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Contemporary Aspects of Critical-Path
Planning and Scheduling

By Earl Glenwright

P R E F A C E

We tend to see History as an evolution. However sometimes, and there are many examples in the Patent Office of today's 'new' technology being actually developed even centuries ago [i.e. Facsimile-FAX technology], it is interesting to roll back time to earlier periods where we can see 'Lessons Learned' and sage advice which may not have been heeded.

Such is the case with the following.

Part II: Synopsis and Lessons Learned: The Rest of The Story**The Challenge, the Goal, and a few of the Gems
Here's what the Authors said.**

“One of the difficulties in the traditional approach is that planning and scheduling are carried on simultaneously.”

“The fundamental problem involved here is to find some way to define the many independent and combinatorial restraints involved into account: priorities, leveling manpower by crafts, *equipment spreads*, shop capacity, *funding*, material and equipment deliveries, etc.”

“The basic elements of a project are activities and resource expenditures associated with each [*schedule*] activity in the project. These factors produce schedules proposing varying completion dates. Management comes into possession of a spectrum of possible schedules.”

“The basic difficulty encountered is defining the work plan of the project because one never knows precisely what will have to be done. But the truth of the matter is that the majority of activities that must occur must be done every time . “

“Consider the underlying characteristics of a project – many series and parallel efforts directed toward a common goal. The Critical-Path Method was designed to answer pertinent questions about just this kind of activity”

“Using the Critical-Path Method has cut the average time an average of 25%, mainly from the better analysis provided.”

“A characteristic of contemporary project scheduling is the over-simplification”

Pre-Construction Planning: ‘Planning ahead’

“We know that a detailed plan is necessary. Experience thus far shows that it may take six months to carry a project analysis through from start to finish.”

“Planning will be done much earlier in the project’s life to incorporate more of the functions of engineering-design and procurement” *construction, and commissioning of the project.. See attached D/B Chart at http://www.pmforum.org/library/papers/2008/PDFs/Glenwright_Design-Build-Chart-10-08.pdf*

“The next project will include *all* design, procurement, and construction, starting with authorization, the point at which funds are authorized to proceed with sufficient design”

“The Critical-Path Method should be used by the Owner in making the original project estimated schedule. In this way many of the unrealities of project work would be sifted out at the start.”

Diagramming the work

“The whole project was divided into WBS work packages. The scope of work in each work package was analysed and broken down into individual activities. With only 30% design information, the total manpower force curve was predicted with a high correlation”.

“A project activity diagram is built up by sections and the individual sections were then connected [*electronically*] to form the complete project network diagram. Diagramming project work has given planners several benefits:

- discipline
- an aid to refining the design of a project
- a clear picture of the scope
- a vehicle for evaluating alternative strategies”

Mathematical Analysis

*** “The duration of each activity is a variable.”**

“The elapsed time duration of an activity may change as the number of men [*and other resources*] put on it changes, as the type of equipment or method used changes, as the workweek changes from 5 to 6 or 7 days, etc. We can reduce the project completion time by expediting certain of the critical activities – those activities that control project completion time. For only 1% increase in the variable direct cost of the project an additional two months improvement could be gained”

“If the project manager was asked for improvement in the project duration and he had no knowledge of the project expense curve, he would first vigorously protest that he could not do it.”

- “Some “floaters” if displaced, will start a chain reaction of displacements downstream in the project.”

“One criteria would be to displace the activities with the least float first, and sub-totals kept by craft to ensure that, even though total force may be all right, craft restrictions also are met.”

Manpower Leveling.

“Considerations of available manpower and equipment would be conspicuous by their absence.”

“The equipment and manpower requirements, for a particular schedule may exceed those available or may fluctuate violently with time. A means of handling these difficulties must therefore be sought —a method which ‘levels’ these requirements”

“The basic assumption is that adequate resources are available (this is an unrealistic assumption). Two extremes that need to be considered are: *one* project, many projects. This [*one project*] may be called *intra*-project scheduling. In the second case, we run into difficulties in trying to share men and equipment among several projects which are running concurrently. We must now do *inter*-project scheduling.”

Incorporating Manpower Sequences

“It is possible to incorporate manpower availability in the project diagram. For example, three activities, A, B, & C, can occur concurrently and each activity requires the same crew. We can avoid the possibility that they occur simultaneously by requiring that A be diagrammed to be followed by B, followed by C. It is also possible to state 5 other combinations.”

“However, by incorporating manpower sequences, we would never really know the true scheduling possibilities. This approach can cause considerable difficulty and may lead to erroneous results and therefore it is recommended that this approach be dropped from consideration.”

