Project Services Pty Ltd

MATHEMATICS MATTERS

IN PROJECT MANAGEMENT

Presented at

THE THIRD AUSTRALIAN COST/SCHEDULE PERFORMANCE MANAGEMENT SYMPOSIUM

Canberra

18th May 1995

By

Patrick Weaver PMP, FAICD.
Brian L. Doyle

For more schedule management papers see:
https://mosaicprojects.com.au/PMKI-SCH-010.php

Mosaic's Planning Home page see:
https://mosaicprojects.com.au/PMKI-SCH.php

Mosaic Project Services Pty Ltd
PO Box 5150
South Melbourne VIC 3205
Tel: (03) 9696 8684
Email: patw@mosaicprojects.com.au
Web: www.mosaicprojects.com.au

INTRODUCTION

A Review of the Importance of CPM Mathematics in Effective Project Management.

Data is not information, information is not knowledge,
knowledge is not understanding, understanding is not wisdom.
T.S.Elliott 1920

Project Management Perceptions

In the minds of many people, the hallmark of a project manager is the ability to accurately schedule and control work using formalised time-based charts and presentation techniques. Similarly, the term *project management software* largely refers to time planning and schedule control tools and the early growth of project management institutions both here and overseas was closely aligned with the spread of computer-based schedule control techniques. All of these factors combined create the perception in the minds of most people (other than professional project managers) that the process of applying time control techniques and the process of project management are almost synonymous. In our view, the various Project Management competency standards offer a more realistic view of the overall functions of a project manager but the *perception* outlined above must be effectively managed if a project manager, and more importantly, the actual project is to be seen as successful.

We would suggest there are two key attributes that separate an effective Project Manager from all other types of manager. The first is the formal ownership of the whole *project*, on behalf of his (her) company, department or client, from beginning to end. The second is the use of formal planning processes to allocate scarce resources, communicate current intentions and report actual progress and trends to all of the project's stake holders. In this context resources include time and money as well as people, space and equipment. Whilst schedule control is only one of the many functions included in the competencies, we would also suggest that it is the common glue that binds all of the other processes together and provides the marketable difference both in perception and fact that separates the processes of *project management* from other management fads and disciplines.

Project Management Competency Processes

All of the processes defined in the A.I.P.M's. competency standards are employed at a superficial level by almost every manager and supervisor. As an example, consider the nine knowledge areas defined in the *PMBOK® Guide* (Project Management Body of Knowledge) and the preparation of a dinner party:

Competency	**Dinner Party**
Scope Management	Number of courses, guests
Quality Management	Type of meat / wine purchased
Communication	To guests, spouse, etc.

Contract / Procurement	The shopping
Cost Management	Budget limits with direct links to quality, scope and procurement
Risk Management	Use a new recipe or play safe?
Time Management	Planning the preparation, cooking and serving times
Resource Management	Persuading the children to help wash up!
Stakeholder Engagement	Ensuring everyone has a good time
Key Integrative Processes	Tying all of the loose ends together

We suggest that almost every endeavour with a defined start and end point could be described in terms of a project[1] and that most competent managers use most of the skills defined in the competency standards (or the PMBOK) to some extent most of the time.

In contrast, some of the key functions incorporated into the competency standards may be very little used by some project managers. Typically, a 'project manager' working for a construction contractor running a traditional tender project, may find the scope of his (her) project fully defined within the contract documents with detailed drawings and specifications already in place, significantly reducing the options for *scope management*. As suggested earlier, the key difference between project managers and other people who use all or most of the basic functions in the competency standards is (or has been) the use of formal schedule control techniques to manage all of the other facets of the project process. Unfortunately, this skill appears to be slipping away leaving the profession of Project Management with little to offer employers and prospective clients that is significantly different from other good management styles and processes bringing into question very existence of *project management* as a distinct process or profession.

Project Management Trends

Over many years, we have identified a steady movement within the ranks of project managers away from the discipline of network analysis to the softer option of barchart scheduling. One of the key indicators of this trend is the move by almost all software developers to offer *project management systems* where the primary method of data input is a barchart view. Very few of the project management software systems sold today encourage users to approach scheduling from a logic network (or traditional CPM / PDM) viewpoint[2]. This trend is driven by market forces and whilst offering an easy fix to the problem of generating a project management graphic, the lack of adequate analysis will in the longer term present significant challenges to the effective completion of the project.

---

[1] For more on distinguishing projects from other forms of management endeavour see, ***Project Fact or fiction – Will the Real Projects Please Stand Up***: https://mosaicprojects.com.au/PDF_Papers/P007_Project_Fact.pdf

[2] One exception is Microplanner X-Pert: http://www.microplanning.com.au/

Project Management Failures!

A report prepared by the Standish Group (in the USA) a few years ago found that for larger companies, 91% of their projects failed to meet time and budget objectives (ie, only 9% were delivered on time and on budget!). Smaller companies had more success with the average failure rate for all size firms being 84% (ie, on average only 16% of the software projects studied were successfully delivered). The two prime areas of management failure identified by the Standish Group were scope control and schedule control. The total cost of cancelled software projects in the USA that year was estimated by the Standish Group to be AUD$112,000,000,000.00! And unfortunately, these measures have remained stubbornly consistent over many years.

