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Schedule Development – A Methodical Approach to Building a Schedule

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Resources for Scheduling

- **PMI – Project Management Institute**
  - Practice Standard for Scheduling
  - Practice Standard for WBS & EV
- **PMI-CoS – College of Scheduling**
  - Scheduling Excellence Initiative (SEI) project writing Best Practices and Guidelines – Scheduling/Claims
- **AACEi** – Association for the Advancement of Cost Engineering
  - Publishing Recommended Practices
- **CMAA** – Construction Management Association of America
  - Revising Time Management Chapter of the Construction Management Standards of Practice

Design or Development?

- Refer to 2008 presentation at PMI-CoS national conference
  - "Schedule Design; Planning for Schedule Development"
- Separate the two processes
  - Design first
  - Development second
- Need to plan (Schedule Design) to create the schedule (Schedule Development)

Schedule Design

- Why design a schedule?
  - A schedule meets the criteria for a “project” in itself
  - A schedule is a guideline or plan for a project
  - A schedule provides a a methodical approach for a project
  - Keeps the schedule development on track
  - Prevents rework due to late understanding of needs
  - Allows buy-in from end users prior to Development
  - Makes the schedule development session much more meaningful
  - Documents the assumptions and intention of the schedule
    - For reviewer and approver
    - For future reference
    - To facilitate changes in schedulers
    - Place to capture Lessons Learned

Schedule Design

- Scope of Design vs. Development
  - Design – Conceptualizing the schedule
    - Planning
    - Starting with the end in mind
    - Providing concept of final product
    - Creating organizational structure to fulfill the concept
  - Development - Building the schedule
    - Input activities
    - Input logic
    - Input durations
    - Review for design compliance
    - Review for CPM methodology best practices
    - Quality control

Schedule Design - Background

- Design vs. Development – How do PMI & PMBOK handle it?
  - PMBOK identifies six Project Time Management processes, usually defined as part of the project lifecycle, Chapter 6 of PMBOK 4th Edition.
    - *Define Activities.*
    - *Sequence Activities*
    - *Estimate Activity Resources*
    - *Estimate Activity Durations*
    - *Develop Schedule*
    - *Control Schedule*

Schedule Design - Background

- Design vs. Development – How do PMI & PMBOK handle it?
  - These processes are paralleled by a planning effort by the PM team, part of PMBOK's "Develop Project Management Plan", PMBOK Section 4.2 (which sets the format and establishes criteria for developing & controlling the project schedule).
  - These processes are documented in what PMBOK calls a Schedule Management Plan contained in the project management plan. This SMP selects the scheduling methodology and the scheduling tool.
  - PMBOK says the majority of effort in the TM Knowledge Area will occur in the Control Schedule process (Section 6.6)

Schedule Design - Background

- The inputs for the Time Management Processes used to Develop the Schedule are listed as:
  - These fall under Schedule Design
    - Scope Baseline
    - Activity List
    - Activity Attributes
    - Milestone List
    - Project Scope Statement
    - Resource Requirements
    - Resource Calendars
  - These fall under Schedule Development
    - Project Schedule Network Diagrams
    - Activity Resource Requirements
    - Activity Duration Estimates

