Project Planning using Logic Diagramming Method

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Preface

This treatise seeks to shine some light back on *collaborative* network-based planning by advocating use of LDM (Logic Diagramming Method). LDM is a technique suitable for collaborative planning that is squarely within the reach of project stakeholders who are not necessarily trained schedulers. When used in conjunction with GPM™ (Graphical Planning Method)[1], LDM allows effortless visualization of activity sequences and timing while also offering interrelationships between activities that are more intuitive and versatile for use by non-schedulers than those offered by PDM (Precedence Diagramming Method) or ADM (Arrow Diagramming Method). LDM is a recently-unveiled activity-based networking method that modifies and extends ADM to permit PDM logic.

This paper's underlying premise is that collaborative planning, as implemented by early Critical Path Method (CPM) practitioners, has become a casualty in time management. PDM and PDM-based software and their vanquish of ADM have been singled out as culprits. Taking advantage of the ability of LDM to combine the strengths of both ADM and PDM into a unifying diagramming technique, it is advocated that reliance on LDM, as posited by GPM, offers the potential to restore planning to the forefront of project planning & scheduling.

Has CPM Ceased to be a Planning Method?

The planning and scheduling literature provides testimonial evidence on the demise of planning as a prerequisite process to scheduling. "If I had to point to the one common thread linking the vast majority of failed projects and slipped schedules, it would have to inadequate collaborative planning. Today's schedulers have been taught a mechanical approach to scheduling that, to a very great extent, downplays or even ignores the planning process."[2]

Further evidence of an institutionalized disinterest in collaborative planning as a precursor to scheduling is the omission of planning per se in the current edition of the PMBOK Guide[3] (an ANSI standard). The new "PMI-SP" (Scheduling Professional) credential even omits the word planning altogether. Chapter 6 of the PMBOK subsumes activity definition and activity sequencing, two legacy CPM planning processes, within project time management, considered to include "the processes required to accomplish *timely completion* of the project."

The equivalent credential sponsored by AACE is the Planning & Scheduling Professional Certification. AACE's PSP Certification Study Guide gives project planning and scheduling comparable coverage and defines planning in the conventional CPM sense.[4] Be that as it may, the planning and scheduling profession has evolved, many may argue devolved, to where few practice what is preached. Consider the following exchange between members of AACE's Planning and Scheduling committee, "I fully agree with the notion that CPM is not the 'holy grail' of scheduling, no matter what the software companies may claim. CPM has, in many ways, ceased being a planning tool: It's become the 'weapon of choice' for unsophisticated owners who don't understand planning and, of course, for experts advocating their professional opinion on a project's failures."[5]

A brief history of how planning became neglected in CPM practice has been offered by this author and others. Key contributors include:

- The disappearance of the logic diagram (as the arrow diagram was also commonly known), the once popular method of using arrows of non-scaled lengths to denote activities, and connecting related activities at common nodes to denote finish-to-start relationships; [6]
- The advent of the PC, which allowed savvy CPM software types, using the capabilities of the software, to take a shortcut and proceed onto scheduling with very little planning;[7]
- For most, manual calculation of PDM is impractical, which makes PDM a method non grata to field personnel and other project management practitioners who could easily calculate ADM;[8]
- Increased difficulty in time-scaling of PDM, which obfuscates the use of a network as a means of communicating information and has limited the use of PDM plots to schedule gurus.[9]

Although ADM and PDM are well established in CPM practice, the following synopsis of their key attributes provides context: ADM denotes activities as arrows between start and finish nodes and connects dependent activities at their nodes, allowing only finish-to-start (FS) logic; PDM places activities on boxes and uses links to connect the finish or start of an activity to the start or finish of a successor, which allows four types of logic.