One reaction has been to abandon traditional project management approaches and adopt various forms of 'agile' development. At one extreme, 'agile anarchists' advocate *no estimates*, and working on 'stuff' until you get an outcome people are happy with. At the other extreme, the 'agile' approach adopted is not much different to traditional command and control management. The 'Agile Manifesto' sits in the middle. Well implemented Agile approaches to some types of project (particularly software development) does seem to offer significant benefits[3]. For the rest, where traditional approaches are still useful, we wonder how many of these projects could have been saved or alternatively never started if the rigorous schedule control techniques discussed later in this paper were in use?

The Project Management Challenge

For better or worse, the process of project management is perceived by most people to be closely aligned with the effective use of formal schedule control techniques. Whilst at the same time the planning skills required to develop and maintain dynamic CPM and PDM networks appears to be diminishing. This trend is compounded by the fact, factors such as *ease of use*, *ease of support* and/or a *common vendor policy* are seen by many people (including most MIS / IT departments) to be more important than accurate analysis.

Unless project managers can offer direction and leadership in the area of effective schedule control, the repeated failure of the *easy* planning options will be seen as the failure of *project management* (however wrong this view may be) and our industry will pass into history. A number of authors writing in the Project Management Institute (USA) journals (eg John Tuman [1993] and James Snyder [1987][4]) are already suggesting that *project management* is in danger of becoming obsolete.

The balance of this paper will address the differences in the quality of the information derived from different input, thinking and calculation processes. The original intention was to offer a simple contrast between static barcharts and dynamic, logic-network-based processes and systems. In the meantime, software developments (particularly some graphical packages) has blurred the lines between the two clear cut options. Therefore, the discussion in this paper has had to move back a step to look at the thinking processes deployed by the scheduler or project manager rather than the actual systems as many software packages can be operated in different modes.

---

3 For more on ***Agile***, see: https://mosaicprojects.com.au/PMKI-XTR-010.php#Process1

4 Tuman, John Jr. (1993) "Its time to re–engineer project management" PM NETwork, Vol.VII No.2, February pp40–41.
Snyder, James R. (1987) "Modern Project Management: How did we get here – Where do we go?" Project Management Journal, Vol.XVIII, No.1, March, pp28–29.

The History of Project Scheduling Techniques

Barcharts or Gantt charts have been around as an effective management tool for well over 150 years, developed in 1765 and progressively refined[5]. Barcharts are static plans that cannot automatically compensate for changes in one section across the full schedule. The only option if something changes is for the planner to work out the consequences of the change and then redraw the barchart.

Starting in 1959, significant improvements in the scheduling process occurred. Cooperation between industry and computer companies led to the development of CPM[6], PERT and PDM virtually independently of one another. The PERT process (using three time estimates) has virtually died out leaving CPM (which is in decline) and PDM (now often incorrectly referred to as 'PERT') as the dominant network scheduling processes. Both of these techniques use a single time estimate for task durations and rely on the use of logic-based networks to calculate the critical path.

The introduction of CPM, developed by the Integrated Engineering Control Group of El du Pont de Nemours and Remington Rand Univac, is credited with cutting plant downtime during scheduled maintenance by up to 25%. The consequential increase in production in the first year was sufficient to pay for the $millions development costs.

PERT was similarly credited with significant savings by the US Navy on the POLARIS project. These gains were made after the implementation of barcharts many years previously. We suggest that the current trends back to basic barcharts has the potential to undo many of these gains.

STATIC -V- DYNAMIC SYSTEMS: BUILDING THE SCHEDULE

The 'Logical' Option – Building a CPM or PDM Network

This process is very similar in concept to Dr. Edward de Bono's *Six Thinking Hats*[7] and draws on the same philosophy for effective creative thinking, ie break the overall thinking process into structured phases whilst letting the 'structured system' deal with maintaining overall coherence. The structured thinking process encouraged by network scheduling and Mosaics's ***Five Steps To Ensure Project Success***[8] (5-STEPS) generally moves through the following stages.

1) **Organise the Project.** This involves defining the project parameters or scope. Logical planning is virtually impossible if the scope of a project (or at least the current scope of the phase to be planned) is not known[9].

---

5 For more on the ***origins of barcharts*** see: https://mosaicprojects.com.au/PDF_Papers/P042_History_of_Scheduing.pdf

6 The original CPM and PERT developments used 'arrow diagramming' (ADM or 'activity-on-arrow'), see: https://mosaicprojects.com.au/PDF_Papers/P042_History_of_Scheduing.pdf

7 For more on ***Six Thinking Hats*** see: https://mosaicprojects.com.au/Mag_Articles/P038_6_Thinking_Hats.pdf

8 For more on the ***5-STEPS methodology*** see: https://mosaicprojects.com.au/PDF_Papers/P004_5-STEPS.pdf

9 For more on ***scope definition*** see: https://mosaicprojects.com.au/PMKI-PBK-015.php#Process2

Other key factors are identifying project stake holders, the project team members and the project reporting requirements (this process will define to a very large extent the coding structures to be used within the project plan and will facilitate selective, relevant and targeted reporting).