Schedule Design - Background

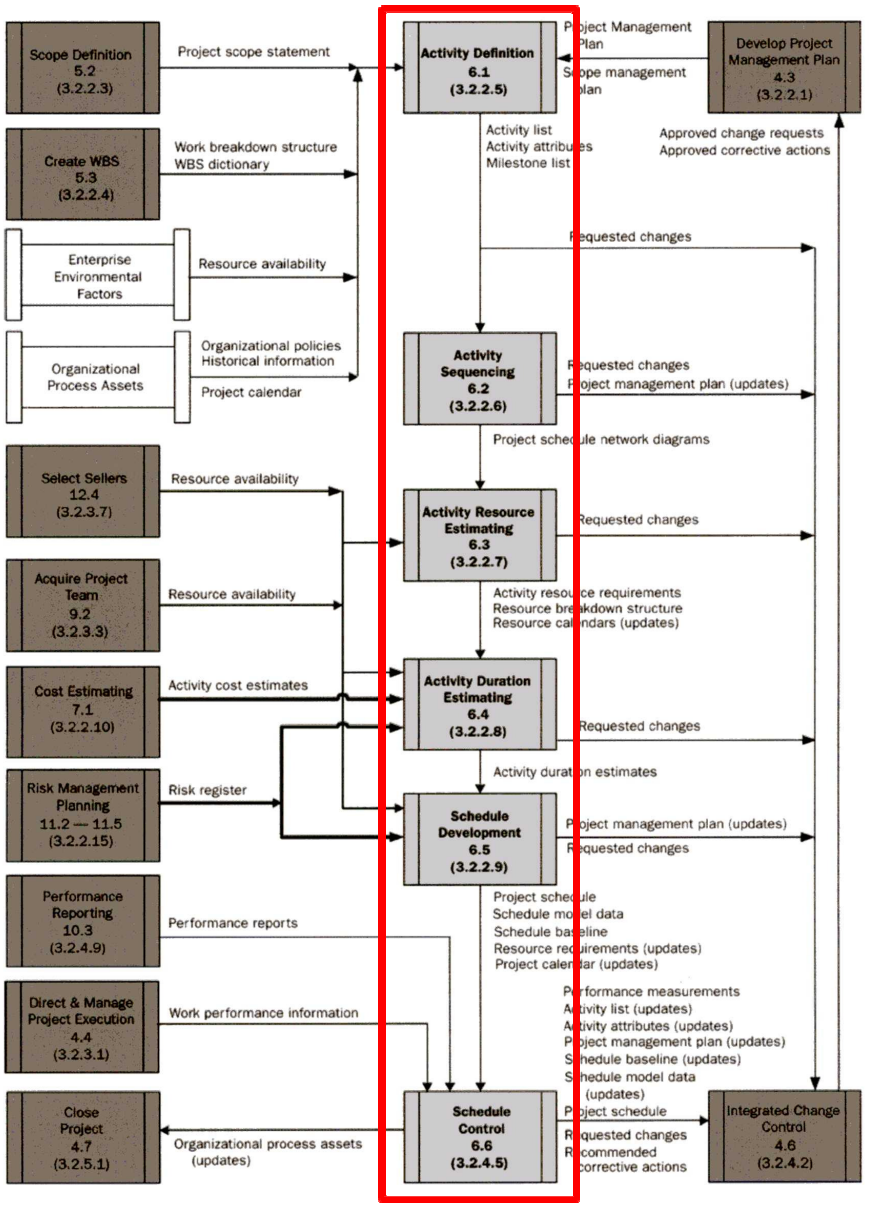
- Design vs. Development – why emphasize the distinction?
  - Design tends to be ignored in favor of jumping right into development.
    - Many schedulers elect to begin creating activities instead of Designing.
    - Work is subsequently repetitive, with lots of potential for rework.
    - Results tend to be disorganized.
- Avoid planning mistakes and problems.

AACEi: TCM Framework:
7.2 Schedule Planning & Development

- .1 Schedule Planning & Development
- .2 Identify Activities
- .3 Develop Activity Logic
- .4 Estimate Durations
- .5 Establish Schedule Requirements
- .6 Allocate Recourses
- .7 Optimize Schedule
- .8 Establish Schedule Control Plan
- .9 Review & Validate Schedule
- .10 Document & Communicate Schedule
- .11 Submit Schedule Deliverables
- .12 Develop & Maintain Methods & Tools

PMBOK 3rd Ed. The diagram to the right is a Project Time Management (Schedule) process flow diagram. This diagram gives us an idea about how integral the schedule is to the management of the entire project.

The six sections related to schedule development are at the center of the diagram.



Note: Not all process interactions and data flow among the processes are shown.

Figure 6-2. Project Time Management Process Flow Diagram

Schedule Development – Art or Science?

- Most texts and good practices state “Identify Activities” & “Develop Logic” and skip any details
  - This is the hardest area for most schedulers
  - Good organization of the schedule is vital
  - It is not that simple
- Every scheduler starts Schedule Development differently
- Using the basis from Schedule Design, the process can be defined and structured

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 final buy-in and approval (includes team)
  - Add resources and costs

Schedule Development Team

- Includes stakeholders:
  - Scheduler
  - Superintendent
  - Project Manager
  - Major trade contractors
- Needs input from:
  - Owner
  - Estimating
  - Senior management
  - A&E, if Design-Build or plans not ready

