Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

TECHNICAL SUPPORT DOCUMENT

SCHEDULE PLANNING AND CONTROL

October 1984

Canada

SCHEDULE PLANNING AND CONTROL

Table of Contents

SCHEDULE PLANNING AND CONTROL

1. INTRODUCTION

1.1 General Remarks

A project schedule is probably the most useful tool available to a project manager. The preparation itself develops a better understanding of project requirements and the relationships between work activities. It is an essential part of the project plan, against which progress can be measured and results controlled. However, its usefulness depends on how well it meets the requirements of the project. Successful project management depends on planning and control which are accomplished by a number of activities. These include the following:

- work breakdown,
- estimating,
- scheduling,
- resource analysis,
- budgeting,
- monitoring,
- analysis, and
- status reporting.

This document only relates to scheduling. It describes how to develop an activity list and prepare a schedule for a project.

1.2 Purpose

The purpose of this document is to provide project managers with a tool for scheduling their projects. All phases of a project can and should be scheduled in order to meet the overall time, cost and quality objectives of the project. Although the examples used in this document deal primarily with the construction phases, all the phases, milestones and activities identified in Appendices E,F,G,H and I of DRM 10-7/4, Project Management can be scheduled using the techniques presented in this document.

1.3 Characteristics of a Good Scheduling System

Scheduling is the laying out of activities to arrive at a final date. To be effective, a good scheduling system should:

a. allow for control and review by all levels of management who have an interest, involvement or responsibility in the project;

b. permit its graphical presentation to be easily understood which requires:

   (1) a visual relationship to the calendar,

   (2) a minimum number of symbols for simplicity,

   (3) sufficient symbols to show the relationship between activities, and

   (4) a clear identification of the critical path;

c. require only minimum training;

d. be easily updated either manually or using automation; and

e. be easily reproduced by photocopying or with an instant camera.

1.4 Critical Path Method (CPM) Barchart

The system recommended by the Department is called Critical Path Method (CPM) Barcharting. This combines the strengths of two older scheduling systems - barcharting and networking. Barcharting provides the simplicity of visual relationship to the calendar while networking shows the relationships between activities and allows tracking of the critical path.

2. DEFINITIONS AND SYMBOLS

Activity (task): the piece of work to be supervised by a manager at the actual site of the work, for example, excavating a foundation. Many of the activities are interrelated. An activity will usually be performed in an on-going period of time and will produce some identifiable product which contributes to the overall project

product. It is normally the lowest level of work which will be managed directly by the project manager and would show on a barchart schedule as one bar.

SYMBOL  OR 

The length of the horizontal bar represents the duration or time span of the activity. The short "down legs" represent the start and finish point and the space between can be shaded later to represent progress.

Activity list: a list of activities by name, number, span time and interfaces shown in rough sequence used to develop the schedule.

Activity leader: the person appointed to lead a work activity in a project.

As of date: the closing date as of the last status reporting period.

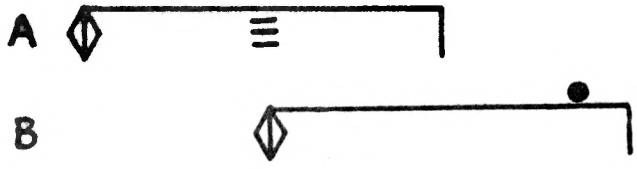
Barchart: this could also be called Critical Path Barchart, Schedule Barchart, or Gantt Chart. The Barchart used by DIAND shows the work activities laid out in sequence across time, their interrelationship, slack times and critical path.

Contingency: as used in estimating, refers to unforeseen happenings which may occur. Contingency must be built into the plan to ensure these unforeseen events are taken into consideration.

Continuous relationship: when an activity requires the work output of another activity, a dependency is established. If the output must be fed into the second activity continuously, a continuous relationship exists. An example is where a road is being built and the right of way must be cleared progressively ahead of the laying of the road -- in this case, the laying of the road has a continuous relationship with the clearing of the right of way.

● SYMBOL

EXAMPLE: Activity B requires 50% of A to start and A must be complete before B does.



Control cycle: the frequency of project management control activities. This may be a weekly, monthly or as required routine of schedule updating and status reporting.

Control date: same as the 'as of date' -- it is the date selected to control the project.

Control period: the period of time between control dates or 'as of dates'.

CPM barcharting: also called Critical Path Barcharting, it is the method of schedule control selected by the Department.

Critical path: the longest contiguous series of activity bars in a schedule along which there is no slack from project start date to project end date.

- - - - SYMBOL

Also see definition of 'slack'.

Earliest possible start: the earliest time that work can start on an activity.

Example

a.

 SYMBOL

Excavating is scheduled to start later than the "Earliest Possible Start" date.

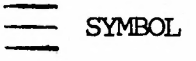
b.

Excavating is scheduled to start at the "Earliest Possible Start" date. The work has been scheduled earlier than in a. and the bar starts at the mid-point of the diamond.

End date: the date a project is scheduled to be completed.

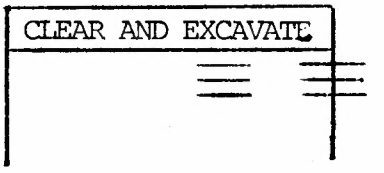
End date impact: the effect that delaying a piece of work or activity can have on the completion date of the project.

Interface point: the time or point at which an activity completes work required by another activity.



Interface Point (Dependency) is the point at which one activity connects with another one. When scheduling, it is necessary to determine which activities must be completed in whole or in part before another activity can begin.

Example: The illustrated activity supports two others (not illustrated). One at its 50% point and one at its 100% point.



Nonproject loss time: time which is not normally charged to a project but must be considered in scheduling. This includes vacation, holidays, sick leave and training.

Percent completed: the portion of a planned activity which has been completed to date.

Plotting: the process of tracking through a CPM Barchart in order to identify the schedule logic through the use of symbols defined ~~in 2.2~~.

Project manager: the person who is leading a project. This person also has some authority to direct the project.

Resources: the goods and services used or required on a project. This includes labour, material, equipment, time and money.

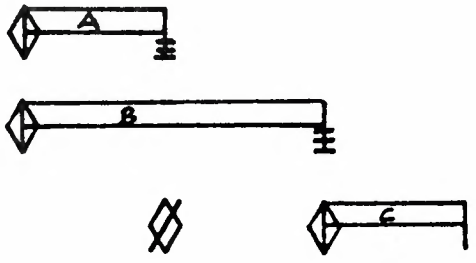
Schedule analysis: examining the effects of delayed or advanced activities and determining their impact on the end date.

Schedule chart: a calendar type of grid chart prepared to show the scheduled activities in a project.

Secondary start: also called prior interface, secondary start occurs when an activity connects with two or more prior activities. Given that the interfaces occur at different times, the symbol is placed vertically under the interfaces which occurred prior to the earliest possible start.

 SYMBOL

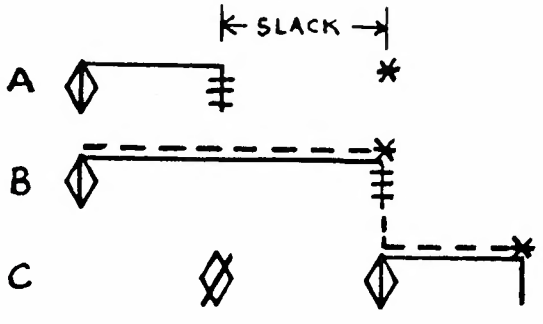
Example: C requires all of A & B before starting, with the interface to A being a secondary, or prior start.



Slack: the amount of time an activity or part of an activity can be delayed without also causing a delay in the completion date of a project. Every activity bar requires the use of the symbol to illustrate how much that bar may slip if the slippage allowed is zero. The position of the symbol identifies the point in time to which that activity can slip.