2) **Structure the process model.** The first step in this stage is to identify all of the operations that need to be completed to achieve the scope defined in *Step 1*. Formal processes such as Work Breakdown Structures[10] (WBS) may be used or less formal brain storming sessions.

   The next step is to organise the operations into a logical sequence (ie draw a typical PDM or CPM chart). The resulting process diagram is based solely on the intrinsic logic of the project and should be checked to ensure all of the necessary logic links are included and questioned to ensure that only 'real' logic is built in[11].

   The third step is to give all of the tasks a duration[12]. This should be based on estimates of 'normal time' sourced from (as far as possible) the people who will have to complete the task or their managers.

   The final step is to analyse the network and check for any logical inconsistencies[13]. The time frame thus developed is a 'best case' scenario based on the availability of unlimited resources. If it fails to meet target deadlines, major reviews of scope and / or delivery dates will be required.

3) **Optimise Resources.** No project operates in isolation. This stage revisits the schedule taking into account the actual availability of resources. In matrix organisations, this will involve gaining commitments from the Divisional Managers who control the resources, in a contracting situation taking into account the probable availability of subcontractors and logical work flows. It is normal for a resource levelled schedule to be significantly longer than the pure logic plan and involves a trade-off between costs, resource availability and planned durations.

   Simplistic software systems like to pretend these linkages are a straight-line ratio. In fact, complex "J–Curve" relationships exist between crew sizes, durations and the cost per unit produced.

   Any resource levelled plan will be a compromise, however, once completed it will show the realistic start and finish dates for individual operations and the overall project based on available resource levels[14].

4) **Gain commitment.** Stake holders should have been involved in all of the previous stages and be fully aware of the matrix of decisions made to achieve the resource optimised plan.

---

10 For more on ***developing a WBS*** see: https://mosaicprojects.com.au/WhitePapers/WP1011_WBS.pdf

11 For more on ***developing a CPM network*** see: https://mosaicprojects.com.au/PDF-Gen/Good_Scheduling_Practice.pdf

12 For more on ***duration estimating*** see: https://mosaicprojects.com.au/WhitePapers/WP1052_Time_Estimating.pdf

13 For more on ***CPM Time Analysis*** see: https://mosaicprojects.com.au/PDF-Gen/Schedule_Calculations.pdf

14 For more on ***resource optimization*** see: https://mosaicprojects.com.au/PDF_Papers/P152_Resource_Optimisation_2.pdf

However, before moving onto the Management phase of the project, the last key step is to ask all of the managers and stake holders as well as the project team members to 'sign off' the completed plan. This formal step is designed to ensure commitment to the plan. If problems are encountered, it may be necessary to revisit *Step 2* and/or *Step 3* until agreement is reached.

5) **Manage for success**. The final step of implementing effective management processes is discussed later in this paper. However, at this stage it is sufficient to note that effective management control is very difficult without both a sound baseline plan and real management support[15].

The Static Options – Drawing Barcharts or 'Time Scaled Networks'

The way scheduled are developed influences the thinking of the person creating the schedule and as a consequence, the information used to manage the project. There are two basic approaches used to develop static charts:

1) **Computerised Barchart Systems**. Observations of many project managers using interactive barchart based software shows a completely different approach to working. Assuming *Step 1* is completed in the same manner as the *logical* processes described above, the next move is almost inevitably for the planner to start writing down task descriptions and drawing out bars. The planner is in effect attempting to complete all of the stages involved in *Step 2* and *Step 3* of the *logical* process at the same time.

   Barchart drawing produces quick results by allowing the planner to push bars around until the result looks right and a plan will be finalised in the shortest possible time frame. The problems with this process are that the ultimate 'cause and effect' of the schedule is not always known or considered by the project team (We have examined a schedule where two tasks of 20 odd days each have been connected with a link of -500 days). Also, the *pattern* of activities in the schedule will be strongly influenced by the nominal project completion date and the time based *pattern* used on previous projects of a similar nature; ie, the opportunity for constructive lateral thinking is significantly reduced.

   The effect of barchart planning is a tendency to lose the logical basis for the network, reduce the scope for lateral thinking and repeat previously used patterns. The loss of logical structure has significant impact on the ability of the software to level resource requirements and calculate the effect of progress on the plan.

2) **Time scaled networks**. This style of network development is probably even more restrictive to creative thinking than the barchart based systems discussed above. The process adopted by most planners is to lay out the project time scale across the top of the drawing first and then to start drawing time scaled activities directly onto the chart. Options for reorganising the schedule are severely restricted by the time and cost required to redraw the plan[16].

---

[15] For more on ***managing for success*** see: https://mosaicprojects.com.au/PDF_Papers/P002_MFS_Full.pdf

[16] **Note**: there are tools available such as GPM that overcome many of these issues and add significant advantages to the process such as interactive 'touch screens' and the ability to work collaboratively with a group of stakeholders.

As with barchart based systems, effective resource scheduling is almost impossible leaving the project management team with significantly deficient information.