Schedule Design – Review Specifications

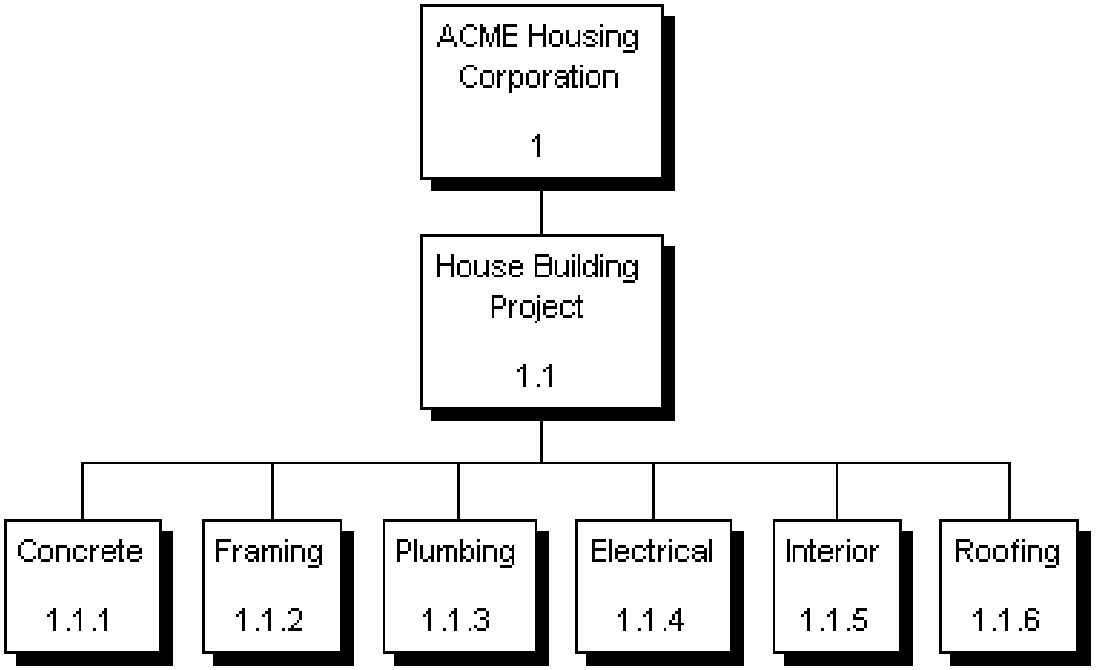
Schedule Specifications

Content of Schedule Specifications

- Related specifications
- Software requirements
- Data exchange requirements
- Master dictionaries/reports
- Preconstruction meeting
- Qualifications of scheduler
- Required submittal contents
- Owner mandated milestone treatment
- Float ownership
- Prohibitions on manipulation
- Planning units/calendar requirements
- CPM Network requirements
- Duration definitions & restrictions
- Initial schedule submission
- Full detailed project schedule (baseline) submission
- Schedule updates
- Delays & time extensions
- Early completion schedules
- Final as-built submittal
- Short interim schedules
- Cost & Resource loading
- Narrative Requirements

Schedule Design - WBS

- Develop Work Breakdown Structure.
  - Translate asset scope into component deliverables ("decomposition").
  - Ensure consistency in WBS levels, to facilitate comparison.



Schedule Scope & Budget

Prepare a Scope & Budget for the work required to prepare and maintain the project schedule. Even if it's an internal document it will come in handy at some point during the project.

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Attachment B

GreatCo Preliminary Budget for Master Planning
ESTIMATED BUDGET FOR SELECTED ACTIVITIES
ALPHA CORPORATION
8/8/2008

