BASELINE SCHEDULING BASICS

Part 1: April 5, 2007

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Baseline Scheduling

- How should you benefit from this session?
  - Basic understanding of concepts and benefits
  - Knowledge of types of schedules
  - Understanding of terminology
  - Recognition of data and processes needed to create schedules
  - QC: What makes a good schedule

Introduction - Why Schedule?

- Why schedule?
  - Why? Benefit to project?
  - Benefit to project management?
  - Mandated by owner?
  - Mandated by contractor influences?
    - Senior management, bonding company, attorneys, subcontracts, materials release

Introduction - Why Schedule?

- Time = $
  - Cost/budget control
  - Change management control
- Pure management tool
  - Forcing involvement of project management team
  - Planning
  - Monitoring
  - Control
- Subcontractor & resource control
- Owner coordination & control
- Predictions/projections
- Claims avoidance, defend claims, documentation
- Specification requirements

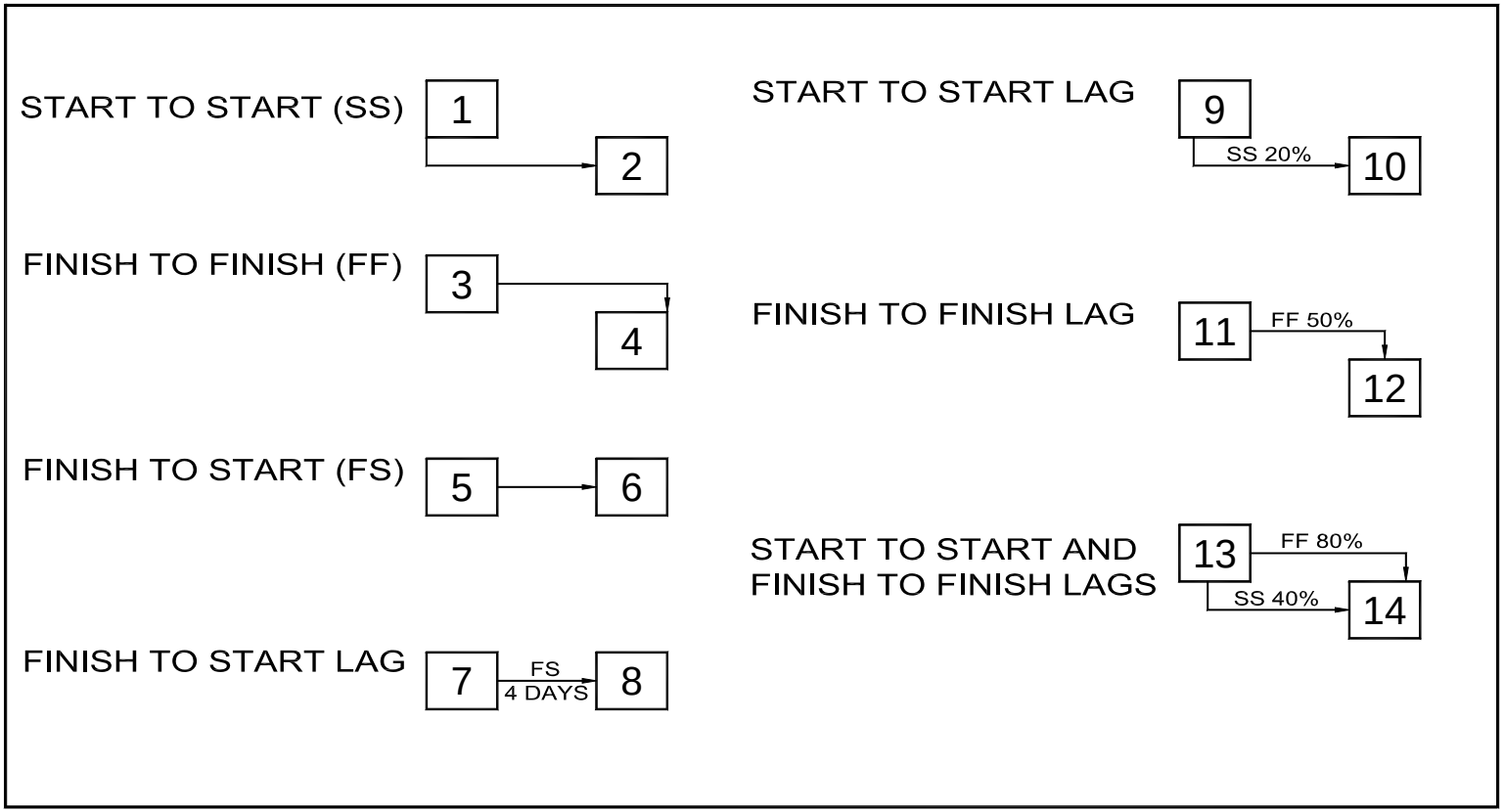
Introduction - Background

- Background & Types of Scheduling
  - Scheduling methodologies
  - Types of schedules
  - Scheduling terminology

Background - Methodologies

- Gantt, Bar Chart, and Line of Balance
- Vertical Diagram Method “VDM” or Linear
  - Visual system for repetitive tasks
- Types of CPM Schedule Formats
  - Arrow Diagram Method or “ADM”
    - IJ Network
    - Activity-on-Arrow
  - Precedence Diagram Method “PDM”
    - Activity-on-Node
    - Current prevalent scheduling methodology