Manual & Computer Based Systems

The conflict between static and dynamic systems extends into the area of schedule preparation. A number of enhancements made to the original 1910 style barchart presentations[17] including 'cascade' charts and time scaled networks. Whilst these techniques clearly indicate the logic of a programme, actually changing the network logic on a manually drawn chart is a major effort[18]. The unproductive effort required to make relatively minor changes manually created charts is the principal reason for the popularity of computer-based scheduling systems.

The essence of good planning is to work through all of the problems confronting a project, try various "What – If" scenarios and as a consequence, optimise the plan. This process is significantly compromised if a simple change is going to involve several hours of drafting and calculation time. There is a world of difference between a static manually prepared chart (which no one is going to change unless they absolutely have to) and a report generated from a dynamic computer-based system to show the consequences of schedule updates and changes to the network logic.

While the use of computers is a major benefit in the "What-If" processes associated with good planning, one major consideration must be the accuracy of the computer system calculations, particularly when resources and cost scheduling are involved. Manual calculations to level multiple resources across tasks working to several different calendars is almost impossible. However, as will be demonstrated later in this paper, blindly relying on inaccurate data from a computer system can in many cases be worse!

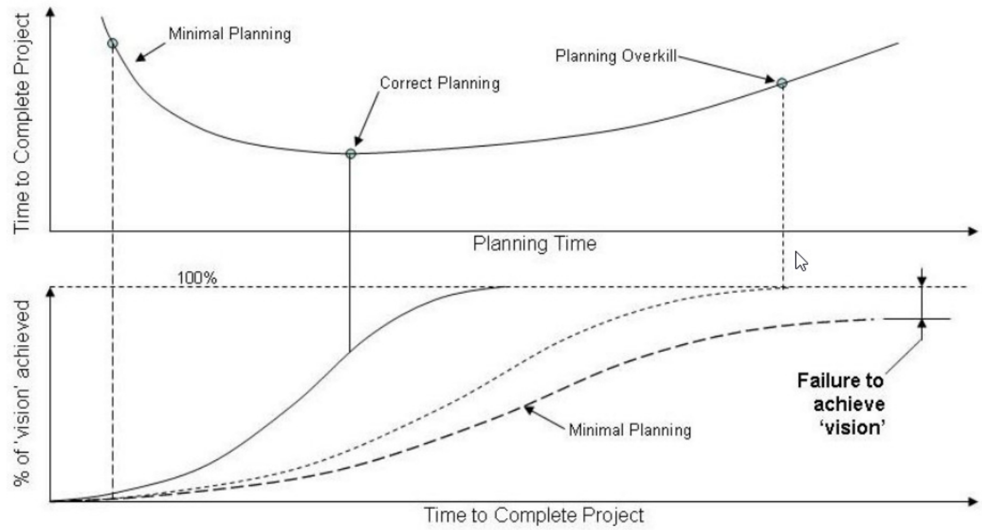
Management Considerations

The plan is seen by many "barchart" planners as an end in itself. Planners using effective logic-based tools see the baseline plan as simply the start of an overall schedule control system. The cycle outlined in Figure 3 shows a typical management process with the regular issue of targeted short-range information to project team members and summary management information to the project office and stake holders. The basis of the planning is the assumption that the project will not work exactly to plan and the identification of trends, revised critical paths and resource requirements is essential for effective control.

This process required the updating and reanalysing of the plan at regular intervals. Unfortunately, many static planners using barcharts and time scaled networks often fail to grasp the significance of a dynamic update as demonstrated later in this paper.

[17] For a published example of a ***barchart from a 1910 railway project*** see: https://mosaicprojects.com.au/PDF_Papers/P042_Barchart_Origins.pdf

[18] While no-one draws schedules using pen and paper these days, the difference between tools designed for the process and general 'drawing' tools such as Visio, PowerPoint and Excel are significant.



Adapted from Firdman, H. E. (1991). Strategic information systems: Forging the business and technology alliance. McGraw-Hill, New York.

Figure 1

Given the basis of most decisions relating to time and resources are based on the schedule, putting the effort into developing an accurate schedule is time well spent. The chart in Figure 1, originally developed by Firdman, shows the relationship between the planning effort and project achievement. The correct level of planning achieves 100% of the project's vision (or deliverables) in the shortest time. Inadequate planning not only results in the longest delivery times but also in the project failing to achieve its original vision or scope. The bureaucracy associated with over planning on the other hand simply delays completion.

Summary of the Three Key Differences

There are three key areas of differentiation between Barcharts and CPM networks.

1) **The development process**:

   a. **Barcharts:**
   Deterministic – The planner needs to know everything, all of the time.
   No logic – The planner decides where all of the bars will be placed.
   Quick – Generally quick and easy to develop.
   Use – Suitable for small jobs where the planner knows the right answer before starting the drawing.

   b. '**Critical Path' Networks**:
   Iterative – The logic contained in one section remains as other sections are built and added around it.
   Logical – Logic already entered will retain its integrity until changed by the planner. The scheduling of all tasks is determined by the network logic.
   Difficult – Developing an 'sensible' logic diagram is a difficult art that needs to be learned. The speed of developing a schedule is dependent on the skill level of the planner.