			Seattle Office - Table of Billable Rates				
	Description		Project Controls Manager	Senior Claims Analyst	Senior Scheduler	Scheduler	Technical and Admin
	Hourly Rate		$ 180	$ 170	$ 150	$ 135	$ 80
Consulting							
Master Plan: Phase 1							
1. Review of company-wide scheduling practices		$ 3,140	12 Hrs	Hrs	6 Hrs	Hrs	1 Hrs
2. Meetings with GreatCo staff to review standards & procedures		$ 1,240	6 Hrs	Hrs	Hrs	Hrs	2 Hrs
3. Meetings with on-site PM staff at all projects		$ 4,480	24 Hrs	Hrs	Hrs	Hrs	2 Hrs
4. Initial review of all active project schedules		$ 3,740	4 Hrs	Hrs	Hrs	20 Hrs	4 Hrs
5. Preliminary risk assessments		$ 3,740	4 Hrs	Hrs	Hrs	20 Hrs	4 Hrs
6. Change management recommendations		$ 4,830	10 Hrs	Hrs	8 Hrs	10 Hrs	6 Hrs
		$ -	Hrs	Hrs	Hrs	Hrs	Hrs
	Subtotal Hrs	143Hrs	60Hrs	Hrs	14Hrs	50Hrs	19Hrs
	Subtotal $$$	**$ 19,650**					
Review of baseline schedule on a project (TBD)							
1. Review project documents		$ 1,080	6Hrs	Hrs	Hrs	Hrs	Hrs
2. Meetings with subcontractors for schedule review		$ 2,440	6Hrs	8Hrs	Hrs	Hrs	Hrs
3. Assist PM staff with schedule prep		$ 1,940	4Hrs	4Hrs	Hrs	4Hrs	Hrs
4. Meetings with senior management to discuss findings		$ 720	4Hrs	Hrs	Hrs	Hrs	Hrs
		$ -	Hrs	Hrs	Hrs	Hrs	Hrs
	Subtotal Hrs	36Hrs	20Hrs	12Hrs	Hrs	4Hrs	Hrs
	Subtotal $$$	**$ 6,180**					
	Reimbursable Expenses	**$ 1,000**					
	TOTAL CONSULTING BUDGET	**$ 26,830**					

Schedule Design

- Technical Scheduling Components
  - Design Activity Coding structure
    - Input Driven - Based on need to organize schedule
      - Look at Stages and Areas (as well as Phases)
      - Stages: Foundations, Structure, Rough-ins
      - Areas: Determined by expected progress
      - Phases: Usually are repetitive sequence activities
    - Output Driven - Based on need to report to different stakeholders
    - Based on need to filter & isolate

Schedule Design - Use

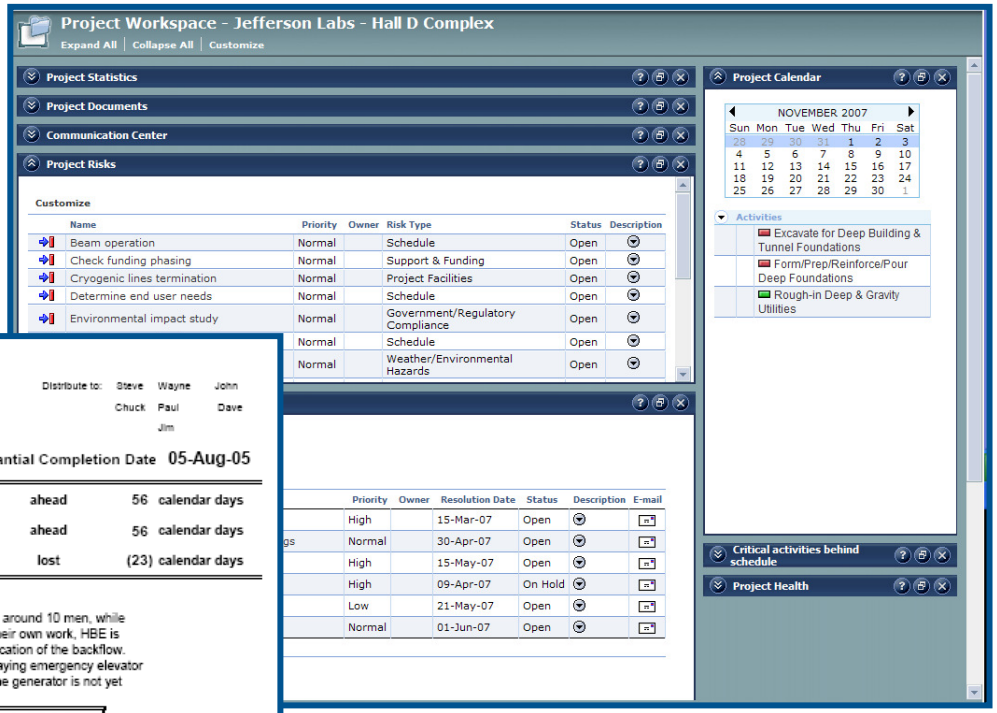
- Schedule Design Output (Software Driven)
  - Level of Detail
    - Determine approach:
      - Bottom-up (starting with detailed activities)
      - Top-down (starting with summary schedule)
      - Both (prepare Top-down, then Bottom-up)
    - Develop functional Stages, then progress-rate Areas
    - Review use of schedule
    - Identify frequency of updates.
    - Establish smallest activity duration range.