* SYMBOL

EXAMPLE OF SLACK AND CRITICAL PATH



Note: Only Activity A has slack time. B and C have no slack and are therefore critical.

Span time: the time taken by a project, an activity or work element from start to finish.

Status: the time, budget and product completion position of a project or activity at a point in time.

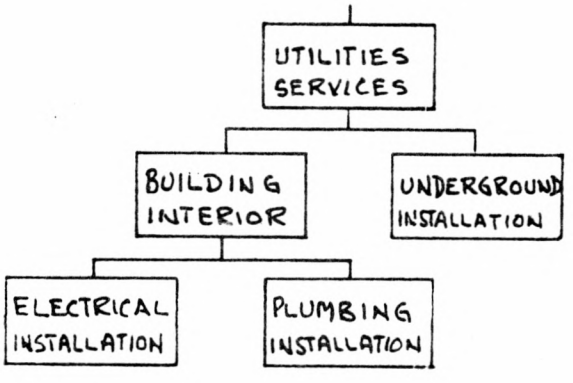
Supporting activity: a work activity on which another work activity is dependent.

Supported activity: a work activity which depends on another work activity.

Units of time: the measure of time used -- either days, weeks or months.

Variance: how far a current forecast of time or budget is from the plan.

Work breakdown structure (WBS): the results of a work breakdown analysis which shows the work detail of the project down to at least the activity or task level, if not further. Part of a WBS is illustrated below.



Work Element: the level of work structure below the activity (task) level which will be necessary for the activity manager to develop in order to plan its execution. It is the smallest defined piece of work. It may or may not be shown in the project work breakdown structure.

3. SCHEDULE DEVELOPMENT

3.1 Developing the Sequence

A list of activities in their rough sequence is essential to the development of a schedule. The list is prepared by the project manager with the assistance of the respective activity leaders.

3.1.1 Elements of the Activity List

3.1.1.1 Name and Number

Activity titles and numbers are normally developed during the work breakdown analysis performed at the start of the project planning phase. The analysis may be in the form of a work breakdown structure or an appropriately numbered hierarchy of activities.

3.1.1.2 Span Times

Activity span times (durations) are derived from estimates of the resources required for each activity. The estimates and the span times are normally prepared by the person most familiar with the work involved in the activity. For example the plumbing activity could probably be estimated best by the responsible plumber.

3.1.1.3 Interface (Dependency)

Interface requirements are determined by analyzing the starting requirements of each activity. The interface requirements should always be expressed as a percentage of the supporting activities. A supported activity may have a number of interfaces specified.

3.1.2 Sequencing

The sequence is developed in rough order by referring to the interfaces identified with each activity. The project manager should work out the sequence and review it with the activity leaders. Figure 1 is a simple example.

Figure 1

SIMPLE ACTIVITY LIST

ACTIVITY NAME	NUMBER	WEEKS SPAN TIME	INTERFACE REQUIREMENTS
CLEAR & EXCAVATE	A	3	NONE OR - - -
BUILD FOUNDATION	B	4	100% OF A
INSTALL U.G. SERVICES	C	3	100% OF A
INSTALL STRUCTURAL STEEL	D	3	100% OF B

3.2 Preparing a Schedule Chart

A schedule can be developed on a number of materials, for example, grid paper, peg boards, magnetic boards or plasticized charts. Changes can more easily be made on magnetic boards or plasticized charts than on paper. In setting up the schedule from the activity list, list the activities on the left of the schedule with only one activity per line. This avoids confusion (see Figure 2).

Figure 2

BASIC SCHEDULE CHART

Activity Name	No.	Span Time (WKS)	5	10	15
CLEAR & EXCAVATE	A				
BUILD FOUNDATION	B				
U.G. SERVICES	C				
STRUCTURAL STEEL	D				

3.3 Schedule Layout with CPM Barchart Scheduling

The process of laying out a schedule is best demonstrated with examples.

3.3.1 Simple Example

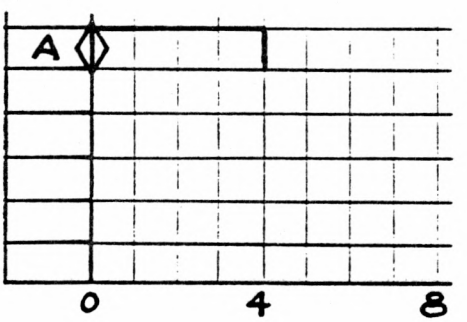
Using the activity list in Figure 3, plot the first activity with no interface requirements on the schedule. In this case the earliest possible start symbol for Activity A is on the zero date line or start of the schedule.

Were an activity has no interface requirements, its earliest possible start is the zero date. As a general rule, all activities should be started as soon as possible unless there is a logical reason not to.

Figure 3

SIMPLE EXAMPLE LAYOUT STEP 1

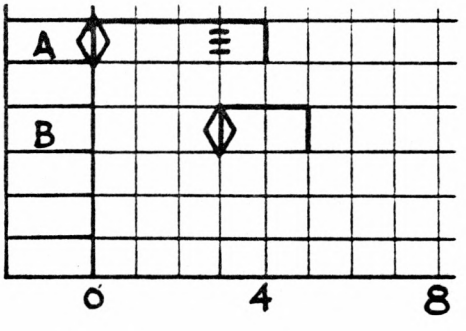
ACTIVITY	NO.	SPAN TIME	INTERFACE
EXCAVATE	A	4	- - - - -
U.G. SERVICES	B	2	75% of A
PLACE FORMS	C	3	100% of A



Continuing with the schedule in Figure 3, the placement of underground services (U.G.) (Activity B) should be plotted as in Figure 4. In this case there is an A-B interface requirement, with excavating (Activity A) required to be 75% complete (3 weeks work) before B can commence. This is shown by locating the 75% point of A, which is 3 weeks, putting in the interface symbol (≡), dropping vertically on the same date line to B and putting in the earliest possible start symbol (◇). As that is the only interface, the activity bar (⌐¬) will start at the midpoint of the B diamond and be drawn for 2 weeks.

Figure 4

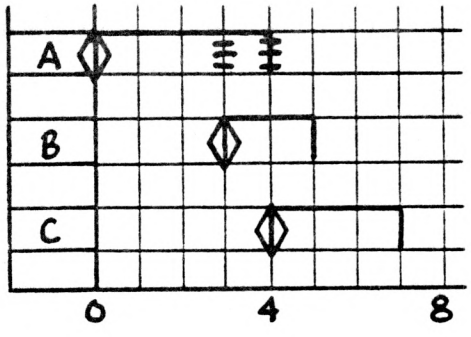
SIMPLE EXAMPLE LAYOUT, STEP 2



The next step is to plot the placing of forms (Activity C) as in Figure 5. Since the interface requirement is 100% of A, locate the 100% point on the A activity bar, week 4, and draw in the interface point symbol (≡). Drop down vertically on the same date line to the horizontal line to be occupied by Activity C and draw the earliest possible start symbol (◇) completing the A-C interface. As there are no other interfaces, the activity bar (⌐¬) can be drawn for 3 weeks starting at the start symbol.

Figure 5

SIMPLE EXAMPLE LAYOUT, STEP 3



3.2.2 More Complex Example

A slightly more complex activity list is illustrated in Figure 6.

Figure 6

ACTIVITY LIST

ACTIVITY	NO.	SPAN TIME	INTERFACE
EXCAVATE	A	4	- - - - -
U.G. SERVICES	B	4	75% of A
PLACE FORMS	C	5	100% of A 50% of B

In Figure 7, Work packages A & B are the same as in the previous example, but C has two interface requirements. Proceed as follows:

a. Plot A & B as before.

b. For C, plot along to the 100% point of A, and draw an interface symbol (≡).

c. Drop down vertically on the same date line (week 4) to the horizontal line for C.

d. At this point draw a secondary start symbol (⌀), because this is prior to the 50% point of B, which is the other interface.