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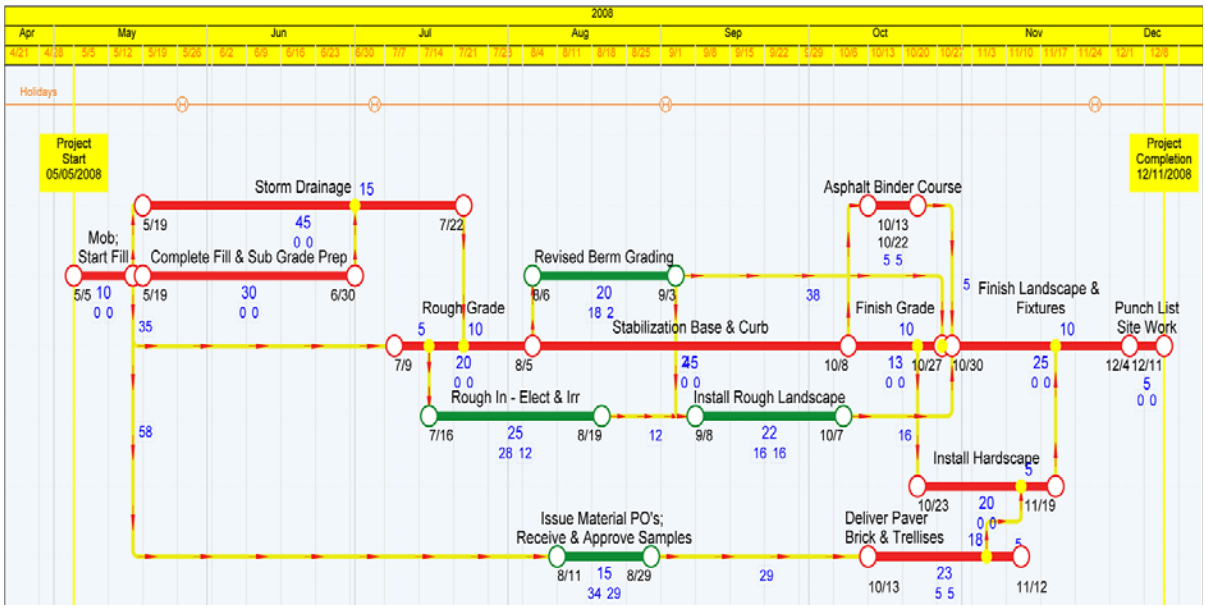
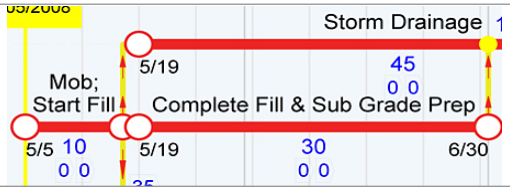
LDM as a Networking Model that Facilitates Collaborative Project Planning

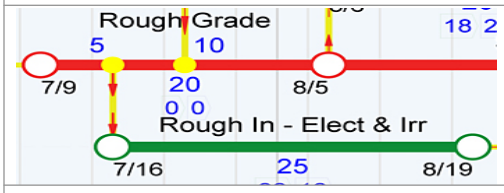
As illustrated below, LDM activity notation resembles ADM notation, albeit on a time scale. Logic ties have multiple arrowheads. Start-to-start (SS), finish-to-finish (FF) and start-to-finish (SF) logic is accepted through *embedded nodes*, intermediate of, or right on, activity start and finish nodes. Driving relationships are conveyed by a common node (FS only) or, owing to the time scale, a *vertical link*. Non-controlling *links* include a horizontal segment or leg, which denotes the *gap* (calculating the amount of leeway existing) in the relationship.



In LDM notation, relationships are simply viewed as connecting a) two nodes, b) an *embedded node*[10] (*embed* for short) and a node, or c) two *embeds*, which makes relationship types no longer relevant. Depending on activity positioning, the PDM four relationship types will graphically appear in LDM notation as follows (the network segments depicted below are from the above-shown LDM plan, which is in working days or wdays for short):

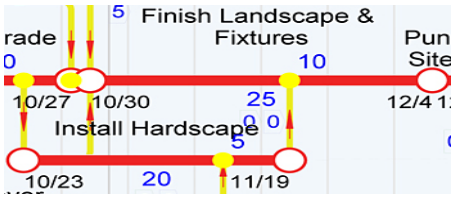
The finish of Mob; Start Fill controlling both the start of Complete Fill and Storm Drainage is conveyed by shared (superimposed) nodes and a *vertical(V) link*, respectively. Not shown is an FS *link* with a horizontal leg (i.e., successor starts later than when predecessor finishes).





A 5-wday SS logic tie between Rough Grade and Rough-In E&Irr is simply conveyed by connecting an *embed offset* 5 wdays after the start of Rough Grade with a *V link* to the successor's tail node.