PDM: Typical Precedence Relationships

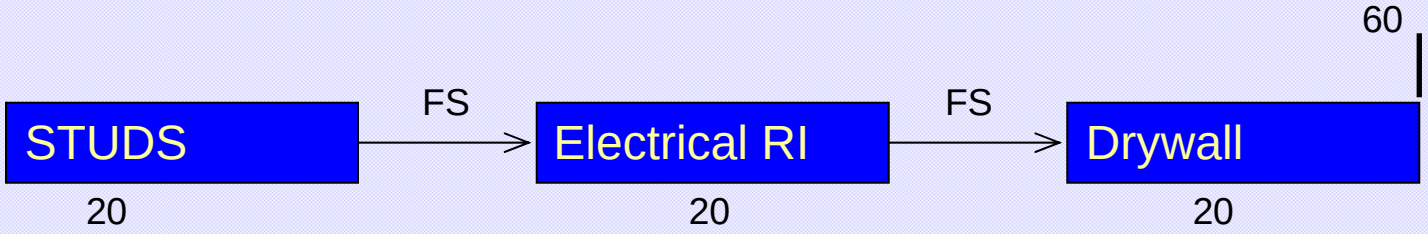


Definitions

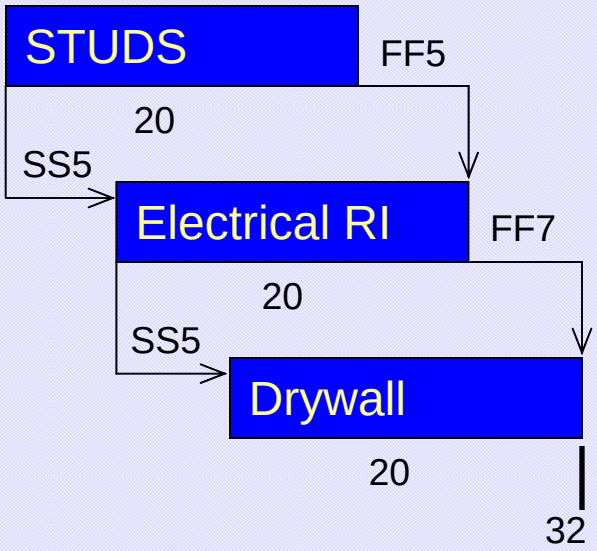
- **Critical Path Method (CPM)** – representation of a project plan by a network that depicts the ***duration***, ***sequence*** and ***interrelation*** of the work activities.
- **Critical Path** – longest path (or sequence) of activities, driven by their relationships, lags, leads, calendars, and constraints, through the project, that determines the total duration of the project.
- **Total Float** – the amount of time an activity can slip without impacting project completion (contingency time).
- **Logic/Relationship Types** – description of the interrelation between the individual work activities

Introduction - CRITICAL PATH METHOD (CPM)

Sequential



Concurrent



SS x = Start to Start

FF x = Finish to Finish

xx 5 = Lag

Relationship Types

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Definitions:

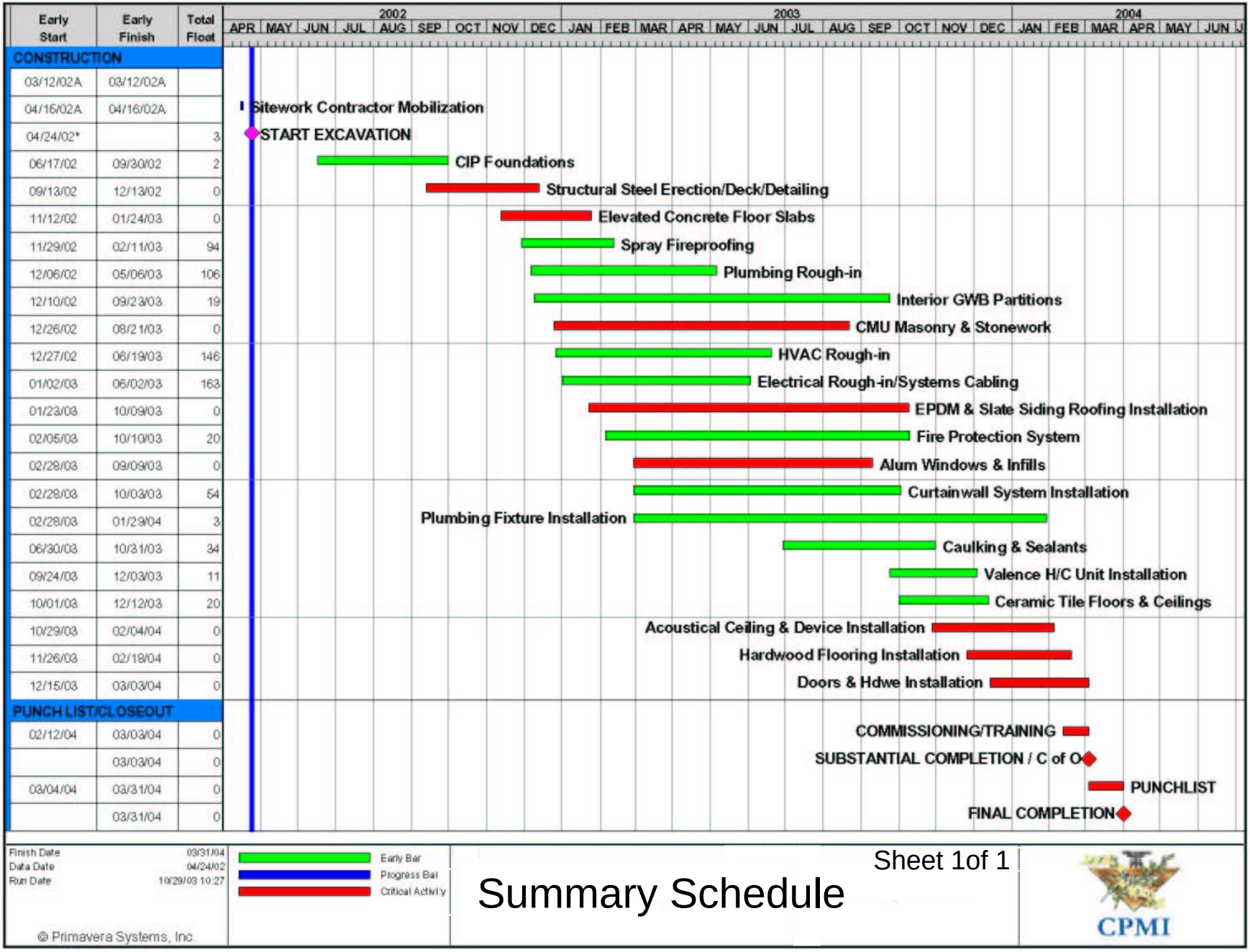
Early Start Date – the earliest date an activity can start, based on predecessor logic