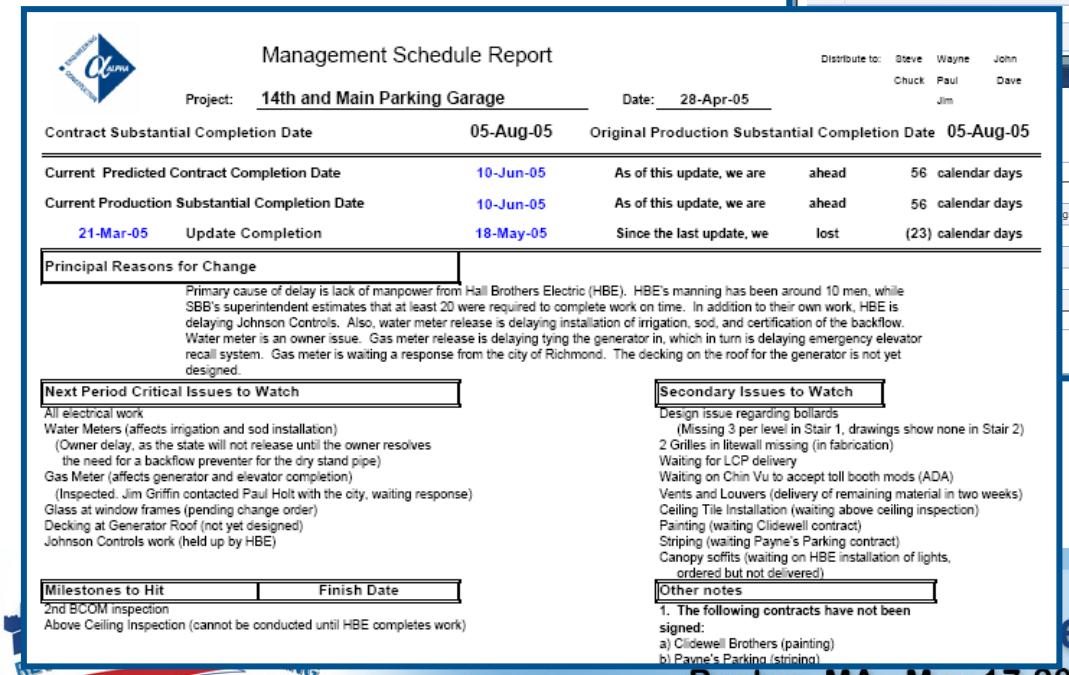
Schedule Design – Level of Detail

- **One of the most important decisions**
  - 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
  - Need ability to monitor individual trade contractors
  - Need enough detail to avoid incomplete activities waiting on others to progress
    - Example: Office/educational building, corridors will not be completed with the offices/classrooms, so if they are covered by the same activities, there will be multiple activities progressed to 85% (room finishes complete, but corridor finishes not started)

Schedule Design

- **Reporting**
  - Define all reports
  - Provide examples





Management Schedule Report

Distribute to: Steve, Wayne, John, Chuck, Paul, Dave, Jim

Project: 14th and Main Parking Garage Date: 28-Apr-05

Contract Substantial Completion Date	05-Aug-05	Original Production Substantial Completion Date	05-Aug-05		
Current Predicted Contract Completion Date	10-Jun-05	As of this update, we are	ahead	56	calendar days
Current Production Substantial Completion Date	10-Jun-05	As of this update, we are	ahead	56	calendar days
21-Mar-05 Update Completion	18-May-05	Since the last update, we	lost	(23)	calendar days

Principal Reasons for Change

Primary cause of delay is lack of manpower from Hall Brothers Electric (HBE). HBE's manning has been around 10 men, while SBB's superintendent estimates that at least 20 were required to complete work on time. In addition to their own work, HBE is delaying Johnson Controls. Also, water meter release is delaying installation of irrigation, sod, and certification of the backflow. Water meter is an owner issue. Gas meter release is delaying tying the generator in, which in turn is delaying emergency elevator recall system. Gas meter is waiting a response from the city of Richmond. The decking on the roof for the generator is not yet designed.