Install Finish Landscape not being able to finish before 10 wdays after Install Hardscape finishes is simply conveyed by connecting an *embed offset* 10 wdays before its head node with a *V link* from Install Hardscape. If Install Finish Landscape is controlled by another activity, the *link* from Install Hardscape to the *embed* would have a horizontal leg.



A SF logic tie with 18/5 wday durations (lead/lag) between Deliver Paver Brick and Install Hardscape, in this case non-controlling, is conveyed by connecting an *embed offset* 18 wdays after the start of Deliver Paver Brick to another *embed offset* 5 wdays earlier than the finish of Install Hardscape.

LDM seizes the little used fact that ADM notation can adapt to SS/FF/SF logic as PDM can. Building on what was first posited 25 years ago[11], LDM modifies ADM notation by using a link (ADM dummy) to convey a PDM (SS/FF/SF) relationship, such being facilitated by LDM's time-scaled framework and the use of embeds. Using links from/to embeds is no more taxing than PDM, as PDM requires a link per relationship, FS or otherwise.

LDM, with its *embedded node* construct[12] and time-scaled v. schematic diagramming synergizes what PDM and ADM individually provide. LDM's modeling of PDM logic through embeds treats PDM leads/lags as elapsed days of work related to the predecessor and successor, respectively. LDM's time-scaled, node-connected rule is easier to interpret and more intuitive than a diagram of boxes or circles or an annotated bar chart. Further, if several activities are connected by controlling FS relationships, LDM allows common nodes to convey the relationships rather than adding unnecessary logic ties (as PDM does). This relatively simple logic construct yields a big payoff in that a chain of activities, all FS- related, is graphed as a continuous end-to-end chain rather than in a cascading, bar chart, which is the case with time-scaled PDM networks and has been the concern of researchers seeking to ameliorate their complex appearance[13]. This is relevant in construction as construction schedules predominantly contain FS over SS/FF/SF logic (nearly 80% of the relationships is not unusual).

Putting Planning Back into Time Management

LDM, while retaining the graphical simplicity of a user-controlled arrow diagram, offers the relationship flexibility associated with PDM, without requiring practitioners to endure the arduous process of learning the complexities of the conventional four types of PDM relationships. LDM allows planning and scheduling to consolidate by planning on the evolving schedule's very same time-scaled calendar. Planning on a time-scaled calendar as opposed to schematically is more efficient and allows planning to evolve spontaneously rather than sequentially, whether by working forward from release dates or backwards from target dates or milestones and vice versa.

When used in conjunction with GPM, LDM planning is a stakeholder-driven, collaborative process in which the participants use instantaneous feedback, which allows milestones and evolving dates, floats, resource profiles and crash-cost curves to impact activity definition and sequencing, and in turn allows them to interactively fine-tune their plan to achieve the desired results. In the GPM scheme of thought, establishing activities and relationships in isolation is not planning, but rather an unrewarding attempt to schedule in the absence of true planning.

Once stakeholder consensus is obtained for a GPM-calculated LDM plan, the dated and otherwise optimized plan can then be exported directly, if desired, to conventional CPM scheduling software to perform project control and monitoring maneuvering using project's pre-established processes and software. In this scenario, the consensus, collaboratively developed, GPM-calculated LDM network diagram "front-end loads" the scheduling process.

In Conclusion

LDM's time-scaling coupled with a variety of simple and intuitive links to convey logic facilitates visualization of activity sequences (many of which can be displayed in a head to tail fashion). This creates a renewed opportunity for joint planning between stakeholders and opens the potential to reverse the trend of true collaborative planning as secondary to schedule manipulation by specialists not directly responsible for delivering the project.

LDM offers the potential once and for all to end the so-called "ADM-PDM battle"[14]. In this author's deployment of the new diagramming method, it has been clear that schedulers that are adept with PDM quickly grasp how the LDM constructs model PDM relationships and select SS/FF logic as if they were working with PDM. On the other hand, seasoned scheduling professionals longing for the days of old have been comfortable minimizing PDM logic, particularly FF and SF relationships, to ensure activity flow logic is clearly understood by non-PDM trained stakeholders as well as to avoid loose ends for SS/FF-connected activities.