Late Start Date – the latest date an activity may start in order to complete on time

Float – the number of days between early start and late start (or between early and late finish)

CPM Schedule Types

- Feasibility Studies
- Presentation
- Budgeting
- Conceptual or Schematic
- Milestone
- Summary
- Baseline
- Short Interval Look Ahead

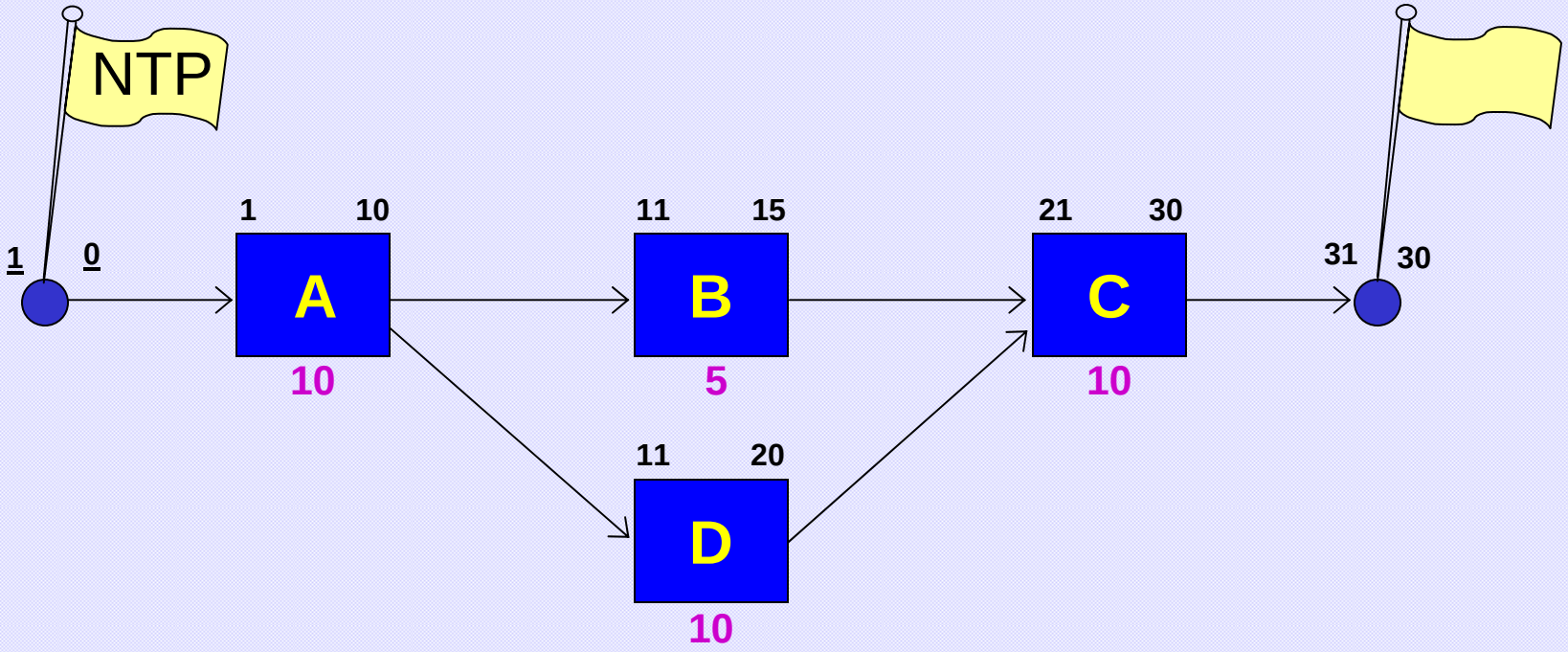

Early Start
Early Finish
Total Float
2002
2003
2004
APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN J
CONSTRUCTION
03/12/02A 03/12/02A
04/16/02A 04/16/02A
04/24/02* 3
06/17/02 09/30/02 2
09/13/02 12/13/02 0
11/12/02 01/24/03 0
11/29/02 02/11/03 94
12/06/02 05/06/03 106
12/10/02 09/23/03 19
12/26/02 08/21/03 0
12/27/02 06/19/03 146
01/02/03 06/02/03 163
01/23/03 10/09/03 0
02/05/03 10/10/03 20
02/28/03 09/09/03 0
02/28/03 10/03/03 54
02/28/03 01/29/04 3
06/30/03 10/31/03 34
09/24/03 12/03/03 11
10/01/03 12/12/03 20
10/29/03 02/04/04 0
11/26/03 02/18/04 0
12/15/03 03/03/04 0
PUNCH LIST/CLOSEOUT
02/12/04 03/03/04 0
03/03/04 0
03/04/04 03/31/04 0
03/31/04 0
Sitework Contractor Mobilization
START EXCAVATION
CIP Foundations
Structural Steel Erection/Deck/Detailing
Elevated Concrete Floor Slabs
Spray Fireproofing
Plumbing Rough-in
Interior GWB Partitions
CMU Masonry & Stonework
HVAC Rough-in
Electrical Rough-in/Systems Cabling
EPDM & Slate Siding Roofing Installation
Fire Protection System
Alum Windows & Infills
Curtainwall System Installation
Plumbing Fixture Installation
Caulking & Sealants
Valence H/C Unit Installation
Ceramic Tile Floors & Ceilings
Acoustical Ceiling & Device Installation
Hardwood Flooring Installation
Doors & Hdwe Installation
COMMISSIONING/TRAINING
SUBSTANTIAL COMPLETION / C of O
PUNCHLIST
FINAL COMPLETION
Finish Date 03/31/04
Data Date 04/24/02
Run Date 10/29/03 10:27
Early Bar
Progress Bar
Critical Activity
© Primavera Systems, Inc.
Summary Schedule
Sheet 1of 1
CPMI

