Project Planning
(WBS, Cost and Schedule)

Ted Lavine
NLC Project Planning & Coordinating Group
Planning and Management Tools in Place for the Conceptual Design Phase (Slide 1 of 3)

• Cost Estimating
  – *Success* relational database for WBS estimating and roll-up, using Project Summary WBS.
  – *Excel* for bottom-up cost detail

• Integrated Schedule Development
  – Integrated project schedule is in use as a working tool
  – Plans are defined to prepare for the execution phase
  – *Primavera Project Planner* for cost-loaded project scheduling
  – *Primavera Suretrak Project Manager* for sub-schedule development
  – Microsoft *Project* and *Excel* used for stand-alone sub-schedules and resource analyses
Planning and Management Tools in Place for the Conceptual Design Phase (Slide 2 of 3)

• **Cost Management Plans**
  - Cost/schedule performance measurement using *Cobra*, following the experience of PEP-II and BaBar
    • Track progress against the plan
    • Track expenditures
    • Analyze ‘value’ earned
  - Apply during CDR/R&D phase through project completion
Planning and Management Tools in Place for the Conceptual Design Phase (Slide 3 of 3)

- **WBS Dictionary (Encyclopedia)**
  - Relational database of WBS definitions, specs, costs, cost bases, risk factors, and native file attachments.
  - Currently in Microsoft Access

- **Automated data exchange being developed**
  - Cost transfer from WBS to schedule
  - Contingency calculation based on risk factors

- **System reliability/quality engineering database**
  - *Relex* software
  - Failure Modes and Effects Analysis (FMEA)
  - Statistical analyses of failures and repairs
  - Etc.
NLC Contingency Database: Separate but linked Access database which computes and stores the project's contingency data. Owned by Project Management.

Project Planning Database: The central database containing technical specifications, earned value management, schedule, and costing books.

WBS Dictionary: Database that stores the Work Breakdown Structure (WBS) and its components.

WBS (Work Breakdown Structure): A hierarchical decomposition of the project into smaller deliverables.

Firewalls: Large blue rings. Mix of both administrative and electronic. Data updates to all databases are limited.

Project Planning Organization in Place for CDR and R&D

- Matrixed representation of major organizational areas
  - Main Linac area
  - Injector areas
  - Beam Delivery areas
  - Beam-line Technical Systems engineering
  - Global systems
  - Conventional Facilities

- Centralized Project Planning & Coordinating Group
NLC - The Next Linear Collider Project

Project Planning & Coordinating Group

- Ted Lavine
  - Top-down costing, WBS development, integration
- Teri Knight
  - Cost and schedule integration
- Albe Larsen
  - Project Management Plans, reports and documentation
- Zane Wilson
  - Database integration, maintenance and reporting
  - System reliability/quality engineering support
- Applied Integration Management, Inc.
  - Planning/integration consultants (PEP-II, BaBar, NIF/LLNL)
Planning Goals for Conceptual Design Phase

- **Monitor the CDR/R&D Process**
  - Periodic progress reports and Cost/Schedule updates

- **Support execution phase planning**
  - Periodic updates of Cost/Schedule, Risk and Contingency estimates

- **Develop catalog of common parts, tasks and rates**
  - Integrate into the TEC database

- **Develop document management/configuration control**
  - For CDR phase
  - For execution phase

- **Additional staff**
  - Database Manager/Programmer
  - Additional Cost/Schedule Planner
NLC PROJECT FUNDING TIME LINE

Preconceptual Design

Conceptual Design

Execution

Operation

CD 1

CD 2

CD 3

CD 4

Design

Implementation

WBS 1 = TEC

Siting Activities

R&D

WBS 2.1 = Preconstruction OPC

WBS 2.2 = Execution-phase OPC

Design Review support, permits

M&O support, startup, spares

WBS 1 (TEC) + WBS 2 (OPC) = TPC
**Components of the Total Project Cost**

- **Total Estimated Cost**
  - Design, engineering construction, management and reporting costs after conceptual design
  - Facility construction costs
  - Other costs specifically related to construction efforts
  - Contingency and economic escalation for TEC costs

- **Other Project Costs**
  - Pre-authorization costs prior to Title-I design
  - CDR
  - NEPA Documentation
  - Supporting R&D
  - Plant support costs during construction, activation and startup
## WBS Branch 2 - Other Project Costs (OPC)

### 2 NLC PROJECT OPC

#### 21 PRECONSTRUCTION OPC (CD1-CD3)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Cost Center</th>
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<tbody>
<tr>
<td>211</td>
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**214 TECH. SYSTEMS ENGINEERING & DESIGN**