Use – Projects where the correct outcome is not known for certain at the start of the planning process.

2) **Progress data and reporting**:

   a. **Barcharts**:
   Barcharts are only capable of showing how far behind (or ahead) of plan current progress may be on a task by task basis. There is no inherent capacity for calculating a revised critical path (there isn't one) or a revised completion date. If progress is not in line with the original plan, the only effective option is to redraw the barchart.

   b. **'Critical Path' Networks**:
   When supported by adequate software, a CPM network will, after the input of progress information, recalculate the critical path, identify the revised end date and report on both the remaining float and any variance from the original plan on a task by task and overall project basis.

3) **Resource Analysis**:

   a. **Barcharts**: The only resource analysis possible within a barchart system is a simple aggregation of the resource required on any given day. If a change is required, eg to reduce an overload, the barchart needs to be redrawn as changes in the timing of one bar are not automatically reflected in the timing of other bars.

   b. **'Critical Path' Networks**: Again, when supported by adequate software, a CPM network will reschedule tasks taking due cognisance of float and logic to optimise resource usage based on pre-set criteria defined by the planner.

Progress Measurements on Barcharts

The schedule in Figure 2 represents a typical mark up of a barchart after 6 days work. Resource effort has been applied to tasks to achieve progress that on an overall basis appears to be "in line" but in fact has a significant number of problems.

The "Test Criteria" task is three days behind programme, the "Implementation Criteria" task three days ahead of programme. Based on this data, when will the project finish? Three days late because the "Test Criteria" task is behind programme or approximately on schedule because the average of the gains and losses to date, the sum of +3 and -3, is zero.

If additional resources became available, based on the available 'barchart' data, which task should receive priority? The natural answer is to allocate the resources to the task that is behind programme. However, this may not be the optimum answer. What do you think?

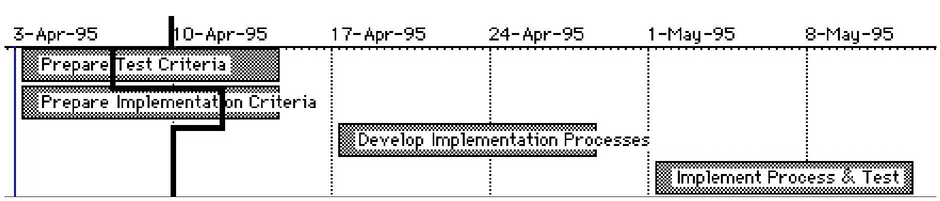


Figure 2

A safe answer to both of the foregoing questions is “not enough information to decide”. However, our experience suggests that many project managers are quite happy to make profound decisions based on the level of information provided in Figure 2.

When the dynamics of critical path are taken into consideration, the answers provided are very different from the ‘obvious’ conclusions to be drawn from Figure 2. Figure 3 shows the situation immediately after the first weekend. At this point in time, the project is three days ahead of programme and if additional resources are allocated to the “Implementation Criteria” task, the project can be accelerated even further (provided adequate resources remain working on the “Test Criteria”). Barcharts are a very inadequate tool for assessing the impact of work that does not align with the original plan and simple averages of gains and losses are almost meaningless. The simple network used for this example is shown in Figure 4. Now imagine how wrong decision can be based on simple barchart information in a complex project environment.

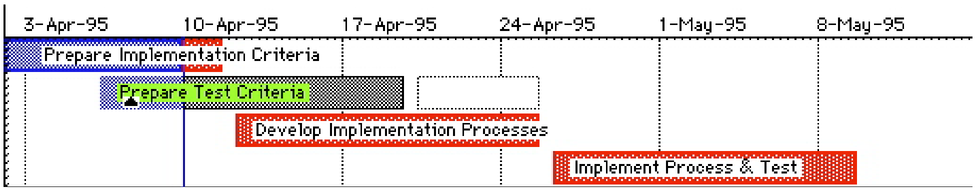


Figure 3

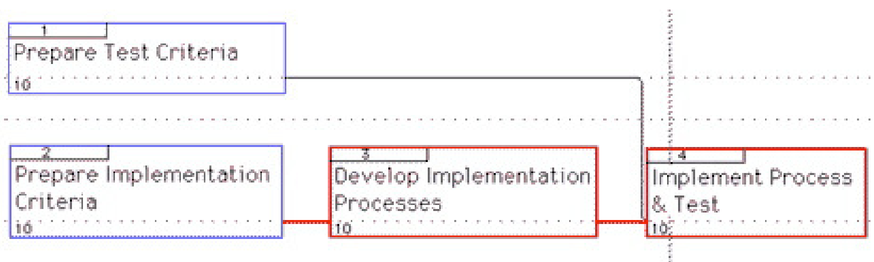


Figure 4

Another important consideration is the difference between saying a task is three days ahead or behind programme and saying that (in this case) a project is going to finish three days early.