Basic CPM Scheduling Exercise

- Forward pass
- Backward pass
- Derivation of Early dates
- Derivation of Late dates
- Calculation of Total Float
- Calculation of Free Float

CPM Scheduling Exercise

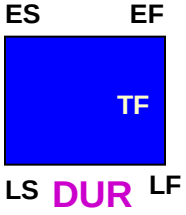
Forward Pass



EF(p) + 1 = ES(s)

ES + D + 1 = EF

KEY:



ES – Early Start
EF – Early Finish
LS – Late Start
LF – Late Finish
DUR – Duration
TF – Total Float

CPM Scheduling Exercise

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Forward Pass

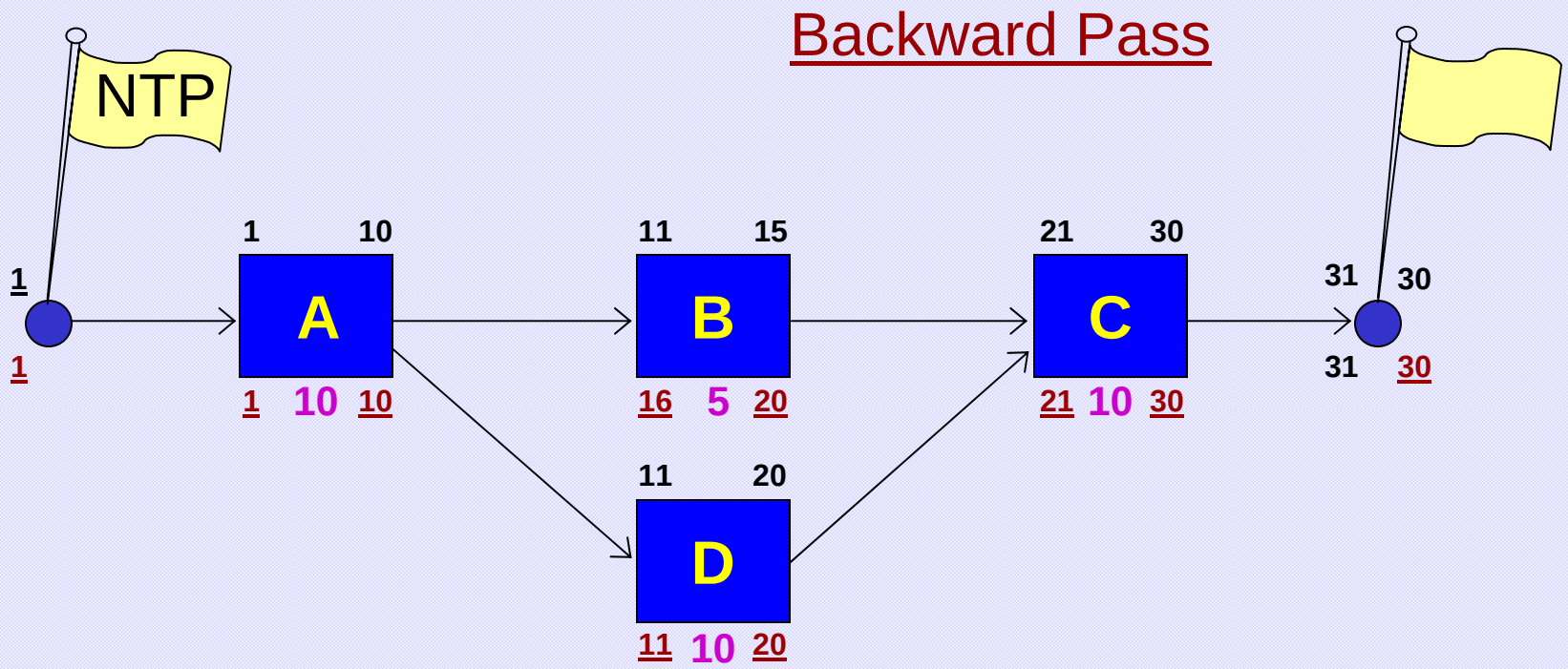
Establishes the Early Start and Early Finish dates

Activity	OD	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30
A	10	n/a	1	2	3	4	5	6	7	8	9	10																				
B	5	n/a											11	12	13	14	15															
C	10	n/a											11	12	13	14	15	16	17	18	19	20										
D	10	n/a																					21	22	23	24	25	26	27	28	29	30

If you don't want to learn formulas, the forward pass is common sense identification of start and finish days.

The earliest that Activity B and Activity C can start is on the 11th day, the day after Activity A finishes. The earliest day that Activity D can start is on the 21st day, the earliest day after the later that either Activity B or Activity C can finish.