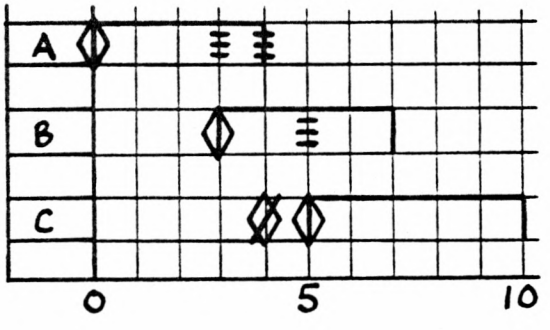
e. Continue along B, locate the 50% point and put in the interface symbol (≡).

f. Drop down vertically on the same date line (week 5) to the horizontal line for C and draw the earliest possible start symbol (◇).

g. As there are no more interfaces, plot the activity bar, symbol (⌐), from that point for 5 weeks.

Figure 7

MORE COMPLEX EXAMPLE LAYOUT



3.4 Plotting of Slack and Critical Path

Once the basic schedule chart is completed, plot the critical path of the project schedule and establish those activities which have slack time.

Critical path and slack are plotted together following a two part tracking process:

a. The first part involves tracking along the critical path and plotting a thread to hold the schedule together.

b. The second part is the pick up routine, establishing slack time for each activity not on the critical path.

To plot the critical path and slack time, start with the activity or activities which finish at the end date of the schedule, and work from right to left back to the beginning. At the same time, move from bottom to top. If you are following the two part tracking process, you will not omit or by-pass any bar or part of a bar.

Figure 8

CRITICAL PATH EXAMPLE

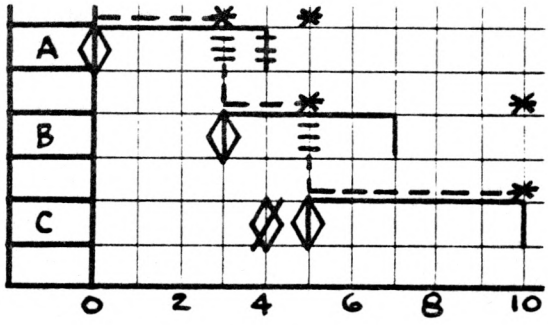
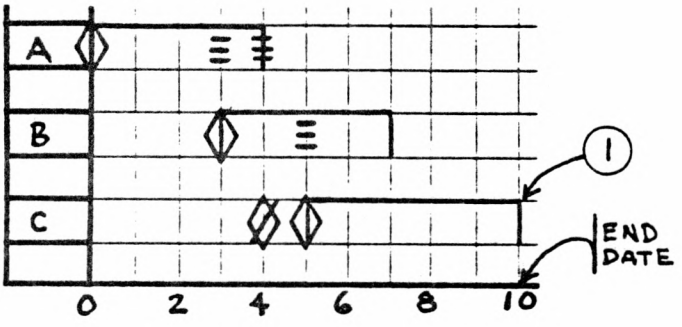


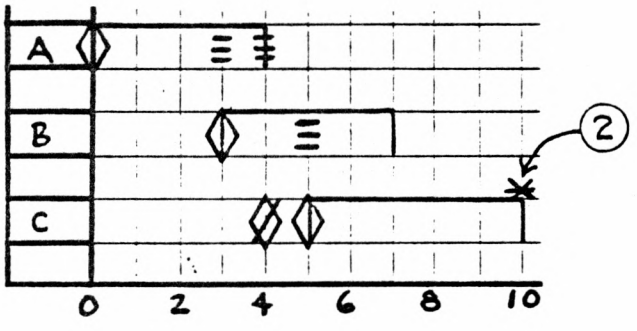
Figure 8 shows Figure 7 with the slack and critical path drawn.

To plot critical path and slack, take the following steps:

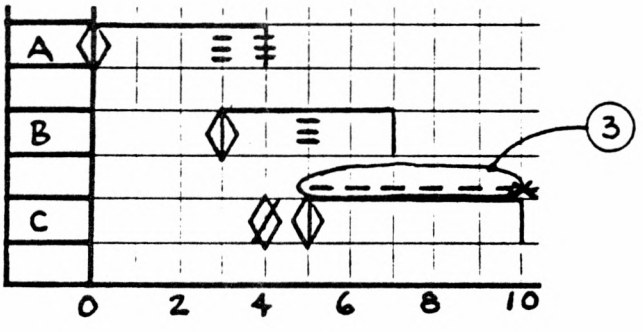
Step 1 Locate the activity which touches the end date (C). In this case it is Activity C.



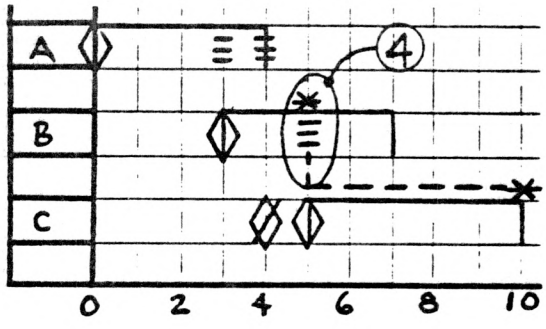
Step 2 Put a slack symbol (*) at the end of the C bar to indicate that is the furthest the activity can slip without affecting the end date. In this case there is no slack time.



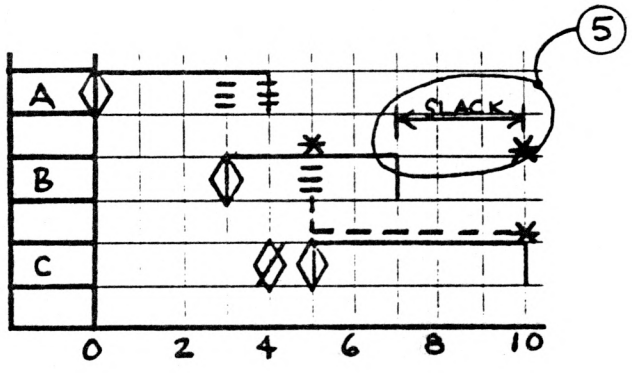
Step 3 Follow from right to left along the bar until the earliest possible start symbol (◇) is reached, drawing a dashed line along the bar to illustrate the critical path.



Step 4 Vertically above the earliest possible start symbol, locate the interface symbol (≡), in this case the 50% point of Activity B. Draw a dashed line up to that point, and on top of the activity bar, put a slack symbol (*) at that point.

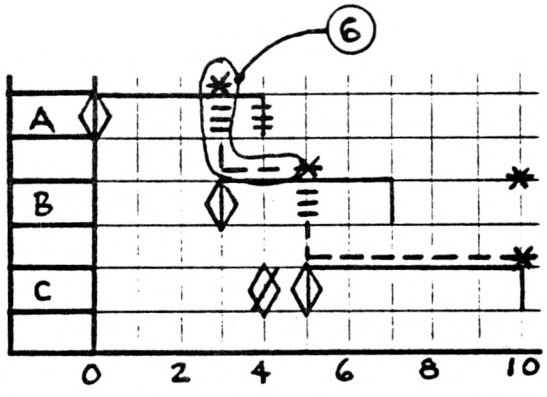


Step 5 The next step is to pick up the remainder of Activity B to establish how much slack time it has, without affecting the critical path. The last 50% of Activity B has no interface with any other activity, therefore it must be complete by the end of the schedule. Since the end date is week 10, a slack symbol (*) is placed at week 10 on the same line as Activity B.