When status (or progress) is added to an effective dynamic schedule control system, the whole project is recast taking into account gains and losses, the current predicted critical path is recalculated and where appropriate, resources reallocated to optimise the project outcome. People do not hop into a Dr. Who style Tardis and fly off into the past or future to work on tasks, they need to decide today and this week which jobs are most important and allocate their effort accordingly. Similarly, project clients are not usually interested in the status of current tasks in a project plan based on a schedule developed some time in the past, their real need is to know when will the project be complete so that they can plan to make effective use of the works as soon as they are delivered.

Traditional (1910 vintage) zig zag mark–ups can never provide the same level of information as an effective ‘status / update’ of an accurate computer-based schedule control system, particularly when resource scheduling is involved. This was the lesson of the 1950’s that is still being missed by many people who have been appointed to the position of project managers. If the role of a project manager is to ensure the completion of the project in the most effective manner, anything less than accurate status data at regular intervals should not be tolerated.

Barcharts –v– Networks, Conclusions

The project manager does not have to be an expert in the application of schedule control techniques. The process role can easily be delegated to a team member or consultant. However, the project manager should take responsibility for ensuring effective schedule control processes are used to provide the best possible data for decision making consistent with the project size and scope. This need not be expensive, manual systems are always an option and schedule control software that meets all of the recommendations discussed above is available for under $1000.00. The key element is the desire to manage time effectively and the willingness to commit resources to the task of preparing an effective plan. Barchart and pseudo barchart planning tools can never provide the depth and integrity of data that a properly used, dynamic network scheduling system will[19].

Software Traps & Problems

Almost every project management software package sold (with only a few exceptions) claim to be based on either CPM or PERT network methodologies. However, most graphical systems actively encourage users to treat them as 'barchart' systems without bothering to indicate to either the user or the recipient of the information whether the results were calculated from a CPM logic network or were fixed within a Gantt view. Without knowing how the information was developed (ie, by having full access to the electronic data and the time to check out the logic in detail) prudent project managers must assume the information produced from these systems is simply barchart based; ie, there is no logic or critical path, there is no capacity for accurate resource analysis and there is no capacity for automatic schedule updates.

Without detailed testing, it is often difficult to differentiate between a true CPM system and a pseudo barchart system. However, two simple checks will give an indication. The first check is to note the primary data input method. Is the software is designed to encourage the drawing of a barchart and lets users add links later (if they bother to take the time) or is the primary input method by way of a logic network drawing?? The second check is to view a barchart and then move the location of a bar – if you can arbitrarily move a bar on the screen without having to change the underlaying logic, the chances are the software cannot be trusted as a CPM logic-based system

Both CPM and Barchart techniques are valid and both techniques have key roles to play in the project delivery process. The art of the skilled project manager is to know when is the appropriate time to use which of the options[20].

---

[19] For more on the advantages of ***dynamic scheduling*** see: https://mosaicprojects.com.au/PDF-Gen/dynamic_scheduling.pdf

[20] We maintain a ***comprehensive list of scheduling software*** at: https://mosaicprojects.com.au/PMKI-SCH-030.php

PLANNING -V- MANAGING

The role of software within schedule control processes associated with project management is almost as old as the processes themselves. A clear understanding of both the process and the supporting software is (or should be) a fundamental skill of all project managers. The tools and the techniques are closely linked, CPM and PERT were directly developed as computer-based scheduling techniques, most other systems were computerised shortly after their inception.

Schedule control techniques fall into two linked, but distinctly different processes. Schedule development (or planning) and schedule management (or project management). Planning involves the organising of the managers thoughts to develop and evolve a project schedule. Project Management involves implementing the plan and carrying the project through to its ultimate conclusion. These definitions are limited but closely correlate to the claimed functionality of so-called project management software, the functionality of which is discussed later in this paper.

Given that a 'project' can be almost anything from organising a meeting, to the preparation of a minute paper, through to building a new frigate; there is obviously a divergence in the requirements for both planning and management techniques as well as the scale of the software based on the size and complexity of the project. However, the essence of all projects remains the same, irrespective of size. A project tends to be one-off in its nature, has defined start and end points and usually requires the responsible manager to deliver the project within pre-set time, cost and quality targets[21]. The objective of this section is to provide an overview of how different software packages assist (and / or potentially hinder) the 'planning' and 'managing' processes required to achieve the projects objectives.

As a concept, if a fully planned and managed project is 100% better than an unplanned one, some 40% of the total gain is achieved in the pre–project planning (thinking!) processes. The remaining 60% of the gain is much harder to win and revolves around effective management of that plan. The management phase involves tracking the progress of the work and taking appropriate action to bring the project back on track or (occasionally) to consolidate gains.

The first 40% of the improvement (from planning) even on a very large project can be gained in a few days hard thinking[22]. The next 60% requires regular and consistent effort every week or month (depending on the reporting cycle) for individually small gains. As projects become smaller and simpler, the percentage ratio shifts in favour of the planning element to the point where on some small, simple projects up–front planning is all that may be required.

