.5d	\$450		
1.6 Integrate & test power system					30.0d	\$1300
2.0 Flight Control Unit					120.0d	\$3000
3.0 Data Archive Unit					90.0d	\$2500
4.0 Auxiliary Transmitter					35.0d	\$1500
6.0 Mechanical Structure					100.0d	\$3500
7.0 Thermal Control					65.0d	\$1750
8.0 System Integration & Testing					55.0d	\$6000
9.0 Management					90.0d	\$1200
Total Project Estimate					710.0d	\$27010