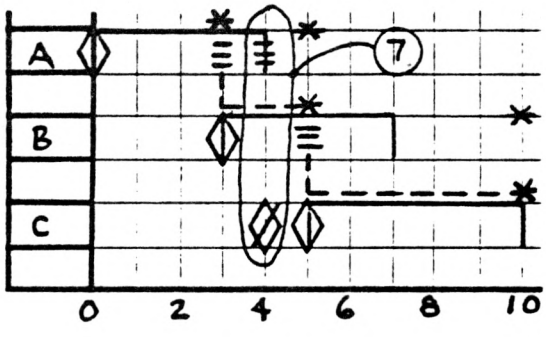


Note: Any bar or part of a bar with no interface at the end or continuous relationship affecting it always has slack to the end of the schedule.

Step 6 Now pick up the critical path at week 5 on Activity B and plot from right to left, drawing a dashed line to the earliest possible start symbol (◇) on B. At this point, plot vertically to the interface point symbol on A, putting a slack symbol (*) above the Activity bar at week 3.

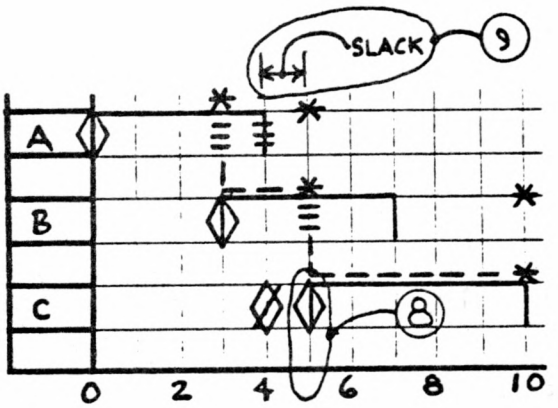


Step 7 Before continuing, pick up the remainder of Activity A, in this case the last week, to establish how much slack time it has without affecting the critical path. Note that there is an interface symbol (⩵) at the end of the activity and vertically below it is a connecting secondary start symbol (⌀) on Activity C.



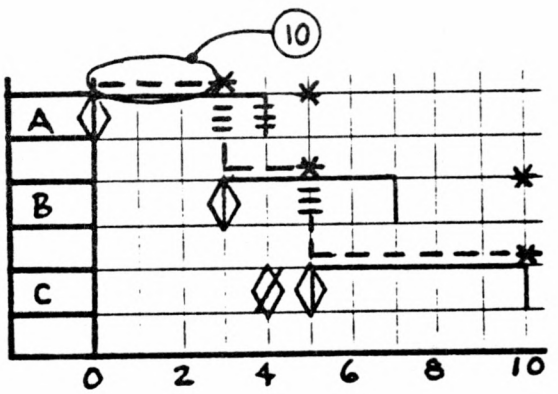
Step 8 The earliest possible start of Activity C is at week 5, and the whole Activity is on the critical path. This means that only the last quarter of Activity A must finish by week 5. Any further delay will cause Activity 5 to be affected, thus having an impact on the critical path.

Step 9 Therefore a slack symbol (*) is placed at week 5 on the same line as Activity A.



Step 10 The critical path is then plotted along Activity A, from right to left, to the start of the activity, or the zero date line.

It should be noted that there may be more than one critical path through a schedule.

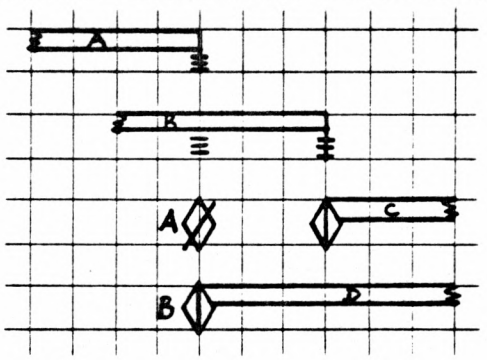


3.5 Multiple Starts and Interfaces on a Date Line

When drawing up a schedule, there are a few complications to watch for. For example in Figure 9 there is more than one interface point symbol (≡), or earliest possible start (◇) which falls on the same vertical date line on the schedule grid. To make sure interface point symbol (≡) and start symbol either (◇ or ⊘) are correctly linked, put the activity number next to the approximate start symbol as shown.

Figure 9

MULTIPLE STARTS AND INTERFACES

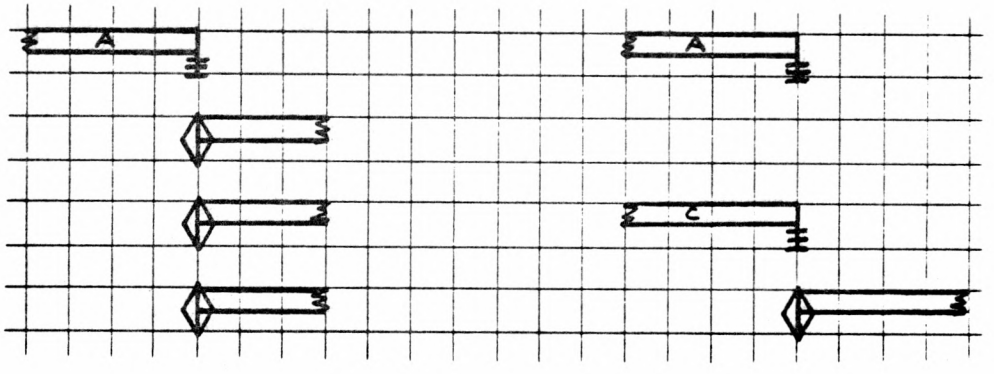


In another example, as shown in Figure 10, one interface point symbol (≡) supports a number of start symbols (◇) on the same vertical date line on the schedule, with no other interface points on that same line.

Conversely, a number of interface points support one start. In these cases, it is not necessary to place the code names or numbers next to the start symbol.

Figure 10

ACTIVITIES WITH MULTIPLE SYMBOLS

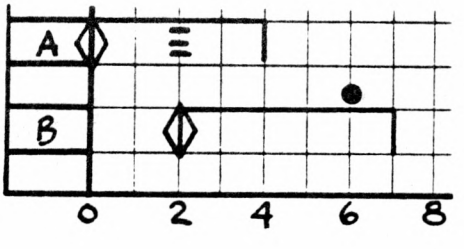


3.6 Using Continuous Relationship

In some cases when there is a partial interface requirement between two activities, there can also be a "continuous relationship". In the example in Figure 11, 'B' requires 50% of A to start. However, to keep B on schedule after it has started, A must continue to provide later pieces of work to B after the 50% point of A. It is important that the two activity leaders involved compare the work element schedules from their activity plans to determine when the last piece of work from A must be received in B, in order to keep B's schedule on time. In this case, B requires A to be complete by B's 80% point. The "continuous relationship" symbol (●) goes on the supported bar B at its 80% point.

Figure 11

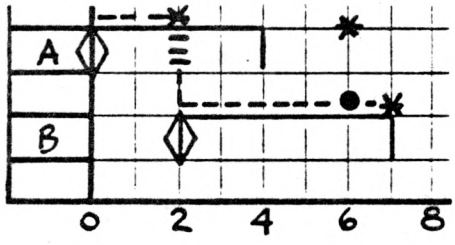
CONTINUOUS RELATIONSHIP EXAMPLE



There are times when continuous relationship, will affect the plotting of slack. In Figure 12, slack and critical path have been applied to the example. In this case, the last half of A must complete by the "continuous relationship" symbol on B, because B is critical.

Figure 12

CONTINUOUS RELATIONSHIP EXAMPLE WITH SLACK & CRITICAL PATH



3.7 Exceptions to Basic Critical Path Plotting

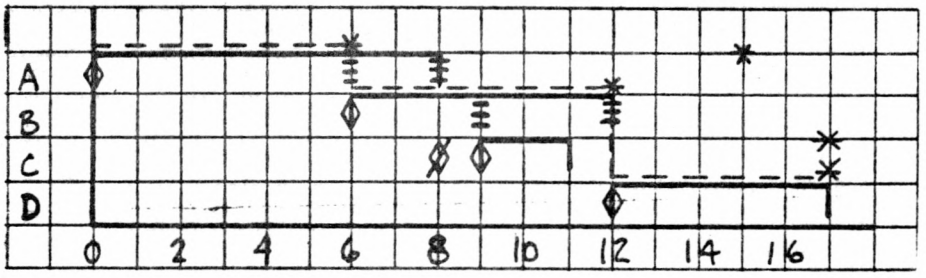
There are two exceptions to the rule that "the critical path tracks along the activity to the earliest possible start".

