

The Origins of Hammocks and Ladders

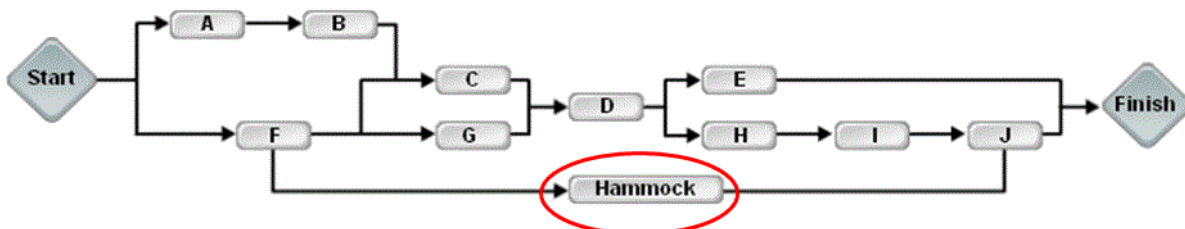
Hammock and Ladders are activity types that were developed in the period 1961 to 1965. This paper is focused on outlining the development of these useful scheduling assets. However, it's important to note Hammocks, LOE and Summary Activities are three completely different types of activity.

- **Summary Activities** are a function of the coding structure in a schedule; at this time the origin of summary activities is uncertain, but the concept seems to have emerged in the mid 1980s as part of the move from DOS and text-based scheduling tools to software designed to operate with the early Windows graphical user interface. The origins may be earlier (any advice on this will be welcome).
- **Level of Effort (LOE)** activities are aligned with Level of Effort work packages in the WBS, and Earned Value systems. Earned Value emerged in the 1970s.
- **Hammock activities** are described in detail below.

All three activity types can be used to carry resources for a period of time (usually 'overheads' or supporting resources) and both Summary Activities and Hammocks can be used to create summary reports, but the differences in the way these three activity types are created and used is significant¹.

Hammock Activities

Hammocks are a cross between a link and an activity. A *Hammock* is an activity that spans between two points in a schedule. Having no set duration of its own, its duration is derived from the difference in time between the two 'connection points' in the schedule. It can be thought of as 'hanging' between these two points in the same way a normal hammock may hang between two trees.



Whilst a *Hammock* has no predetermined duration, it can have descriptions, codes, calendars, resources, costs and other attributes of a normal activity. *Hammocks* are very useful for carrying time related costs and determining the duration of supporting equipment needed for a project, as well as being used to create summary reports.

Hammocks originated in Activity-on-Arrow networks as activities which are connected across a series of activities from the 'i node' of a specific start activity to the 'j node' of the last activity in the span². The

¹ To understand the differences see *Hammocks, LOE and Summary Activities in Schedules*: https://www.mosaicprojects.com.au/Mag_Articles/P016_Hammocks_LOE_and_Summary_Activities.pdf

² The i-j notation refers to the numbering of the 'arrows' in a CPM network. The 'i' number is at the beginning of the arrow (left), the j number is at the end (right). Therefore, each node is both the 'j' number of the activities preceding the node and simultaneously the 'i' number of the activities succeeding the node. To understand more about the Activity-on-Arrow notation for CPM networks see: A Brief History of Scheduling (page 8) https://www.mosaicprojects.com.au/PDF_Papers/P042_History_of_Scheduling.pdf

Hammocks duration is calculated from its 'i node' early start (ES) to its 'j node' late finish (LF), and is derived from the number of working periods in the calendar attributed to the Hammock between these two dates.

Hammocks in precedence networks (PDM) have a similar function but are activities linked Start-to-Start (SS) at the beginning to the first activity in the span, and Finish-to-Finish at the end to the last activity in the span (this development came much later).