Before the relative merits of different manual systems and software packages can be compared, the project manager needs to decide how much planning is appropriate for the current project? Does it simply need Planning or does it require a full Project Management system and if so, how big? No one intending to buy a new vehicle would attempt to compare a Mac Truck with a 4 x 4 utility and a Ferrari for the same job. If an off-road utility is required, two or three suitable vehicles from different manufacturers are compared; the Mac Truck and Ferrari don't enter into consideration. The same principles apply to project management software, comparing a low-end planning system with a high-end project management system is futile, they are built for different purposes.

---

[21] For more on the ***definition of a project*** see: https://mosaicprojects.com.au/PDF_Papers/P007_Project_Fact.pdf

[22] For more on ***the planning of a project*** see: https://mosaicprojects.com.au/WhitePapers/WP1039_Project_Planning.pdf

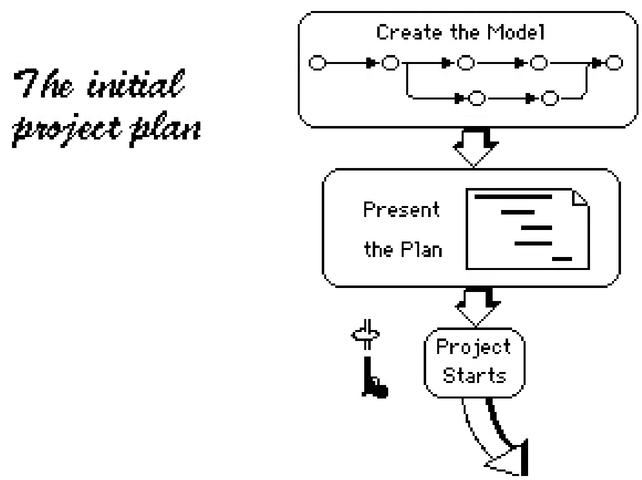
As mentioned above, two distinctly different processes are involved in planning and managing a project, planning is the up-front thinking process, managing involves making the plan happen (see Figure 5). The first stage in the process of controlling a project is always the planning phase. This is where the manager decides what has to be done, in which order and by whom.

To complete the plan, the project manager needs to convert the concept of how the project will be accomplished into a schedule that can provide answers to the following questions:

- What tasks must be achieved in order to attain the end objective?
- How will the tasks be performed?
- Who will perform the work required to achieve these tasks?
- How much time will be required to perform these tasks?
- What relationships exist between these tasks?

The Schedule Development Cycle

The essence of good planning is to identify and solve all of the foreseeable problems likely to affect the project 'on paper'. This is a far cheaper option than trying to resolve problems on the run during the course of the project. It is also a fact of life that many 'plans' may be developed before one turns into a real project!



The result of a well thought out plan is a clear understanding of how the project is going to function once it has started. This will include an assessment of the level of resources and costs required for the work and a realistic appraisal of the time frame and risks involved in completing the project. Once the plan is completed, sometimes no further action is required other than getting on with the job, in other situations, particularly on longer running projects, on–going management is needed; ie, project management.

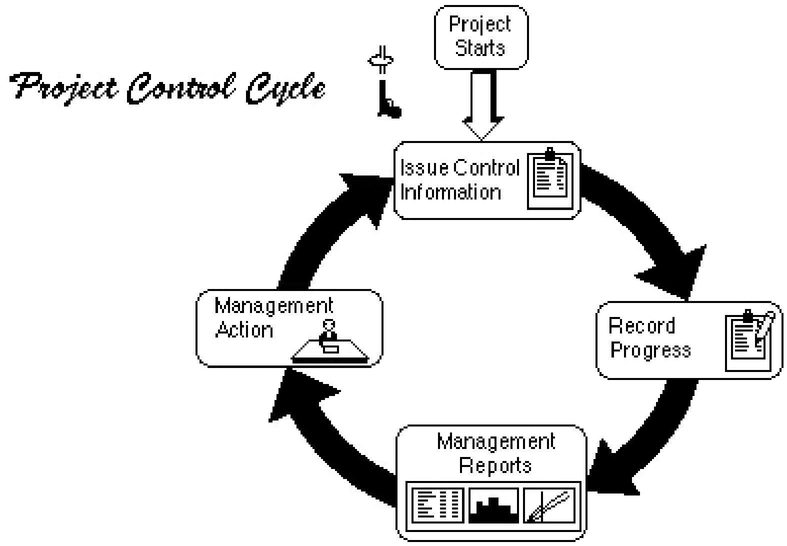


Figure 5

The longer the project period, or the more variable the project outcome, the more important the on–going management of the plan becomes. However, a good initial plan remains the essential foundation of any effective control function. The management cycle involves issuing short term, targeted control information to the project participants, recording and analysing actual progress, measuring deviations from the plan, testing and deciding on various "catch up" scenarios, updating the plan and reissuing new control information (Figure 6).