Next Period Critical Issues to Watch

All electrical work
Water Meters (affects irrigation and sod installation)
(Owner delay, as the state will not release until the owner resolves the need for a backflow preventer for the dry stand pipe)
Gas Meter (affects generator and elevator completion)
(Inspected. Jim Griffin contacted Paul Holt with the city, waiting response)
Glass at window frames (pending change order)
Decking at Generator Roof (not yet designed)
Johnson Controls work (held up by HBE)

Secondary Issues to Watch

Design issue regarding bollards
(Missing 3 per level in Stair 1, drawings show none in Stair 2)
2 Grilles in litewall missing (in fabrication)
Waiting for LCP delivery
Waiting on Chin Vu to accept toll booth mods (ADA)
Vents and Louvers (delivery of remaining material in two weeks)
Ceiling Tile Installation (waiting above ceiling inspection)
Painting (waiting Clidewell contract)
Striping (waiting Payne's Parking contract)
Canopy soffits (waiting on HBE installation of lights, ordered but not delivered)

Milestones to Hit	Finish Date
2nd BCOM inspection	
Above Ceiling Inspection (cannot be conducted until HBE completes work)	

Other notes

1. **The following contracts have not been signed:**
a) Clidewell Brothers (painting)
b) Payne's Parking (striping)

Schedule Design – Level of Detail

- **Steps to determine level of detail**
  - **How will schedule be used?**
    - **Management tool for daily trade monitoring, look-ahead schedules generated out of main CPM schedule**
      - **Need weekly data, will update weekly**
    - **Overview for superintendent to correlate his weekly bar chart which will be used for look-ahead schedules**
      - **Need monthly data, will update monthly**
  - **Assess minimum duration**
    - **For weekly management, smallest typical duration set at 1 to 3 days**
    - **For monthly overview management, smallest typical duration set at 4 to 10 days**

Schedule Design – Level of Detail

- Steps to determine level of detail
  - Break down the project into appropriate Stages
    - Each Stage may progress somewhat independently from other Stages (other than Intra-Stage dependencies)
    - Facilities
      - Underground utilities may require some initial work and then run concurrently
      - Foundations will progress alone until sufficiently ahead to start structure
      - Foundations and structure will progress independently from interior work and exterior façade
      - Exterior façade, other than dry-in, will proceed concurrently with interior rough-ins and finishes, but lagged from structure
      - Interior rough-ins will lead interior finishes but can overlap
      - Some interior finishes, such as museum millwork, may require full unencumbered access
      - Site work will proceed separately, but treat as infrastructure

Schedule Design – Level of Detail

- Steps to determine level of detail
  - Break down the project into appropriate Stages
    - Each Stage may progress somewhat independently from other Stages (other than Intra-Stage dependencies)
    - Infrastructure & Transportation
      - MOT (Maintenance of Traffic) may dictate sequencing
      - All work proceeds partly independently from other work
      - Earthwork (cut and fill) will progress ahead of but lag utilities
      - Wharf work will proceed separately from piling but lagged
      - Roadway work will progress at a lag from utilities
      - Bridge work will follow abutments but ahead of utilities

Schedule Design – Level of Detail

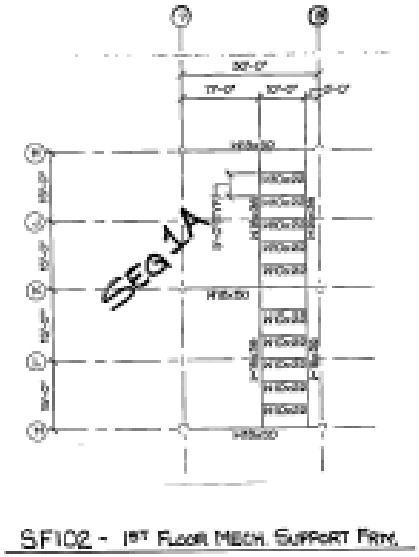
- Steps to determine level of detail
  - Consider how progress will actually happen
    - Review & correct the Area sequencing plan
    - Identify the Areas in the project and assess the rates of production
      - Group Areas with similar rates of production
      - This will keep updates clean and minimize out of sequence or incomplete work - especially true if cost loaded
    - Think about what will prevent an Area from completing
      - If completion can be held up due to other rooms or systems, then separate out those rooms into Areas
    - Important: All sections of the project within each Area should progress at a similar rate
    - Note: The SME (Subject Matter Expert) for each Stage are typically different, but are combined in Areas
      - They won't be thinking about rate of progress