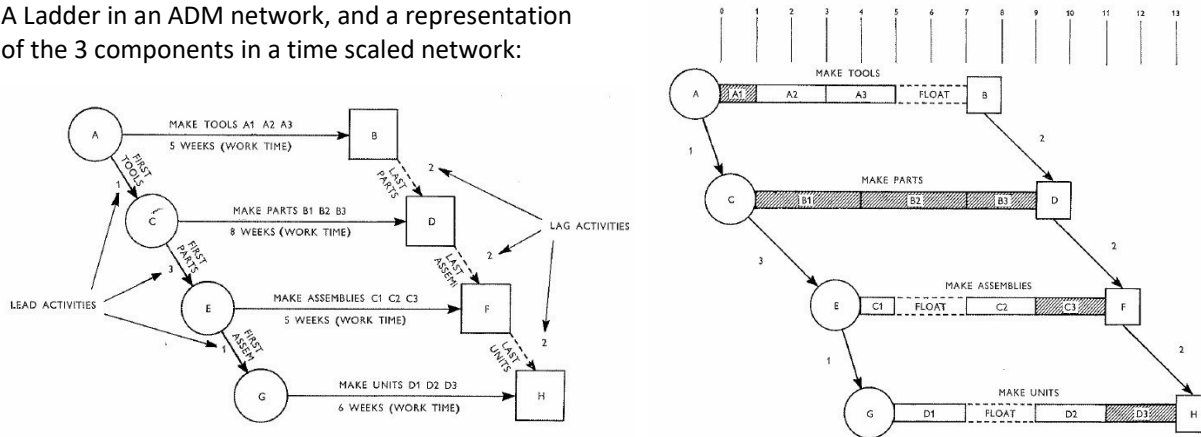
Ladders

Activity-on-Arrow diagramming became complicated when projects had multiple resource types and multiple identical activities that were interdependent, usually differing only in their physical location (e.g. chainages along a pipeline) and the situation is not much easier to manage in PDM networks.

To overcome this problem, Ladders were developed as a special group of activities that are used to represent progressive feed tasks. An example of a progressive feed task occurs in the manufacture of a number of identical components, each component having to go through several processes such as manufacturing, assembly and testing. To represent these processes in a network in the normal way would require one activity for the manufacture of each component, another to assemble the unit, probably another for inspection, etc. The same sequence of activities would have to be repeated for each unit. The resulting network could be extremely complex; Ladders simplify the representation of the work.

Rung activities are the various tasks to be undertaken with defined durations, resource requirements, etc., but designated as a 'rung' type of activity. The leads and lags are special activities specified with reference to the rung activity from which they originate. Before the second task in such a progressive feed process can start, the first task must have been in progress for a given time to ensure a supply of components for the second task. The time that must elapse before the second task starts is called lead time. Similarly, there is a lag time after the completion of the first time before the second task can be completed (note: these are quite different concepts to 'leads and lags' in normal PDM networks).

A Ladder in an ADM network, and a representation of the 3 components in a time scaled network:



Whilst this is similar to the operation of SS and FF links in a PDM network, from an analytical viewpoint, the major advantage of a Ladder is if work stops on one rung, the delay is automatically flowed through to the work on all of the dependent rungs, not just the end event³.

³ For more on Ladders see **Links, Lags and Ladders**:
https://www.mosaicprojects.com.au/PDF-Gen/Links_Lags_Ladders.pdf



The Development of Hammocks and Ladders

Hammocks and Ladders were developed in the first half of the 1960s by the BTM / ICT Operational Research applications group in the UK. This group was managed by John Grant with two team leaders Professor Perry Alfred (Dusty) Rhodes and H. Sam Woodgate. Other members of the team included Hamish Carmichael, John O'Rouke, Arthur Winter, David Hallman and Raf Dua⁴.

There was also a cadre of 'operations research' (OR) people involved in these developments in conjunction with the ICL team, all of whom were members of the British OR Society⁵. The connection between the development of CPM and OR is highly significant and discussed in *The Origins of Modern Project Management*⁶ and these link to academia and industry facilitated by the OR Society certainly contributed to the developments discussed below.

In 1961, the ICT team had taken the RCA 301 PERT package⁷ that they had been jointly working on and upgraded and renamed it the ICT 1500 Series PERT; 1500 PERT included resource scheduling and costing. The team were also supporting the ICT 1301 PERT software and working on APPRAISE for the ATLAS computer and OPUS for the ORION computer and a small simple CPM software package for Pegasus and Mercury range of computers.

During this period, the team worked on the development of Hammocks, Ladders and an interesting technique called '*Skeletonisation*' which shrank the 'big' data requirements of a CPM network to more manageable size appropriate for the limited processing power, and high costs of mainframe computers at that time. Hammocks were a major part of the '*Skeletonisation*' process.

Ladders were the first of the three concepts to be released. ICL 1500/4 PERT included Ladders on its release in May 1963 and the documentation suggests Ladders were part of the 1500/3 PERT program (1962) with only minor improvements in the /4 release.