3.7.1 Activity Start Delay

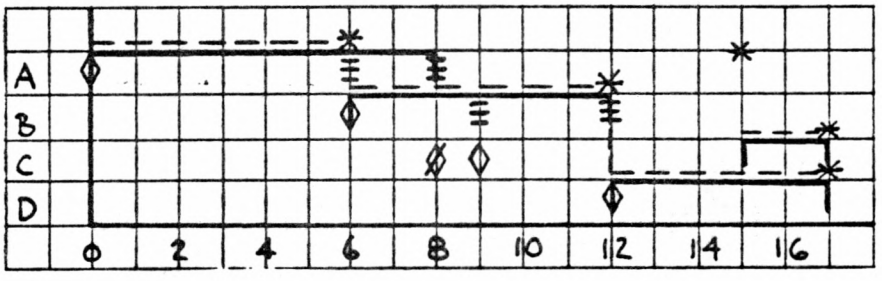
The first occurs when activities are moved to the right to take up all their slack. In such a case, the activity becomes a parallel part of the critical path and the critical path only extends the length of the activity bar (see Figure 13).

Figure 13

CRITICAL PATH PLOTTING - EXCEPTION 1 - EXAMPLE 1



• Original Schedule



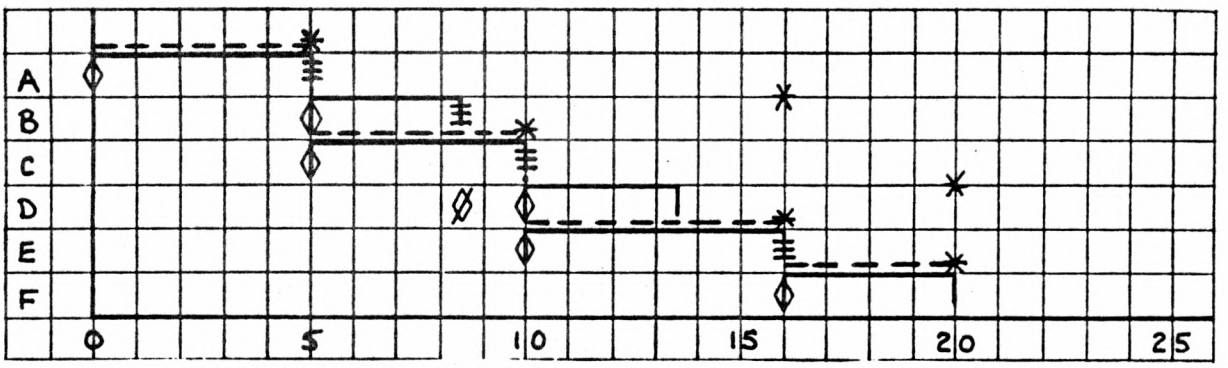
Revised Schedule
(Delayed Activity Start)

In the original plan Activity C has an earliest possible start at week 9 with slack to week 17. Normally, work should commence as soon as possible but there may be reasons (economy, lack of resources, risk reduction) not to execute an activity or activities until later in the schedule. In the revised schedule the effect of moving an activity is shown, in this case to the limit of its slack. The reason for not drawing the critical path back to the earliest possible start symbol is that until the fifteenth week is reached, Activity C can still be moved back and therefore taken off the critical path.

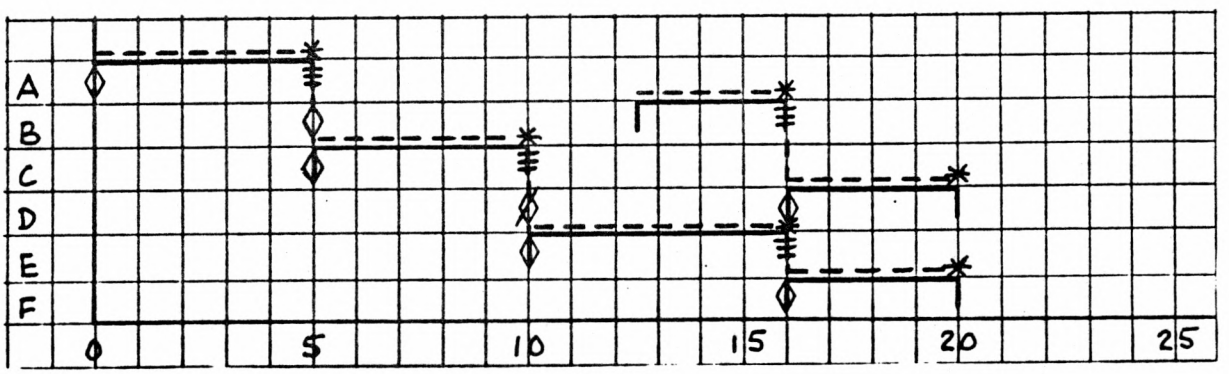
Figure 14 shows the effect of moving a series of activities to the limit of their slack time. In this case, the parallel critical path along Activities D and B is drawn to the beginning of the earliest activity in the series (Activity D).

Figure 14

CRITICAL PATH PLOTTING - EXCEPTION 1 - EXAMPLE 2



Original Schedule



Revised Schedule
(Showing Multiple Activity Delays)

3.7.2 Continuous Relationship Constrained

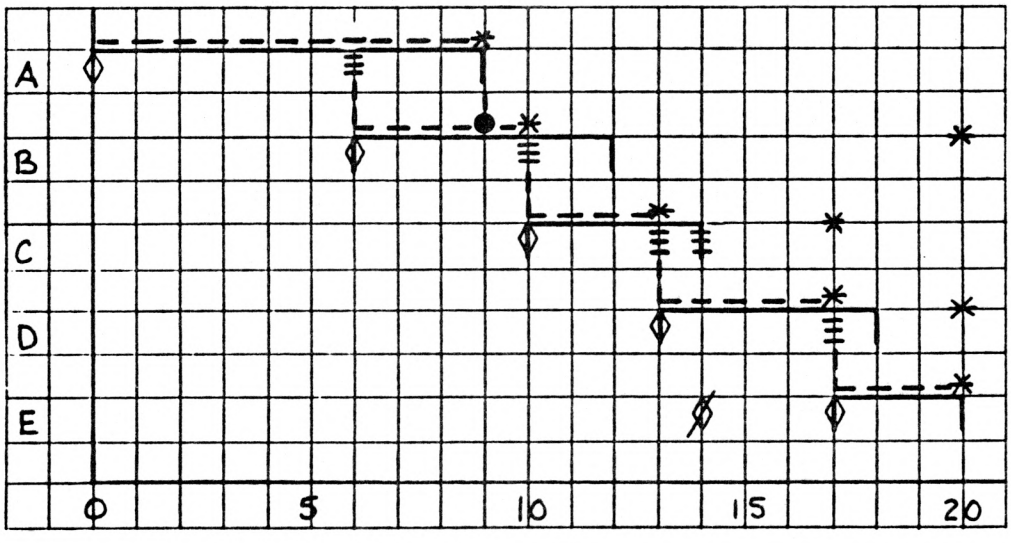
The second exception occurs when the critical path involves a continuous relationship.

Figure 15 shows an example of a continuous relationship which moves the critical path.