Because of the transparency it affords, a GPM-calculated LDM network diagram has the potential to obsolete a common malaise in current CPM practice: CPM schedules which, although technically error-free, are not well coordinated with all stakeholders, do not correlate well with project reality and are therefore unworkable and often ignored by project management and field supervision during project execution.

Implicit in this treatise is the availability of LDM graphics software that, without impairing the simplicity that belies the new diagramming paradigm, relies on an event-driven graphical user interface where the visual display of diagramming objects is an intrinsic part of planning. Such tool may even answer the following concern, "I have wondered how, given the diverging routes that planners, schedulers, project managers, owners, and educators are taking we will ever again bring to projects the kind of synergistic creativity known in the early days."[15]

Notes

1. Ponce de Leon, Gui (2008). *Graphical Planning Method (A New Network-based Planning/Scheduling Paradigm).* PMICOS 5th Annual Conference, Chicago, IL. Graphical Planning Method (GPM) is defined as an activity-based networking technique enabling the simplest possible scheme to connect activities and create a network schedule in the shortest possible time. GPM advocates simultaneous planning and scheduling, using the schedule's time-scaled calendar and, **without** a backward pass, calculates floats on-the-go as activities and logic are added to the schedule on user-specified positions. It is further posited that "GPM fundamentally alters CPM by allowing evolving dates, floats, resource profiles and crash-cost curves to impact activity definition and sequencing." Through its simple constructs, GPM permits simultaneous interactive, network planning and scheduling by inexperienced professionals and even the common person.

2. Woolf, Murray B. (2007). *Faster Construction Projects with CPM Scheduling*. New York, NY:McGraw-Hill. Also, Engineering News Record (2003). *Critics Can't Find the Logic in Many of Today's CPM Schedules.* New York, New York. "Among the young guys, computers have made it easy to slap together something that looks right but there is a thought process that must be involved, and it is hard to tell in many contemporary schedules if the thinking happened or not."

3. Project Management Institute (2003). *A Guide to the Project Management Body of Knowledge; (3rd Ed.)* Newtown square, PA: PMI. Unlike other project management standards or well known texts, planning is not even a defined term. In contrast, see Clough, Richard H., Sears, Glen A & Sears, S. Keoki (2000). *Construction Project Management.* (4th Ed). New York, NY: John Wiley and Sons, Inc. "Construction planning may be said to consist of 5 steps: (1) a determination of the general approach to the project; (2) breaking down the project into job steps or "activities" that must be performed to construct the project; (3) ascertainment of the sequential relationships among these activities; (4) the graphic presentation of this planning information in the form of a network, and (5) ***endorsement by the project team***." (Emphasis is by this author).

4. AACE International (2007). *Draft Planning & Scheduling Professional Certification Study Guide*. AACE, Morgantown, WV: AACE. It defines:
   - **Planning** – Identification of project objectives and the orderly activities necessary to complete the project (the thinking part) and not to be confused with scheduling; the process by which the duration of the project task is applied to the plan. It involves answering the questions: 1) What must be done in the future to reach the project objective; 2) How it will be done; 3) Who will do it; 4) When it will be done?
   - **Scheduling** – A description of when each activity in a project can be accomplished and must be finished so as to be completed timely. The simplest schedule depicts in Bar Chart format the start and finish of activities of given durations. More complex schedules, general in CPM format, include schedule logic and show the critical path and floats associated with each activity.

5. AACE. (2008). Morgantown, WV: . Go to pscommittee@poweredge.aacei.org.

6. Engineering News Record (2003). *Critics Can't Find the Logic in Many of Today's CPM Schedules.* New York, New York. Refers to ADM as a once popular, but disappearing method, and that a turning point came in 1994 when Primavera, when switching to the Windows operating system, stopped supporting ADM. "You almost can't get a program on ADM and it is frustrating."

7. Ponce de Leon, Gui (2008). *Graphical Planning Method (A New Network-based Planning/Scheduling Paradigm).* PMICOS 5th Annual Conference, Chicago, IL. Through the 70's and early 80's, as CPM software became more powerful, scheduling creep took over. Newer practitioners arriving on the scene realized they could rely on the computer to obtain a schedule from a rough plan. With the advent of the PC, the pendulum swung most of the way over to scheduling; savvy CPM software types, using the capabilities of the software, could take a shortcut and proceed onto scheduling with very little planning. Eventually, the dialog between stakeholders and scheduler was reduced to the minimum necessary and the scheduler was relied upon to get the schedule right, even if it meant backing into dates and logic. In this rush to computerize, planning became the casualty.