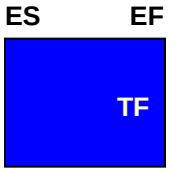
CPM Scheduling Exercise



LS(s) - 1 = LF(p)

LF - D + 1 = LS

KEY:



ES – Early Start
EF – Early Finish
LS – Late Start
LF – Late Finish
DUR – Duration
TF – Total Float

CPM Scheduling Exercise

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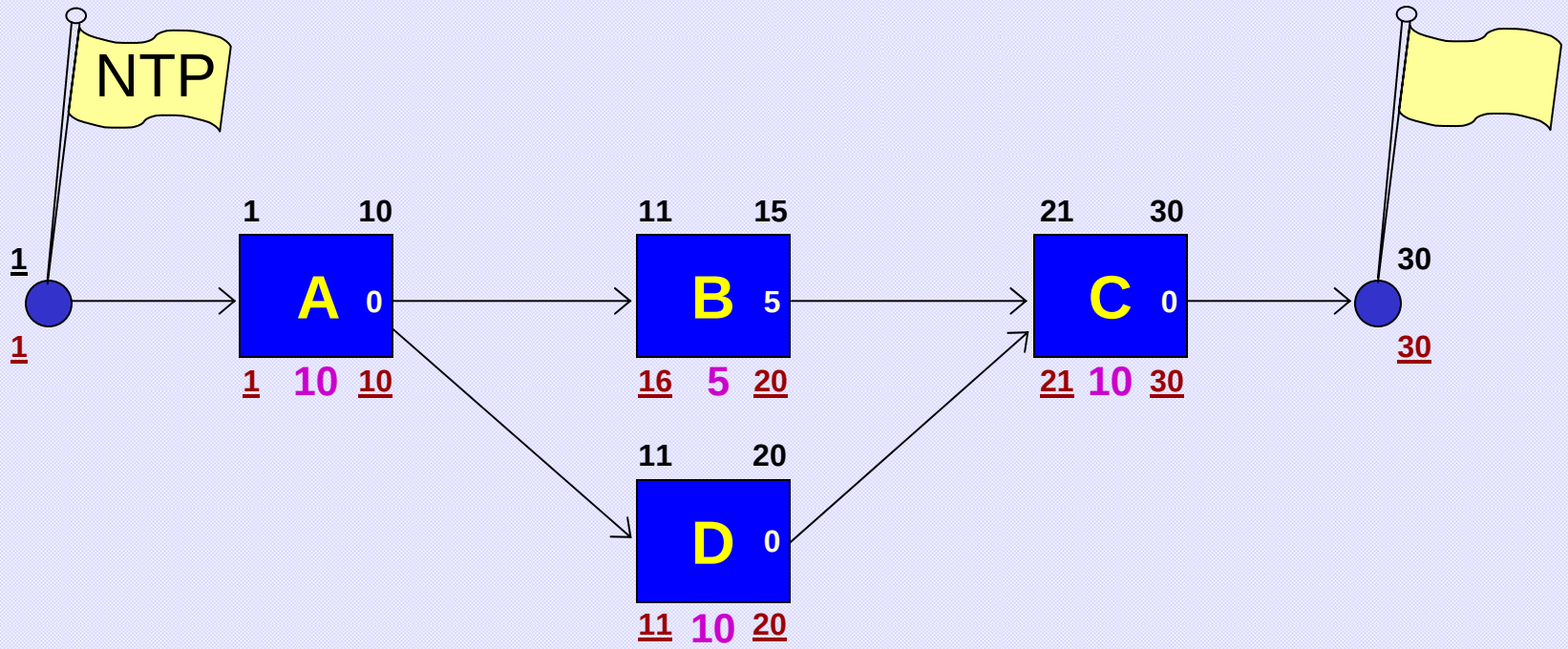
Backward Pass

Establishes the Late Finish and Late Start dates

Activity	OD	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30
A	10	n/a	1	2	3	4	5	6	7	8	9	10																				
B	5	n/a																16	17	18	19	20										
C	10	n/a											11	12	13	14	15	16	17	18	19	20										
D	10	n/a																					21	22	23	24	25	26	27	28	29	30

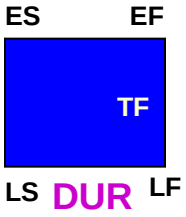
Working from the last day towards the beginning, both Activity B and C cannot finish any later than the day before Activity D starts, so both have a Late Finish of Day 20, the day before Activity D starts on the 21th day.

CPM Scheduling Exercise



Description	ES	EF	LS	LF	TF
A	1	10	1	10	0
B	11	15	16	20	5
C	21	30	21	30	0
D	11	20	11	20	0

KEY:



ES – Early Start
EF – Early Finish
LS – Late Start
LF – Late Finish
DUR – Duration
TF – Total Float