Figure 15

CONTINUOUS RELATIONSHIP EFFECT ON CRITICAL PATH
ACTIVITY LIST

ACTIVITY	TIME/WEEKS	INTERFACES
A	9	- - - - - - -
B	6	B requires 66% of A and A must complete before the 50% point of B
C	4	C requires 66% of B
D	5	D requires 75% of C
E	3	E requires 100% of C and 80% of D



In this case, the continuous relationship symbol (●) on the B bar at its 50% point is on the B critical path, and the end of the A bar is also sitting directly above the symbol (●). When this occurs, the critical path leaves the B bar at the continuous relationship symbol (●) and moves up to the end of the A bar. Technically, the critical path should also go back to the early start symbol of B (◇), then up to the interface point (≡) on A. No slack symbol (*) is required at the 66% of A. Anytime a slack symbol is at the end of the bar as it is with the A bar, no others are required.

3.8 Schedule Compression Techniques

When the initial schedule has been plotted, the completion date for the project can be determined. Very often this date is considered to be too late and the project manager must shorten the schedule or compress it into a shorter time.

To be able to compress a schedule the project manager must have a thorough knowledge of all the activities.

The first step is to examine each of the activities to determine the following:

a. Has optimum team loading been applied in all instances?

b. Can any of the elements or activities which have been scheduled behind each other that is at the 100% point, be overlapped at say the 80% point? For example, the last elements of construction activities often involve clean-up such as removal of concrete forms or scaffolds. It may be possible to start a supported activity with the forms or scaffolds in place as long as reference is made to complete the activity.

c. Can the span times be compressed any further for each of the elements?

d. Is all the Non Project Loss Time (NPLT) necessary? This includes vacation time, holidays, etc. Care should be exercised here because the only savings can be with a short project where it may be possible to exclude vacations.

e. Has contingency been added in each level of estimating? Again, care should be exercised that contingency is not reduced too much or altogether as the unforeseen does happen.

Once all these approaches have been examined and the schedule reworked to reflect them a new completion date can be determined.

If the new date is still unacceptable to the responsibility centre manager, it is necessary to negotiate the product as it must now change if the date is to be met. For example, if part of the project involves collecting site information, it may be necessary to reduce the amount collected to shorten the time needed.

The advantage of a detailed work breakdown is now apparent as it is possible to determine which parts of the plan must be sacrificed to achieve a satisfactory completion date.

4. SCHEDULE CONTROL

4.1 Introduction

The greatest value of a project plan is that it provides the project manager with a basis for evaluating progress and forecasting the future, based on what is actually happening rather than what was planned. In order to serve this function, all parts of the plan must be kept up to date and revised as the project manager and his/her staff become aware of changes. It has been said that a plan is only valid at the time of signing. From that point on changes will occur. In terms of control, a plan which is not maintained is more of a hindrance than a help. This section examines:

a. data required for control;

b. plotting the status;

c. status analysis and effect on end date; and

d. problem correction.

4.2 Data Required for Control

In order to evaluate the schedule status and analyze what is happening to the schedule, it is necessary to collect data that affect the end or final date of the project. This is referred to as "end date" control. The data the project manager requires from the activity managers are as follows:

a. a fresh estimate of the time needed to complete the activities in progress as of the control date selected -- referred to as the "as of date" it is usually the end of a normal control cycle period; and

b. confirmation of span time estimate and interfaces, or if there has been a change during the last control cycle period, provision of a new estimate of the span time and interfaces for those activities yet to commence.

The data should be collected, and status plotted reasonably quickly after the end of the control cycle period.

Figure 16 is an example of data collected at the end of the last control cycle period in a small project, which was week 5.

Figure 16

STATUS INPUT DATA EXAMPLE

ACTIVITY	WEEKS TO COMPLETE
A	Completed
B	2
C	2 1/2
D	Net span time is 10 weeks from the "as of date".
E	No change in span time. Still require 75% of D and 100% of C to start.

4.3 Plotting the Status

The end of the most recent control cycle in the plan is known as the "as of date" of the plan. In a weekly control cycle, it is the close of working hours on the last Friday. In a barchart schedule, the "as of date" line should be visibly displayed vertically down the schedule at the end of the grid block for the last control period as in Figure 17. It is to this "as of date" line that the schedule plan will be reconciled.

To plot the status input data given in the previous example:

Step 1 Take each activity and from the right end of the bar

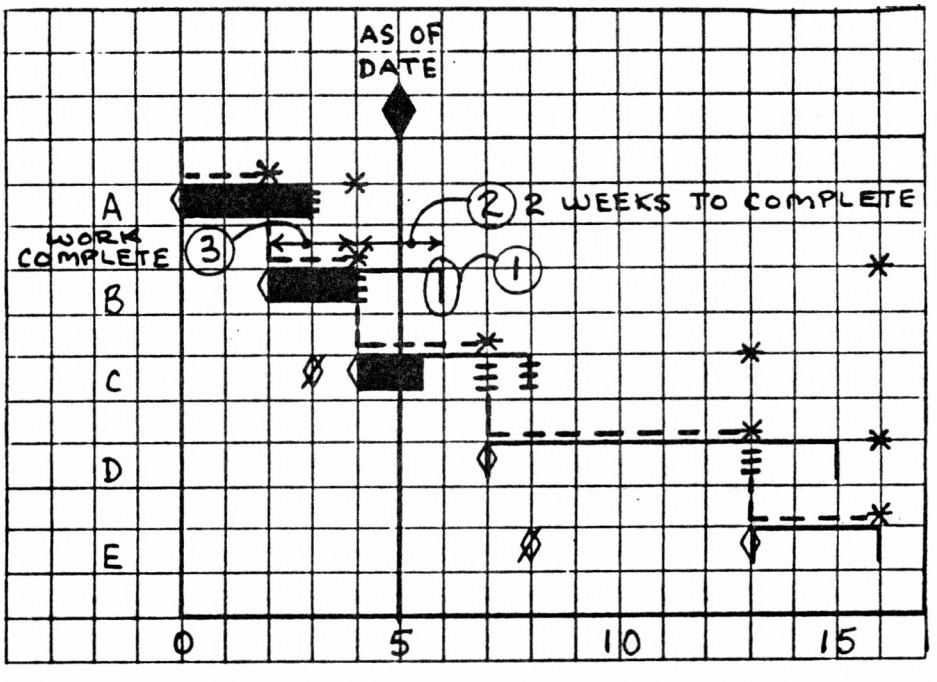
Step 2 count back the units of time required to complete it.

Step 3 Draw a vertical line in the bar at that point.

Step 4 Shade in the area to the left of the line to indicate the work which has already been completed.

Figure 17

SCHEDULE STATUS PLOTTING EXAMPLE



One of the prime objectives of plotting status is to determine the impact of the current status on the "end date". Therefore, defining the amount of time required to complete each activity takes priority over defining "work completed" when plotting status. The percent of work completed is used to identify work accomplished rather than schedule control.

Take particular note that in Figure 17 the data input only contains the units of time required to complete each activity.

4.4 Forecast Analysis and Correction

4.4.1 General Remarks

In order to examine the end date impact, analyze the effects of time changes on the schedule. In a schedule with a number of activities astride the "as of date" line, there will usually be a number of different paths along different series of activities leading to the end date. Some may not be on the critical path.

4.4.2 Forecast Analysis Process

4.4.2.1 General Remarks

In order to conduct an analysis of the impact on the end date, the project manager must evaluate two major items:

a. the effect of the "ahead or behind" status of any activity bar astride the "as of date" line as displayed in Figure 17 -- these are the active activities; and

b. the effect of changes to future activities' span times and/or interfaces. In the example in Figure 16, Activity D has increased to 10 weeks from a displayed 8 on the schedule.

4.4.2.2 Adjusting the Working Activities

Move the bars astride the "as of date" line until the shaded area right edge coincides with the "as of date" line. However, moving the bars has an effect on those interfaces which should also move with each bar. This causes a ripple effect to the right in the schedule. In Figure 18, bar C causes bar D to move right by moving its earliest possible start symbol (◇) and it also moves the secondary start symbol (⌀) of bar E.