⁴ Raf Dua is the source of much of this information. He is currently the owner and Principal of the Micro Planning International Group (MPI). MPI's flagship scheduling software X-Pert grew out of the ICL mainframe systems in the 1980s and still incorporates Ladders and two types of Hammock correctly in both its PDM and ADM options. Normal Hammocks use resources as required. Sponge Hammocks only use resources if any are available after the completion of resource allocation and levelling calculations - this option tells you the cost of unallocated resources in a schedule. See: <http://www.microplanning.com.au/>

⁵ Between 1961 to 1965, there were many meetings with people such as Keith Lockyer from the London Polytechnic, Dennis Corke, Albert Battersby, and many others who were the UK pioneers in CPM, promoting Hammocks, Ladders and resource scheduling. Some early users of 1900 PERT (who also contributed to the system requirements include):
D.J. Armstrong who was with Richard Costain Construction and J.A Carruthers who went from Costain to Unilever,
R Coker from WS Atkins who were traditional Business consultants,
R.C.J. Taylor from CEGB,
EG Trimble of Loughborough University, and
D.J. McLeod of Hunting Engineering.
Almost everyone listed was a member of the OR Society.

⁶ To download the *Origins of Modern Project Management*, see:
https://www.mosaicprojects.com.au/PDF_Papers/P050_Origins_of_Modern_PM.pdf

⁷ RCA - Radio Corporation of America - was an early manufacturer of computers and collaborated with the ICT team to developed an early 'PERT' scheduling system.



The concepts of Hammocks and '*Skeletonisation*' followed and were fully developed and tested by the time the ICT 1900 Series computers were released and were incorporated into the 1900 PERT software released to the public in November 1965⁸.

The initial use of hammocks was to produce high level management reports (ie, summary schedules) as part of the '*Skeletonisation*' process. If you had (say) Electrical, Mechanical and Civil activities in a schedule, you could 'hang' a *Hammock* across each of these groups of tasks and create a bar chart showing just the three *Hammock* activities with their dates and the calculated durations. This process reduces the volume of data printed considerably; a major cost saving when considering the charges associated with running a mainframe computer in the 1960s and 70s. For a number of years, having *Hammocks*, *Ladders* and *Skeletonisation*, gave ICT (later ICL) a significant advantage over its major competitor, IBM.

The concepts of *Hammocks*, *Ladders* and *Skeletons* were discussed in the 2nd edition of HS Woodgate's book, *Planning by Network*, published in 1967, and seem to have been adapted into many of the scheduling system available by the 1970s.

As the processing power of computers increased and running costs decreased, the need for '*Skeletonisation*' disappeared but Hammocks and Ladders are still useful for both summarisation and resource calculations.

As with both LOE and Summary Activities, Hammocks can be used to carry overhead costs and resources for a section of the project.

- The benefit of a Hammock over LOE is the Hammocks duration is flexible and adjusts automatically as the underlying logic in the schedule changes, whereas LOE activities have a set duration that requires manual adjustment.
- The benefit of a Hammock over a Summary activity is that its connection points do not need to be in the same part of the schedule's coding / summarisation structure. Summary activities are part of the coding structure and summarise lower level tasks within the coding system. Hammocks are not dependent on any coding structure and therefore the Hammock can connect from any point in the schedule logic to any other point (but depend on correct logic).

Ladders continue to resolve the scheduling problems caused by progressive feed and 'unbalanced' chains of activities connected with both Start-to-Start and Finish-to-Finish links.

Conclusion

Summary Activities, LOE and *Hammocks* are distinctly different activity types. Of the three, the development of *Hammock* in the period 1961 to 1965 would seem to predate the other two options. However, the origins of code-based Summary Activities remains uncertain.

Ladders were and are a useful way of managing progressive feed between overlapping activities.

Unfortunately, whilst the origins of these activity types and their functions are quite clear, the practice of scheduling continues to be undermined by the misappropriation of names by software developers. Why people chose to misuse names and spread confusion by using terms incorrectly is beyond me, but until the

⁸ A section of the 1900 PERT manual describing some of these features can be downloaded from: https://www.mosaicprojects.com.au/Mag_Articles/P040_Extract_ICL_1900_PERT_Manual.pdf



scheduling community starts to insist on everyone using the same name for each distinct function or activity type, we are always going to look unprofessional⁹.



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⁹ For more on the damage caused by incorrect naming conventions see:
<https://mosaicprojects.wordpress.com/2013/03/18/pert-whats-in-a-name/>