CPM Scheduling Exercise

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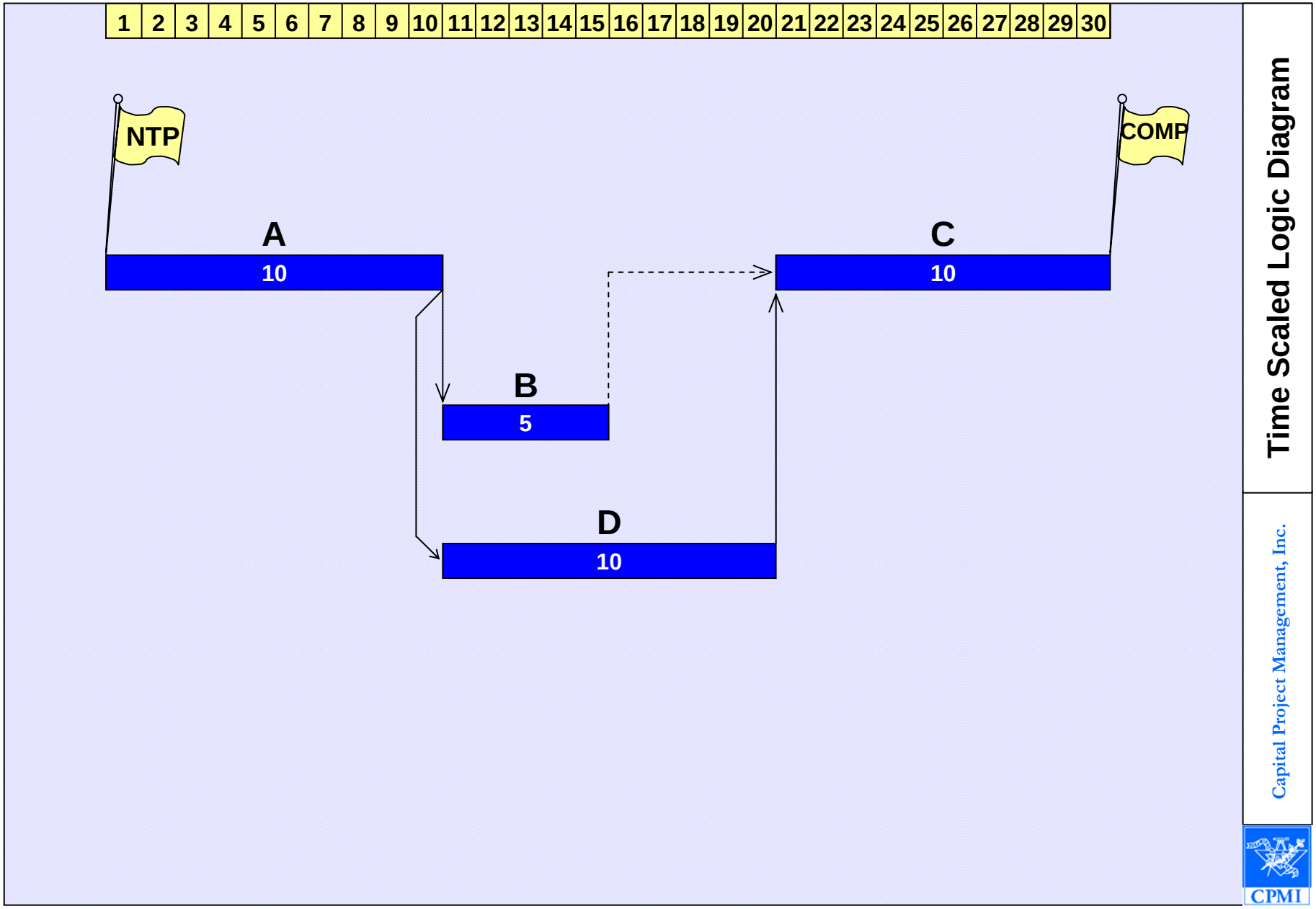
CRITICAL PATH METHOD (CPM)



Time Scaled Logic Diagram

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CPM Schedule Creation

- How should we do it?
  - Lessons learned (what are typical conflicts)
  - Schedule design
  - Schedule development
  - Schedule components
  - Schedule logic
  - Schedule settings

Typical Areas of Conflict

- Stakeholders: Who uses the schedule?
- Level of detail
- Reasonableness of schedule
- Clarity of schedule
- Schedule Approval/Non-approval Issue standoff
- Failure to Involve major trade Contractors
- Failure to include Owner requirements (other contracts, utilities, commissioning, etc.)
- Early Completion Schedules
- Ownership of float, contingency time

Schedule Development - Process

- Assemble development team
- Design the schedule
  - Identify Level of detail required
  - Identify output needed – Activity Code & WBS structures
  - Identify scope of work - Activities (input from subs/primes)
- Develop the schedule
  - Calculate Durations (input from subs/primes)
  - Assign logic (input from subs/primes)
  - Input to computer
  - Analyze and adjust
- Finalize the schedule
  - QC checklists & verification
  - Seek buy-in and approval (includes team)
  - Add resources and costs

Schedule Development - Owner-Controlled, Design Related And Procurement Activities

- Treat Owner activities like any other work activities
  - Look in Contract for specification requirements
  - Submittal approval times – specification or verify
  - Consider re-submittal cycle for difficult or highly detailed activities
  - Include all Owner scope of work (include permits, permanent telephone and other utilities, owner supplied equipment, other contracts, Health Department approvals, etc.)
- Code Owner activities so they can be filtered and tracked
  - Owner and Contractor are both interested parties
- Ensure the successor activities are accurately defined
  - Any delays related to these activities should be captured accurately for the protection of both the Owner and the Contractor

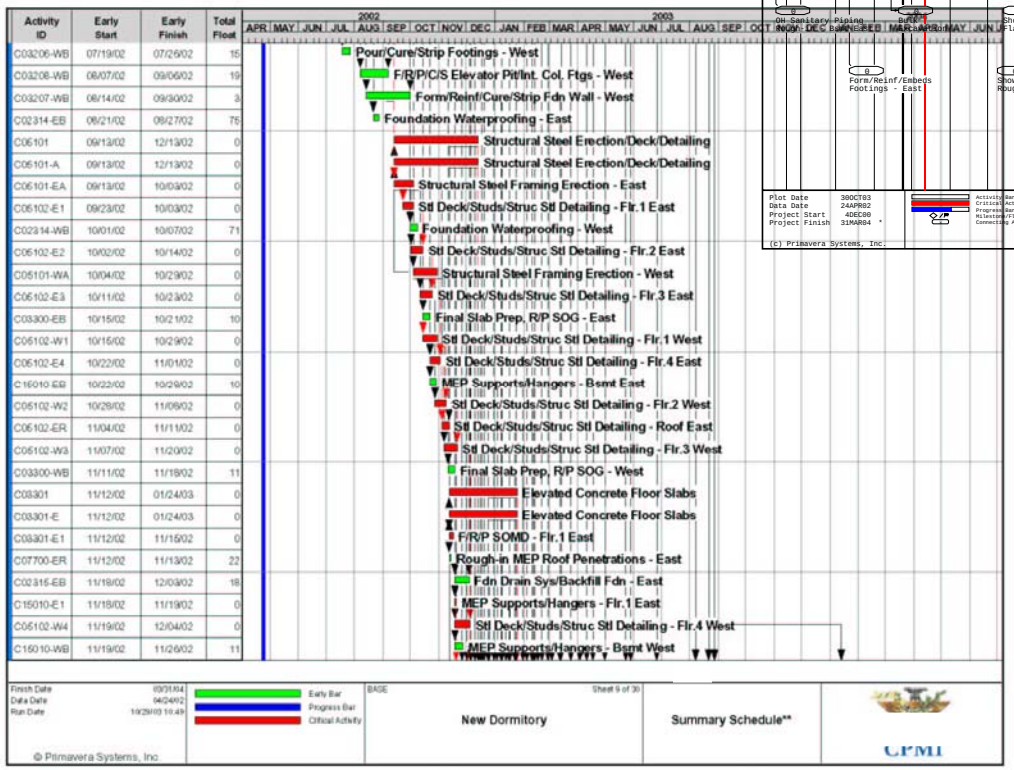
Schedule Development - Feasibility of Specified Schedule