4.4.1.3 Future Activities

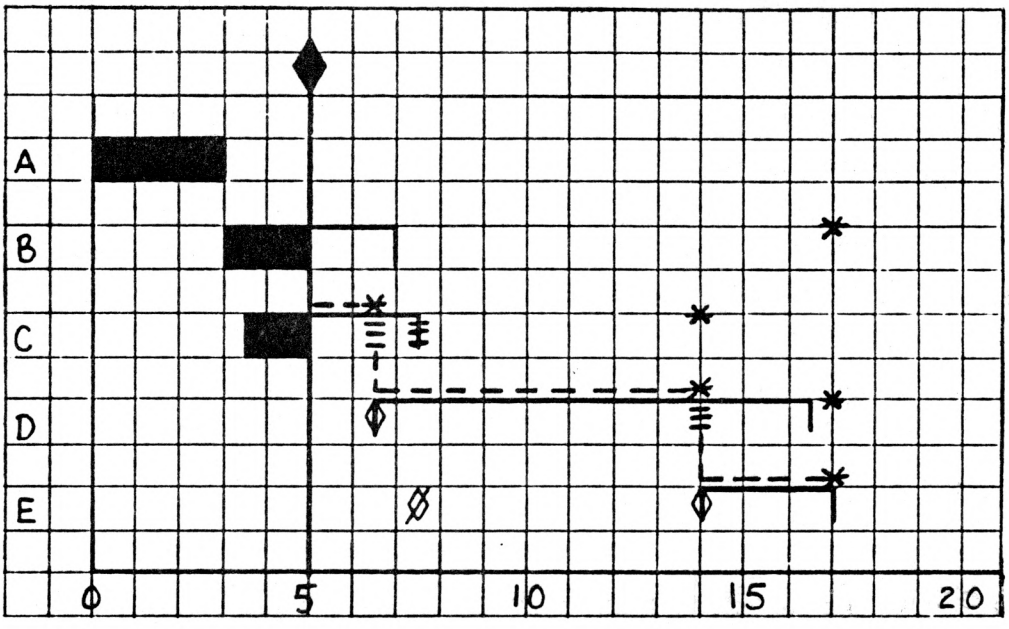
Make any required interface or span time changes to future activities with the resultant movement of the schedule. Figure 18 shows bar D expanded to 10 weeks. Since there was no indication of a changed interface to bar E, the interface symbol (≡) is adjusted to remain at the 75% point on bar D.

4.4.2.4 Impact on End Date

The combined effect of all the moves required should show any impact on the planned end date of the schedule. Figure 18 shows the resulting schedule following all the required moves.

Figure 18

SCHEDULE ANALYSIS



Once the impact has been determined the project manager checks whether any variance is within the project's acceptable variance range. The acceptable variance range is the limit to which a schedule is allowed to deviate from the plan before corrective measures must be taken and is determined by the project manager or her/his supervisors. Variance should normally be expressed as allowable minimum and maximum units of time variance from the planned schedule. If it is within the acceptable variance, no correction is usually necessary. If it is outside the acceptable variance range, the project manager must correct the schedule if possible.

4.4.3 Problem Correction

Following the end date analysis, take any corrective actions to return the schedule to the original end date. There are two areas of possible correction. The first is a close evaluation of the span time of each activity yet to be executed and secondly, a re-evaluation of the interface points. In the case of activity span times, the project manager must exercise care to ensure that those activities in the near future are evaluated first. If the project time contingency is spread across each activity, care should be taken not to tighten a long schedule too much. To evaluate interface points, consider the near future activities and attempt to be more precise with interface points.

5. EXAMPLE OF A TYPICAL PROJECT SCHEDULE

5.1 Project Schedule Plan

Figure 19 illustrates a form used to display project schedules. If the project schedule is too large for one chart the project manager will organize the schedule across as many charts as necessary, being sure that the connections between the charts are clear. Once the entire schedule is completed, a summary schedule will be completed using one chart.

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

PROJECT SCHEDULE | **CALENDRIER DE PROJET**

Legend / Légende

- Activity / Activité
- Earliest Possible Start / Démarrage le plus avancé possible
- Secondary Start (Prior Interface) / Démarrage secondaire (dépendance antérieure)
- Interface Point (Dependancy) / Point d'interface (dépendance)
- Continuous Relationship / Lien de continuité
- Critical Path / Chemin critique
- Slack / Écart

Project Name – Titre du projet	Date of Original Plan – Date du plan initiale
Project Number – Numéro du projet	Date as of Present Period – Date à ce jour

Activity / Activité		Time Span / Délais d'ex. ( )	CALENDAR – CALENDRIER	Resources / Ressources	
Name / Nom	Number / Numéro		5 10 15 20 25 30 35 40 45 50 55	Planned / Prévues	Actual / Réelles

Figure 19
PROJECT SCHEDULE PLAN FORM

Project Manager – Chargé de projet	RCM – G C R	Prepared by – Préparé par	Date	Approved – Approuvé	Date

58-252 (7-84) 7530-21-036-8994

To prepare the project schedule plan, enter the activity name and number in the first two columns. In the third column, enter the span time for each activity in days, weeks or months.

Calendar dates are recorded on the grid. The scale used will be dependent on the duration of the project. For example, one square could be equal to 1 day on a short project, 5 days on a one-year project or 1 month on a 5-year project. The last column identifies resources, both planned and actual. When filling out the form, the cost and/or labour should be shown for each activity in line with the span bar.

5.2 Example Project Schedule Activity List

Figure 20 is an example activity list used by the project manager to develop the project schedule. It is shown here separately. Notice, however, that there is room on the project schedule plan form to capture all of this data.

Figure 20

ACTIVITY SCHEDULE LIST

ACTIVITY NAME	NUMBER	SPAN (WEEKS)	INTERFACE REQUIREMENTS
Pre-start meeting	1A	1	----
Mobilization	2A	2	100% 1A
Commissioning brief	1B	1	100% 2A
Clear & excavate	2B	3	100% 2A
Build foundation	2C	4	100% 2B
U.G. Services	2D1	3	100% 2B
Install structural steel	2E1	4	100% 2C
Install joints	2E2	2	100% 2E1
Build roof	2F	10	100% 2E2
Build concrete floor	2G	7	100% 2D1, 90% 2F
Build outside walls	2H1	4	100% 2E2
Build partition framework	2H2	6	100% 2H1, 100% 1B
Install heating system	2J	3	100% 2H2, 100% 2G
Install interior plumbing	2D2A	4	100% 2H2, 100% 2G
Install interior electric	2D3A	3	100% 2H2, 100% 2G
Install drywall	2H3	3	67% 2J, 100%, 2D2A, 100% 2D3A
Install acoustic ceiling	2K	5	100% 2H3
Install tile	2L	6	100% 2H3
Install trim	2M	7	100% 2H3
Painting	2N	8	33% 2M & 2M must complete one week ahead of 2N comp.
Plumbing fixtures	2D2B	2	25% 2N
Electric fixtures	2D3B	3	75% 2N & 2N must complete one week ahead of 2D3B completion
Clean-up	2P	1	100% 2F, 2J, 2K, 2L, 2M, 2D2B, 2D3B
Inspection	3		Site Visits
Commissioning & turnover	4		

5.3 Example Completed Project Schedule Plan

Figure 21 shows the schedule of the example project displayed on a project schedule plan form using the developed activity list which has been transferred to the form.

Note: Inspections and commissioning activities have no interfaces. The symbol shown(Δ) is a milestone or event symbol.

5.4 Example Project Schedule With Status Plotted

The Project schedule status has been plotted on the example project's schedule as of the end of week 13 in Figure 22.