The Management Cycle

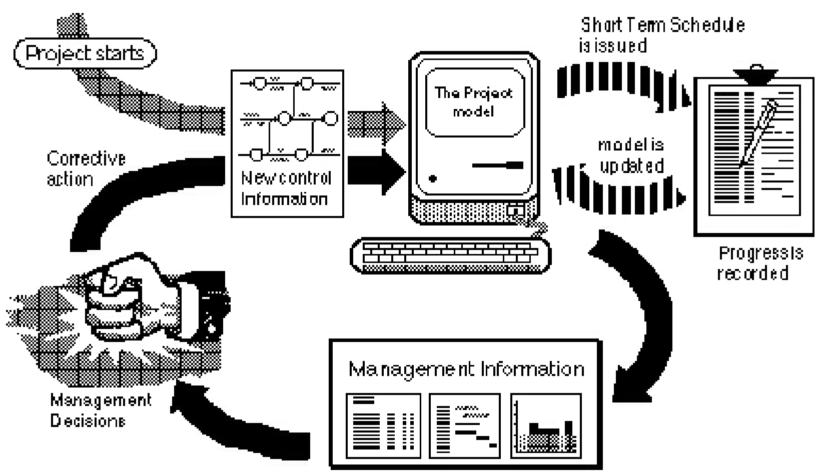


Figure 6

When planning complex projects, the mental processes required to work out the correct overall duration is immense and the planning process moves into an interactive mode where the 'Project Management' software is required to feed-back enhanced and consolidated information based on a mass of data (logic, durations, resources, calendars, costs, etc.) and then act as a tool for the manager to see what will happen "IF" something is changed. Similarly, when managing large projects, the software has to work out the effect of actual progress to date on several hundred different activities, many of which may have been started early, late or have been missed altogether; ie, 'out–of–sequence' progress. This type of calculation requires effective heavyweight scheduling software that produces accurate and predictable results.

A further requirement for large projects is effective communications[23]. The project management system must be capable of printing very select reports, targeted to show the receivers precisely what is expected of them. The project workers need to know what is expected of their team. At the same time consolidated information is required for senior management and variance reports for line management. This process requires effective code and label structures to allow reports to be selected and sorted as required.

A number of software packages are designed to appeal to a mass market. This class of software concentrates on 'ease–of–use' and is often deficient in the areas discussed above. The software is easy to learn and quick to use but relies on the Project Manager intuitively knowing what the correct answer should be when the project does not run to plan.

The degree of sophistication required from each project plan and the associated software needs to be judged after a careful cost / benefit analysis. The objective should be to develop an effective planning and management system, not a complex and expensive one. Choosing the correct type of software is often difficult and revolves around four key points:

1. Simpler systems are generally speaking cheaper, easier to use and produce the quickest results for the minimum effort and are ideal for 'planning'.
2. If you run out of steam with a lower end package the loss of time and accuracy in trying to shoe horn big project plans into small systems will be significant.
3. Changing packages is expensive and the smallest part of the cost is buying new software.
4. Too complex "heavy weight" systems may sit on the shelf gathering dust and contributing nothing – a complete waste of money and any early effort put into trying to develop a working plan.

Managing to succeed requires the correct tools for the job and there is no universally correct answer. In many circumstances, a "planning" package will be the correct choice making up in "ease–of–use" what it lacks in sophistication (it is better to have managers doing some planning rather than none at all). In other circumstances, a full Project Management system is essential to effectively control a project through to a successful conclusion.

Planning –v– Managing, Summary

The **Planning** process usually is usually an internal function of an organisation which includes:

- Defining the objectives to be achieved
- Listing the tasks to be completed
- Organising the sequence and priorities of the tasks
- Optimising the plan

[23] For more on ***communication*** see: https://mosaicprojects.com.au/PMKI-PBK-040.php#Overview

- Allocating tasks to people, and finally
- Implementing the plan.

The **Project Management** processes start with a plan and encompass many of the following features depending on the precise nature of the project:

- Monitoring and reporting of progress
- Updating and changing the plan
- Resource management
- Cost management
- The preparation and presentation of legally binding contract documents "the Contract Programme"
- Contractual claims and directives[24] (in all directions to and from Subcontractors, Head Contractors, etc.)

Project Management usually involves externally imposed obligations and responsibilities and managing a limited number of resources to meet these requirements.

The software range available today is capable of meeting all of these various demands but not all at the same time with a single package. If all that is needed is "forward planning" the cost and complexity of one of the "project management" systems will be wasted. On the other hand, if the project requires on–going effective management and the Project Manager ends up with "planning" software, the final costs caused by inadequate control may be far greater.

Is it worth the cost!

A mathematical study undertaken by Olusegun O. Faniran, Peter E. D. Love, and Heng Li in 1999[25] found the optimum investment in planning for Australian construction projects was 0.72% of the project value. The authors noted this value will vary depending on the type of project and the size of project.

Our experience suggests the percentage tends to reduce on larger projects and increase on smaller, and 'soft project' (business change, IT, etc) tend to need more planning than 'hard projects' due the increased influence of stakeholders. For most projects, a planning budget of between 1% and 2% seems appropriate. For a $1 million IT project this means a budget of $20,000 for the project planning and scheduling, for a $1 billion engineering project $1,000,000. Unfortunately, our observations tend to indicate these optimum investments are rarely achieved.

____

[24] For more on ***managing claims*** see: https://mosaicprojects.com.au/PMKI-TPI-080.php

[25] Journal of Construction Engineering and Management. September/October 1999 pp 311 - 319

First Published 6 April 1995 – Augmented and Updated