- Coordination → 11XY1
- RF Systems → 11XY2
- Magnet Systems → 11XY3
- Instrumentation → 11XY4
- Vacuum Systems → 11XY5
- Movers & Supports → 11XY6
- Installation → 11XY6
- Manufacturing Facilities → 12
- Global Systems → 13

### 22 EXECUTION PHASE OPC (CD2-CD4)

- Startup

### 215 CONVENTIONAL FACILITIES → 14

### 216 SITE SELECTION & NEPA DOCUMENTATION
NLC - The Next Linear Collider Project

WBS Branch 1 - Total Estimated Cost (TEC)
Preliminary Cost Model for the Execution Phase

1 NLC PROJECT TEC

11 BEAM-LINE TECH. SYSTEMS
Breakdown by 9 beam-line areas
Breakdown by 24 subareas
Breakdown by ‘Systems’
  Coordination
  RF Systems
  Magnet Systems
  Instrumentation Systems
  Vacuum Systems
  Installation & Checkout
  Other Systems

12 MANUFACTURING FACILITIES
  Production Lines
  Supporting Shops

13 GLOBAL SYSTEMS
  Control System
  Software
  Protection systems

14 CONVENTIONAL FACILITIES
  Site Development
  Housings
  Buildings
  A-E/CM

15 MANAGEMENT & SUPPORT
  Administration
  Planning & Control
  Business Services
  Accelerator Physics
  ES&H
# Beam-line Technical Systems - 'Area/System' Matrix

## 11 Beam-line Technical Systems

<table>
<thead>
<tr>
<th>Area</th>
<th>Sources/Boosters</th>
<th>Damp. Rings</th>
<th>Pre-linacs</th>
<th>Main Linacs</th>
<th>Collimation</th>
<th>Beam Delivery</th>
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Cost Categories

- ED&I, Construction Management and Project Management
- Labor
- Materials and Services (M&S)
- Conventional Facilities Construction Contracts
- Major Capital Equipment
Sample WBS Reports

- WBS level roll-ups by level and cost category
- Cost item reports
- Beam-line Area/System matrix
- Pareto-style histograms of totals at fixed WBS level
- Variances from a previous iteration
WBS 1.1 Beam-line Tech. Systems

Beam Line Cost by Category

- Modulators
- RF Structures
- Klystrons
- Quad Power Supplies
- Vacuum Systems Mech
- Waveguide RF Mech
- Waveguide Vac Mech
- Install Magnet Systems
- Coordination
- LLRF
- Area Management
- Install Cables
- RF Sys Activities
- Install RF Systems
- Quad Magnets
- Install Cable Trays
- Install Vacuum Systems
- Quad Supports/Movers
- Install Instrumentation
- Laser Wire Mech
- Other Magnet System
- Vacuum Systems Mech
- Dipole Magnets
- Sextupole Power Supplies

Cost
- Cumulative Cost

$0
$50,000,000
$100,000,000
$150,000,000
$200,000,000
$250,000,000
$300,000,000
$350,000,000
$400,000,000
$450,000,000
$500,000,000
$550,000,000
$600,000,000
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$2,300,000,000
$2,350,000,000
$2,400,000,000
$2,450,000,000
$2,500,000,000

System

- Systems
- Cumulative Cost
Working Schedules
loaded with staff salaries and M&S

- 21 Preconstruction OPC
- 211 Project Management and Administration
  - Directorate
  - Planning and Controls
  - ES&H Planning
  - QA Planning
- 2112 Planning and Controls Group
  - 40% Conceptual Design Phase
  - 80% Conceptual Design Phase
  - 100% Conceptual Design Phase
WBS Database

Next Linear Collider
Project Planning Database

- WBS Dictionary
- Reports (incl. WBS Dictionary Report)
- Attachments
- Live Database

What's New to the Database
New report pages which contain the dictionary and reports.

Next Linear Collider
Project Planning Database

- WBS Dictionary Reports
  - WBS 11 XYZ BeamLine System Rollup Matrix
  - WBS 11 XYZ BeamLine Detail Rollup Matrix
  - WBS 11 XYZ BeamLine Rollup Variance Matrix
  - NLC Cost by Category (Parent)
  - Technical Data Sheet Report
  - Return to Main Switchboard

What's New to the Database
New report pages which contain the dictionary and cost reports.
WBS Dictionary with Attachments

The Next Linear Collider (NLC) is an electron-positron linear collider designed to produce collisions at a nominal center of mass energy of 1 TeV (800 GeV per beam) with luminosity of $1 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$. The collider consists of several major functional areas and subareas:

- Injector Systems
- Electron Sources
- Photon Sources
- Beamlines and Detectors
- Collimation and Beam Switchyard
- Final Focus Systems
- Interaction Regions
- Diagnostics & Beam Dumps

Additionally, the facility includes the infrastructure and global technical systems.
Definition Document linked to all Magnet System WBS Elements in all Beam Areas

WBS DICTIONARY FOR MAGNET SYSTEMS
WITHIN EACH BEAM-LINE SUB-AREA


Common definitions apply to all elements within the sub-tree of elements that describe the magnet systems of each beam line. The same basic set of elements, which constitutes a common basis for the description of each beam line, shall be interpreted to apply locally within each of the following sub-trees (beam lines) of the WBS:

1112... Electron Sources
1113... Electron Booster
1114... Drive Linac
1115... Positron Sources
1116... Positron Booster
1117... Gun Test Lab
1122... Positron Pre-damping Ring Transport
1123... Positron Pre-damping Ring
1124... Positron Damping Ring Transport
1125... Positron Damping Ring
1126... Electron Damping Ring Transport
1127... Electron Damping Ring
1132... Positron Pre-linac
1133... Electron Pre-linac
1134... Positron BC2
1135... Electron BC2
1142... Main Linacs 500 GeV
1143... Main Linacs Diagnostic Stations
1144... Main Linacs Upgrade
1152... Collimation
1162... Beam Delivery 1
1172... Interaction Region 1
1182... Beam Delivery 2
1192... Interaction Region 2

In the definitions that follow, the elements of the above sub-trees (beam lines) are generically designated “11XY…”

Definitions of WBS Elements 11XY2...

11XY3 MAGNET SYSTEMS

11XY31 MAGNET SYS ACTIVITIES
System engineering, design and integration of the components of magnet systems which include, typically, magnets, DC power supplies and their cables, support systems, movers and their cables, and BPMs and their electronics and cables. Includes engineering (including reliability and manufacturing) that is shared (and therefore difficult to amortize) between different magnet families (dipole, quad, etc.).

11XY311 Magnet Sys Activities
Enter cost items at this level. Append elements as necessary to cover different activities. (ED&I and Equipment.)

11XY32 DIPOLE SYSTEMS
Iron-core, DC electromagnetic dipole magnet systems of all varieties including the subsystems broken down below.

11XY321 Dipole Magnets
Includes magnet cores, coils, terminal strips, personnel-protective covers, inlet and outlet water flanges, and magnet interlock devices and controls. Includes, for all varieties of dipole magnets assigned to this element, a pro-rata share of system engineering (including design and reliability), documentation, production (or procurement), quality testing, and inventory control. Does not include installation and checkout.

11XY322 Dipole BPMs
Beam Position Monitor systems that are assembled in magnets prior to installation of the magnets on the beam line. BPM mechanical devices include the beam tube and alignment mechanism for mounting, and installation, checkout, and calibration of the BPM and its vacuum chamber in the magnet. BPM electrical system includes electronic control modules and cables, but not the standard control crates or their IOC modules. Includes, for all varieties of BPM systems assigned to this element, a pro-rata share of system engineering (including design and reliability), documentation, production (or procurement), quality testing, and inventory control. Does not include installation and checkout of the BPM control electronics and cables.

11XY325 Dipole Supports/Movers
Includes supports from floor up, including grout plates and pedestals. Includes mover system mechanical components up to and including the cam followers. Includes mover system electrical components up to and including electronic control modules and cables, but not the standard control crates or their IOC modules. Includes, for all varieties of supports and mover systems assigned to this element, a pro-rata share of system engineering (including design and reliability), documentation, production (or procurement), quality testing, and
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</table>
WBS Database Demographics, 5/6/99

- 3588 elements are in the WBS
  - 1592 elements of cost
  - 1996 roll-up elements

- 1555 definitions are in the WBS Dictionary

- 4437 native file documents are attached to WBS elements

- Work in progress!
Administrative Configuration Control for the WBS Database

• As the engineering teams revise the TEC ...
  
  – They review their work with engineering and area management.
  
  – They develop and update their Access attachments.
  
  – A small group of coordinators update the costs in Success.
  
  – The Planning Group updates the roll-up and schedule loading.
  
  – The new estimates are compared to a previous “gold standard.”
Answering the Four Questions

• Planning and cost management tools are in place and ready for the CDR/R&D phase.
• The budget and schedule for the Planning & Coordinating Group in the CDR/R&D phase will meet the goals of the project.
• The Planning & Coordinating Group, with budgeted staffing increases, is appropriate for guiding the project through the CDR/R&D phase.
• The preliminary cost and schedule model for project execution, and the WBS database, are an appropriate starting point for the conceptual design phase.