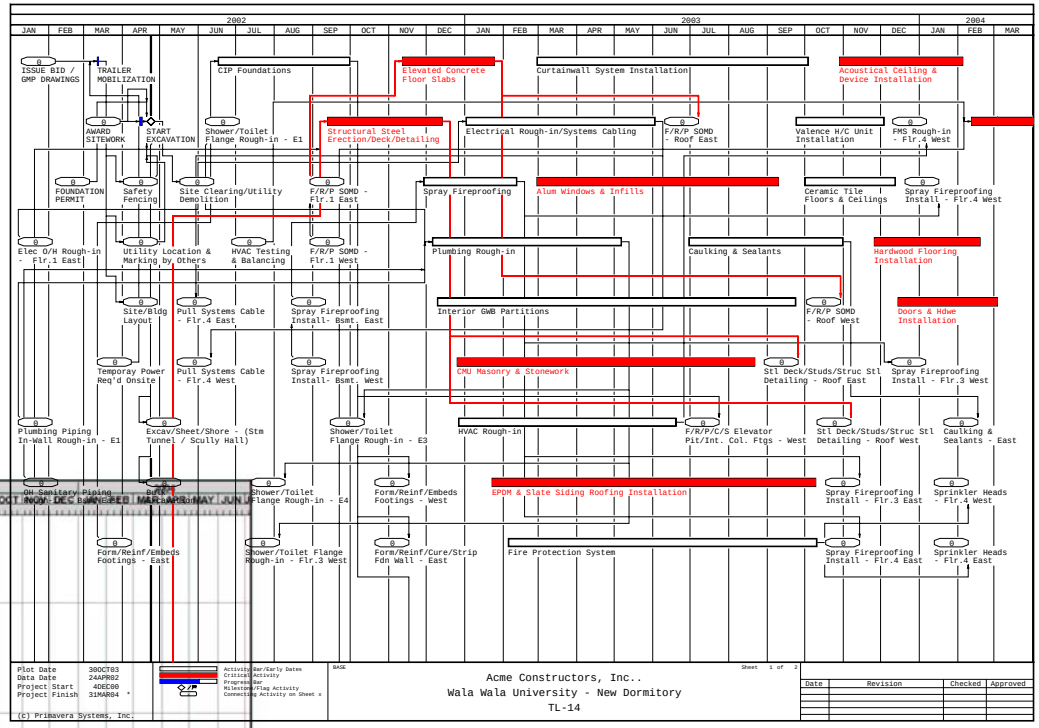
- Need real commitment to scheduling process
- Requirement for schedule to be actually used during performance
- Must have buy-in from PM team, senior management, subcontractors, suppliers, and Owner
- Must have resources to perform detailed schedule updates and analyses
  - Do it during project ($)
  - Do it in claims environment – post project ($$$$)

Schedule Components – Output - Type of Diagram

- Bar Chart
- Network Analysis System (CPM)
- Most specs require multiple printouts
- Require electronic file
- Output types insignificant if you get the disk - electronic file is the only way to go
- Still need to understand means & methods – rationale of construction

Barchart Schedule With Logic





Time Scaled Logic Diagram

Schedule Components - Type of Diagram (continued.)

- Must be clear on what is required
- *H.I. Homa Co.* case
  - Contract unclear on whether CPM required
  - Government's insistence on CPM schedule was constructive change entitling contractor to added compensation

Schedule Components - Number of Activities

- Depends on the nature, size and complexity of the project
- Need enough activities to reflect intricacies and interdependencies
- Too few activities will require use of SS and FS lagged activities; harder to analyze
- High level of detail will make updates more time consuming
- High level of detail will allow better monitoring & updating

Schedule Components - Resource Loading

- Only way to confirm validity of an activity's duration
- Resources/Productivity = Duration
- Even without resource loading, determination of durations must be made through resource calculations (even if based on experience)
- Effective use of resource loading requires detailed schedule
- Out of sequence work during updates can warp resource reports

Schedule Components - Resource Loading (cont.)

- A 5 worker crew, with crew productivity of 4 windows per day will install 40 windows in 10 days
- Two 5 worker crews with the same productivity will install 40 windows in 5 days
- Notes should be kept to record how durations were derived
- Keep in mind: 100 crews with productivity of 4 windows per day will NOT install 400 windows in a day.

Schedule Components – Cost Loading

- Used for Progress Payments
- Owners should retain ability to adjust schedules that are excessively front loaded
- Separate overhead & profit from direct costs
- Cost loading lends itself to reasonable scope deletion with resulting predetermined costs & time
- Separate large materials delivery activities so progress can be monitored (labor & materials production should be a linear curve)
- Use cost metrics (earned value) as another check on progress evaluation
- Update percent complete (track cost) separately from remaining duration (track time).

Schedule Components - Control of Record Schedule and Updating

- DON’T OVERWRITE last period schedule!!!
- Who will maintain the schedule?
- Joint updating meetings
- Determine in advance what constitutes normal updating or schedule revising
- Owner approval of logic changes (revising)
- Determine level of detail required for each different stakeholder
- Identify process for schedule recovery discussions when lack of progress is reported

Schedule Logic - Approval

- Who approves and when
- Owner leverage in approval process even though Contractor may own the schedule
- Owner's entitlement to backup data
- Approval creates rebuttable presumption of reasonableness
- In the absence of formal approval, a working schedule that represents the work will likely be acceptable as the initial schedule for analysis purposes

Schedule Logic - Approval
(continued.)