8 & 9. O'Brien, James J. & Plotnick, Frederick L. (2006). *CPM in Construction Management*, (6th Ed). New York, NY:McGraw-Hill. In the most-recent edition of their highly-regarded text, O'Brien and Plotnick posit that "The result can be a network diagram that is apparently simpler than a regular CPM network because it takes fewer work package "boxes" to describe the same set of circumstances. Although the depiction appears simpler, PDM users have to think harder to understand the logic depicted…PDM, in its sophistication, takes a step backward in communications capability…Further, time-scaling of PDM is more difficult than time scaling of CPM. Since time scaling is, in itself, a calculation, the difficulty in doing it confirms two things: (1) manual calculation of PDM is impractical, and (2) PDM obfuscates the use of a network as a means of communicating information…PDM has the paradoxical characteristics of apparent simplicity and built-in sophistication. The result is that the PDM scheduler becomes the project guru rather than a participating project team participator."

10. Ponce de Leon, Gui (2008). *Graphical Planning Method (A New Network-based Planning/Scheduling Paradigm).* PMICOS 5th Annual Conference, Chicago, IL. An embedded node (or embed) is defined as an event intermediate of, or right on, the start and finish nodes of an activity, through which the activity is connected to a successor start node, from a predecessor finish node, or to/from an embed of another Activity. An embed is generally offset (PDM lead/lag) from the finish or start node. An offset is the required, minimum interval between the connected dates of two interconnected activities, e.g., an FS offset denotes the interval between the finish of the predecessor and start of the successor; an SS offset denotes the interval between the start of the predecessor and start of the successor; and so forth for FF and SF relationships.

11. Ponce de Leon, Gui. (1983). Overlapping Arrow Networks. *Stratagem, A Project Controls Journal 1*(2), 1-2. Arrow networks can adapt to overlapping logic as well as precedence networks can by adding dummies for each relationship in an arrow diagram even if not required by dummy rules. Such dummies single out each logic tie individually, which allows them to be labeled as FS, SS or FF (or, if allowed, SF).

12. Other researchers have independently allowed for events as opposed to embedded nodes to be placed within an activity but the posited solutions for working around the ADM and PDM hurdles lead to substantially different methods. Plotnick, Frederick L. (2006, June). *RDM – Relationship Diagramming Method.* 2006 AACE International Annual Meeting, Las Vegas, NV, US.

13. Herold, Scott C. (2004, April). *Enhanced PDM Scheduling Systems*. PMICOS 1st Annual Conference, Montreal, Quebec, Canada. Addresses the lack of clarity in CPM/PDM plotted schedules, however, the recommended protocols fail to ameliorate the complexity of PDM plots. "Once the relationships are converted to activities (where the duration is equal to the relationship lag) the PDM network essentially becomes, from the computer's perspective, an arrow diagramming method (ADM) network comprised of a mixture of activities and relationships, both 'on-arrow.' The EPDM scheduling software can now analyze this network because there are no missing links between the activities. All nodes (activities and relationships) have early dates, late dates, and total float. The EPDM scheduling system has the PDM benefits of simplicity and comprehensibility, and the ADM benefits of network traceability."

14. Woolf, Murray B. (2007). *Faster Construction Projects with CPM Scheduling*. New York, NY:McGraw-Hill. It is generally accepted, ADM-PDM debate notwithstanding, that PDM has overwhelmed ADM to the point where the leading CPM applications do not even support ADM. Murray Woolf devotes nearly 6 pages in this text to "The ADM-PDM Battleground." From this author's perspective, truth be told, once CPM software applications stopped supporting ADM altogether, the PDM-ADM debate (ergo ADM-PDM battleground) became mostly rhetoric, as manually calculating a CPM schedule and proceeding to hand draw the schedule is impractical, if not draconian, in this day and age.

15. Woolf, Murray B. (2007). *Faster Construction Projects with CPM Scheduling*. New York, NY:McGraw-Hill. This is a quote from the must-read Foreword penned by Jim O'Brien