Schedule Design – Level of Detail

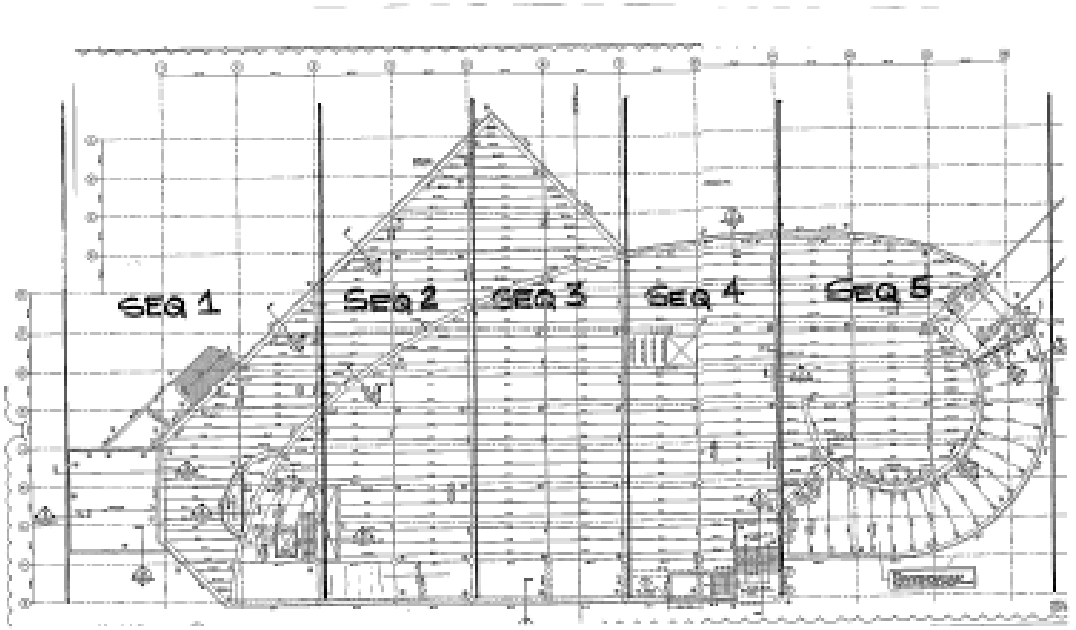
- Steps to determine level of detail
  - Group Areas with similar rates of production
    - Keep corridors separate (utilities & traffic will slow progress)
    - Offices, classrooms similar rate of progress
    - Labs, exam rooms, and other specialty rooms will progress slower
    - Auditoriums, meeting rooms, theaters, sanctuary (chancel/nave),
    - Kitchens, Bathrooms, Operating Rooms have significant utilities
    - Mechanical & Electrical Rooms will incur lead time issues as well as long installation durations
    - Second floor space MEP rough-ins will progress after first floor MEP rough-ins

Schedule Development

- Use Sequencing Plan from Design



SF102 - 1ST FLOOR MECH. SUPPORT FRM.



SF303, SF304 - 2ND FLOOR FRM. PLAN

Schedule Design – Level of Detail

- Steps to determine level of detail
  - Group Areas with similar rates of production
    - Each major trade in infrastructure work will operate at its own rate of production – this is why Linear Scheduling is popular for transportation work
    - Infrastructure/transportation will have varying rates of progress depending on subgrade conditions
    - Sports fields will progress independently of parking lots
    - Plant work will have individual processes that are relatively independent
    - Renovation work will bring in entirely new requirements for phasing, start with these
    - Justice and Courts work will have production rates dictated by security installations or product lead times

Schedule Design – Level of Detail

- Steps to determine level of detail
  - Watch for switches in Area sequencing
    - Structure for high-rise will be built from bottom to top
    - Rough-ins will likely follow
    - Finishes will likely not follow:
      - May run horizontally
      - May start at top floor and move down to bottom
    - You may need horizontal (or lateral) logic along with vertical (or linear) logic
      - Rough-in Inspections (linked floor to floor) are predecessor to Hang Drywall (linked side to side)