- Contractor's termination for default upheld due to its failure to produce an acceptable schedule. *Stone and Webster*, 279 B.R. 748 (D. Del. 2002)
- It is in every party's best interest to get schedule approved as quickly as possible
- Discussion: Is constant manipulation & re-submittal of baseline schedule a sign of claims positioning? Are there risks in repeated re-submittals of schedule?

Schedule Logic - Subcontractor Involvement

- Teamwork and commitment
- Schedule must be understandable to subcontractors
- Subcontractors must be part of any revision or recovery discussion

Schedule Logic - Float Use and Reporting

- Reporting requirements for project float, free float and activity specific float
- Risk allocating provisions
- Predecessor/Successor Reports
- Total float
- Ownership of float – check state case law – in general, float belongs to project

Schedule Logic - Prohibition on Schedule Manipulations

- Float sequestering (everything is critical)
- Critical Path manipulation (CP runs through all Owner controlled activities)
- Heavy constraint use (nothing is critical)
- Unidentified/unnecessary lags or leads
- Weather planning
- Develop a checklist for hot items

Schedule Settings

- Schedule Calculations Methods
- Work Calendars
- Resource Calendars and Lags
- Resource Constraints
- Date Constraints
- Schedule presentation

Schedule Settings - Options

- Critical from Float or Longest Path
- Float calculation: Start, finish, or most critical
- Out-of-sequence progress
  - Retained Logic, Progress Override, Actual Dates
- Continuous or Interruptible activities
- SS lag from actual or early start

Work Calendars

- Purpose
  - Tailor the schedule to specific work or non-work periods
- Examples
  - Holiday periods
  - Non-work periods (e.g., winter months for sitework activities)
  - Adverse weather planning (based on NWS average records, 3 to 5 year averages)
  - 7 day activities vs. 5 day activities (curing or submittals)
  - Fixed time periods (e.g., available work areas)

Work Calendar Best Practice

- Use the least number of calendars that you can, while reasonably modeling the project
- Multiple calendars make analysis more difficult
- Multiple calendar use will amplify or reduce the effects of delay
- Calendars are a convenient and logical way of modeling non-work periods and risk predictions.

Scheduling Standards

- What SHOULD we do?
  - What's being done (AACEI and PMI-COS) to set standards?
  - Industry Standards
    - PMI Practice Standard for Scheduling – in review
    - AACEi – Recommended Practices – in development
  - Best Practices
    - PMI – College of Scheduling SEI project
    - AACEi - Professional Practice Guides
  - Practical limits
    - Certifications
    - Education
    - Association Involvement
  - Get involved with professional associations!!!!

Schedule Quality Control

- How do we get a good schedule?
  - Project team involvement
  - Design the schedule before starting development
  - Stakeholder buy-in
  - Quality checklist
  - Address contingency time and early completion
  - Targeted reporting to Stakeholders
  - Written narrative

Develop a QC Checklist

Review of Baseline Construction Schedule Checklist

Project Title:	Name of Project
Client:	Name of Client
Alpha Corporation Analyst:	Name of Schedule Reviewer

A. Review of Schedule Specification

PRI	SEC	TER	Task Description	Scope	Associated Report Title	General Review Notes	Results & Comments for Specific Project
8			***Evaluate Critical Path***				
	a		Verify the method of calculating critical path.			Under TOOLS:SCHEDULE:OPTIONS, check for progress override vs. retained logic, calculation of total float as most critical vs. finish float. Prefer RL over PO and most critical float rather than start or finish float. Also, in MS Project, check on the use of the "reschedule uncompleted work to start after" option as it functions similarly to P3's progress override.	
	b		Review critical path		Critical Path Report	Trace the Critical Path to confirm validity – watch for Lags. Check the Float values for propriety. Check if the Critical Path meet the necessary requirements. What is the percentage of activates that are on the critical path? Is that reasonable? Should be in range of 10% to 40% of activities are critical (20% to 60% for linear projects), and 25% to about 60% near critical (TF<10). Is the CP reasonable; i.e., does it make sense? What drives the CP; logic, resources, weather?	
			Look for specific activities on critical path		Critical Path Report	Critical path should contain NTP, Substantial Completion, Final Completion. Critical path would normally be expected to contain commissioning & TABS, lighting trim-out, ceiling grid, above ceiling rough-in mechanicals, inspections for same,	

Schedule Quality Checklist

- Check for clean and reasonable Longest Path
- Appropriate calendars, applied appropriately
- Eliminate open ends in general
- Ensure reasonable ratio of LP activities to total activities
- Minimum necessary date constraints (can cause multiple LP)
- Minimum necessary lags
- All lags identified with purpose (change to activities if possible)
- All lagged or SS/FF activities have ends tied in logically
- Run histogram of trade activities to check good coverage
- Run Total Float check
- Good use of Activity Codes, organized for clarity
- Definitive Activity Descriptions
- Compare & evaluate Activity Durations
- Written narrative identifies rationale for decisions

Know the Project!

- Know the…
  - Contract Requirements
  - Scope of the Work
  - Basic CPM logic rules and how they are applied in the software
  - Contractor means & methods
  - Limitations & constraints
    - Owner
    - Contractor
    - Site & industry

Characteristics Of A Useful Schedule

- Schedule must model the project
- Proper level of detail (limited number of critical activities)
- Summarize to one page
- Team buy-in; all stakeholders involved in schedule process
- Describes superintendent's plan (not the President's plan)
- All activities tied to completion
- Resource-based durations
- Meet the specification
- Include procurement activities (and coordination)
- Written narrative to identify plan

BASELINE SCHEDULING BASICS

Part 1: April 5, 2007

See You **May 6 for Part 2!**

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