The Rest of the Story

Some statements are clearly ‘dated’ in that they give us a clue as to when the source document was written. The source document was 25 pages! But it had the above ‘gems’ embedded in it. ‘The String of Pearls’.

There were 2 authors who were reporting to their peers about a problem they were tasked to solve. One was a Mathematician and the other an Industrial Engineer. One worked for Univac/Remington Rand, the other for DuPont.

For those of you who know your history of network-based resource scheduling, you know who the authors were. For those who don’t [and that must be most if not all of the readers of the 1st article as you didn’t take the challenge bait?] now you will learn the **Rest of the Story**.

But first, let me tell you an interesting bit of ‘trivia’. The mathematician’s solution was a series of equations for the sequence of the work [*simultaneous?*]. But no one could understand the concept. So he reverted to the tried and true method of drawing a picture. That picture became what we now call an activity network. At the same time the U.S. Navy had formulated a similar solution for the Polaris program. He liked what they called the sequence of activities/events so he borrowed their term. Hence, his ‘critical chain’ was renamed and the term ‘Critical Path’ was coined.

I think both authors joined Dr. John Mauchley’s firm and continued to develop the Critical Path Method and the Mathematical Analysis algorithms that we still use today. Dr. John Mauchley who was then with Univac is a co-holder of the patent for the 1st electronic computer, the ENIAC developed at the University of Pennsylvania. And since he had this wonderful computing machine he sought an application for its use. Because it was affected by moth-type insects resting on the vacuum tubes, Admiral Grace Hooper says this inspired the term ‘bug’ in computer jargon.

James J ‘Jim’ O’Brien, an icon of CPM, worked with these 2 authors at Mauchley Associates in Amber, Penna. In the 1960’s.

So here is the ‘Rest of the Story’!

- When ? ‘at the creation’ /the birth of network analysis circa 1959
- Where ? Philadelphia
- Why ? To present to their peers a new technique for application in Construction Project Resource Management
- Who ? By the ‘creators’, James Kelly & Morgan Walker

Critical-Path Planning and Scheduling
James E. Kelly and Morgan R. Walker
Proceedings of the Eastern Joint Computer Conference, circa 1959

Author's note. Several years ago Eric Jennet (a founder of PMI) sent me a copy of the original proceedings paper by Kelly & Walker. About 20 years ago the PMI NETWORK magazine featured articles on the creation of both ADM [Kelly-Walker] and PDM [John Fondahl]. When I read the original proceedings I thought, 'This is as applicable today as it was 50 years ago.

I have taken care to extract exactly what Kelly & Walker said. And when I felt it necessary to add a word or two, I did so in Italics [ad libing?]

I hope you enjoyed this short remembrance of an historical event and can also appreciate the 'String of Pearls' of advice they gave us. Some of their 'Lessons Learned' we still need to learn.

Editor's note: If you missed Part I of Earl Glenwright's paper "Contemporary Aspects of Critical Path Planning and Scheduling", published in the March 2008 edition of PM World Today, you can see the paper at <http://www.pmforum.org/library/papers/2008/PDFs/Glenwright-3-08.pdf>.

About the Author:***Earl Glenwright****Author*

Earl Glenwright, PSP, has a career spanning 40+ years in construction project scheduling. Earl is certified as a Planning and Scheduling Professional [PSP] by the Association for the Advancement of Cost Engineering International [AACEi]. He frequently gives presentations at their annual conferences. Earl has both a BS in Civil Engineering and a MBA degree and is a Registered Professional Engineer. Earl's career has included multi-year positions in several countries including Brasil, Saudi Arabia, and Sudan. He currently lives in Bulgaria and Colorado. Prior to 1988 he was employed by the [US] Bureau of Reclamation and the [US] Army Corps of Engineers. After retiring in 1988 he has been a free-lance consultant for both contractor's construction scheduling and small business Enterprise Project Management. His experience includes large and very large [super-mega] construction projects, very small projects such as construction planning, and scheduling for home construction by his Habitat for Humanity affiliate. Through his extensive scheduling experience he has been recognized as a Subject Matter Expert [SME], a Master Scheduler, and an Expert Advisor. Earl has been active in the Project Management Institute for 30+years. He has presented "Time & Cost" training at PMI's annual seminar-symposia, and was a member of the initial PMBoK Guide Project Team, the 2000 update team, and the project team that prepared the 3rd edition. Earl has recently presented 'workshop/seminars' for Bulgarian project scheduling and controls persons which covers the 3 phases of scheduling: framework preparation/planning, schedule development, and schedule management and control. The work books are dual language English and Bulgarian. Earl can be contacted at earl_csss@yahoo.com.