Schedule Design – Level of Detail

- Steps to determine level of detail
  - Identify repetitive work opportunities
    - A full repetitive type project (high-rise, roadway) needs to be treated slightly differently
    - Separate out the stages
    - Detail a small portion of the repetitive work, summarize the major trades and develop the overview schedule from those summarized trades (we call it an Outline Schedule)
  - Watch for switches in Area sequencing
    - Structure for high-rise will be build from bottom to top
    - Rough-ins will likely follow
    - Finishes will likely not follow:
      - May run horizontally
      - May start at top floor and move down to bottom

Schedule Development - Process

- Develop an Outline Schedule
  - High level overview schedule
  - Provides guidance in overall systems durations
    - Finishes in a medical facility might take 10 weeks
    - Foundation for high-rise might take 2 months
  - Provides guidance in repetitive areas
    - Floor to floor structure cycle time might be 7 days
    - Floor to floor finishes cycle time might be 30 days
    - Station to Station roadway storm sewer might take 4 days
  - Use this Outline Schedule to identify the summary schedule and check for reasonableness
  - Acts as a guideline during detailed development

Schedule Development - Process

- Start the Detailed Schedule Development
  - Input activities by Area (detail by trade)
    - Foundation area
      - Strip
      - Structural fill
      - Underground utilities
      - Layout footings
      - Dig footings
      - Form/prep footings
      - Set rebar in footings
      - Inspect rebar
      - Pour footings
  - Try to keep each the similar granularity within each Area (can base on durations)

Schedule Development - Process

- Detailed Schedule Development
  - Use the Activity Code Structure to keep trades separate
    - Develop all activities in all areas
    - Go through each area trade-by-trade
    - Make sure all work scope is covered in each area
  - Check overall scope of work by trade
  - Go through schedule from beginning
    - At each activity, question, “What activity cannot start until this activity is completed (or partially complete)?”
    - Make missing logic connections
    - Ignore dates, just review logic connections & sequencing
  - Identify hard (physical) logic and soft logic

Schedule Development - Process

- Detailed Schedule Development
  - Go through the schedule and review all durations
  - Sort by Activity Description
    - Compare similar activity scopes to see if durations are same
    - Check full coverage
  - Summarize to trades, look at count of activities in each trade; should be similar & reasonable
  - Print Detailed Predecessor Report
  - Have report in hand to check relationships

Schedule Development - Process

- Detailed Schedule Development
  - Start at the end of the schedule
    - Work backwards from last activity
    - At each activity, ask, “What work has to be done for this activity to start?” (what prevents this from starting?)
    - Make the missing logic connections
    - Use the Pred Report for quick entry of predecessors
  - Compare the areas of the detailed schedule to the Outline Schedule
    - Should be similar
    - Review and adjust as necessary

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

Early Completion Schedules

- Unintentional Early Completion
  - Review durations and other components carefully
  - Do not leave float in baseline schedule unless positive that the job can be completed early
  - Constrain Substantial Completion for contractual date
  - Review durations and logic very carefully
- Intentional Early Completion
  - Check specification requirements for early completion
  - Document that project was bid with general conditions to match planned project duration
  - Notify Owner that intention is to finish early
  - Be aware that Owner may suggest formal change order to move the completion date to the scheduled completion
  - Negotiate the completion date during baseline review

Project Team

- Who owns the schedule?
  - Project Manager?
  - Superintendent?
  - Scheduler?
  - Project Team?
- It is absolutely imperative that someone on the Team has primary responsibility for maintaining the schedule in order for it to be successfully utilized.

Site Visit &/or Photographs

- Have you, as the scheduler, ever been to the site?
- Do you know what it is you're scheduling?
- It is always helpful to visit the site if possible. Particulary with the project team so they can describe their ideas about how they will be constructing the project.

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

Schedule Logic - Subcontractors

- Subcontractors should be an integral part of Baseline Schedule development team.
- Teamwork and commitment
- Schedule must be understandable to subcontractors
- Subcontractors must be part of any revision or recovery discussion

Typical Areas of Conflict

- Stakeholders: Who uses the schedule?
- Level of Detail
- Reasonableness of Schedule
- Approval/Non-approval Issue/Approval 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

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 of the Owner, Contractor, the Site & the Industry

Questions/Comments

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