5.5. Example Project Schedule With Analysis Conducted

In the following example in Figure 23, the schedule analysis has been conducted showing the impact on incomplete activities and the "end date".

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

PROJECT SCHEDULE — **CALENDRIER DE PROJET**

Legend / Légende

- Activity / Activité
- Earliest Possible Start / Démarrage le plus evancé possible
- Secondary Start (Prior Interface) / Démarrage secondaire (dépendance antérieure)
- Interface Point (Dependancy) / Point d'interface (dépendance)
- Continuous Relationship / Lien de continuité
- Critical Path / Chemin critique
- Slack / Écart

Project Name – Titre du projet	Date of Original Plan – Date du plan initiale
Project Number – Numéro du projet	Date as of Present Period – Date à ce jour

Activity / Activité		Time Span / Délais d'ex. (wk)	CALENDAR – CALENDRIER	Resources / Ressources	
Name / Nom	Number / Numéro			Planned / Prévues	Actual / Réelles
PRE-START MEETING	1A	1			
MOBILIZATION	2A	2			
COMMISSIONING BRIEF	1B	1			
CLEAR & EXCAVATE	2B	3			
BUILD FOUNDATION	2C	4			
U.G. SERVICES	2D1	3			
STRUCT STEEL	2E1	4			
INSTALL JOISTS	2E2	2			
BUILD ROOF	2F	10			
BUILD CONC. FLOOR	2G	7			
BUILD OUTSIDE WALLS	2H1	4			
PARTITION FRWK.	2H2	6			
HEATING SYSTEM	2J	3			
INTERIOR PLUMBING	2D2A	4			
INTERIOR ELECTRIC	2D3A	3			
INSTALL DRYWALL	2H3	3			
ACOUSTIC CEILWG	2K	5			
INSTALL TILE	2L	6			
INSTALL TRIM	2M	7			
PAINTING	2N	8			
PLUMBING FIXTURES	2D2B	2			
ELECTRIC FIXTURES	2D3B	3			
CLEAN - UP	2P	1			
INSPECTION	3				
COMMISSIONING & TURN-OVER	4				

JAN. 6, 13, 20, 27 | FEB. 3, 10, 17, 24 | MAR. 2, 9, 16, 23, 30 | APR. 6, 13, 20, 27 | MAY 4, 11, 18, 25 | JUNE 1, 8, 15, 22, 29 | JULY 6, 13, 20, 27 | AUG 3, 10, 17, 24, 31 | SEPT. 7, 14, 21, 28 | OCT. 5, 12, 19, 26 | NOV. 2, 9, 16, 23, 30 | DEC. 7, 14, 21, 28

5 10 15 20 25 30 35 40 45 50 55

Figure 21
COMPLETED PROJECT SCHEDULE PLAN

Project Manager – Chargé de projet	RCM – G C R	Prepared by – Préparé par	Date	Approved – Approuvé	Date

56-252 (7-84) 7530-21-036 8994

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

PROJECT SCHEDULE — **CALENDRIER DE PROJET**

Legend / Légende					
Activity / Activité	Secondery Start (Prior Interface) / Démarrage secondaire (dépendance antérieure)	Continuous Relationship / Lien de continuité	Slack / Écart
Earliest Possible Start / Démarrage le plus avancé possible	Interface Point (Dependancy) / Point d'interface (dépendance)	Critical Path / Chemin critique	

Project Name – Titre du projet	Date of Original Plan – Date du plan initiale
Project Number – Numéro du projet	Date as of Present Period – Date à ce jour

Activity / Activité		Time Span / Délais d'ex. (WK)	CALENDAR – CALENDRIER												Resources / Ressources	
Name / Nom	Number / Numéro		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	Planned / Prévues	Actual / Réelles
			6 13 20 27 3 10 17 24 2 9 16 23 30			6 13 20 27 4 11 18 25 1 8 15 22 29			6 13 20 27 3 10 17 24 31 7 14 21 28		5 12 19 26 2 9 16 23 30		7 14 21 28			
			5	10		15	20	25	30	35	40	45	50	55		
PRE-START MEETING	1A	1														
MOBILIZATION	2A	2														
COMMISSIONING BRIEF	1B	1														
CLEAR & EXCAVATE	2B	3														
BUILD FOUNDATION	2C	4														
U.G. SERVICES	2D1	3														
STRUCT. STEEL	2E1	4														
INSTALL JOISTS	2E2	2														
BUILD ROOF	2F	10														
BUILD CONC. FLOOR	2G	7														
BUILD OUTSIDE WALLS	2H1	4														
PARTITION FRWK	2H2	6														
HEATING SYSTEM	2J	3														
INTERIOR PLUMBING	2D2A	4														
INTERIOR ELECTRIC	2D3A	3														
INSTALL DRYWALL	2H3	3														
ACOUSTIC CEILING	2K	5														
INSTALL TILE	2L	6														
INSTALL TRIM	2M	7														
PAINTING	2N	8														
PLUMBING FIXTURES	2D2B	2														
ELECTRIC FIXTURES	2D3B	3														
CLEAN-UP	2P	1														
INSPECTION	3															
COMMISSIONING & TURN-OVER	4															

Figure 22
PROJECT SCHEDULE WITH STATUS PLOTTED

Project Manager – Chargé de projet	RCM – G C R	Prepared by – Préparé par	Date	Approved – Approuvé	Date

6-252 (7-84) 7530-21-036-8994

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

PROJECT SCHEDULE — **CALENDRIER DE PROJET**

Legend / Légende

- Activity / Activité
- Earliest Possible Start / Démarrage le plus avancé possible
- Secondary Start (Prior Inferface) / Démarrage secondaire (dépendance antérieure)
- Interface Point (Dependancy) / Point d'interface (dépendance)
- Continuous Relationship / Lien de continuité
- Critical Path / Chemin critique
- Slack / Écart

Project Name – Titre du projet	Date of Original Plan – Date du plan initiale
Project Number – Numéro du projet	Date as of Present Period – Date à ce jour

CALENDAR – CALENDRIER

JAN. 6 13 20 27, FEB. 3 10 17 24, MAR. 2 9 16 23 30, APR. 6 13 20 27, MAY 4 11 18 25, JUNE 1 8 15 22 29, JULY 6 13 20 27, AUG. 3 10 17 24 31, SEPT. 7 14 21 28, OCT. 5 12 19 26, NOV. 2 9 16 23 30, DEC. 7 14 21 28,

5 10 15 20 25 30 35 40 45 50 55

Activity Name / Activité Nom	Number / Numéro	Time Span / Délais d'ex. (WK)	Resources Planned / Ressources Prévues	Resources Actual / Ressources Réelles
PRE-START MEETING	1A	1		
MOBILIZATION	2A	2		
COMMISSIONING BRIEF	1B	1		
CLEAR + EXCAVATE	2B	3		
BUILD FOUNDATION	2C	4		
U.G. SERVICES	2D1	3		
STRUCT. STEEL	2E1	4		
INSTALL JOISTS	2E2	2		
BUILD ROOF	2F	10		
BUILD CONC. FLOOR	2G	7		
BUILD OUTSIDE WALLS	2H1	4		
PARTITION FRWK. /	2H2	6		
HEATING SYSTEM	2J	3		
INTERIOR PLUMBING	2D2A	4		
INTERIOR ELECTRIC	2D3A	3		
INSTALL DRYWALL	2H3	3		
ACOUSTIC CEILING	2K	5		
INSTALL TILE	2L	6		
INSTALL TRIM	2M	7		
PAINTING	2N	8		
PLUMBING FIXTURES	2D2B	2		
ELECTRIC FIXTURES	2D3B	3		
CLEAN-UP	2P	1		
INSPECTION	3			
COMMISSIONING +	4			
TURN-OVER				

2F 2J 2P

Figure 23
PROJECT SCHEDULE WITH ANALYSIS

40

Project Manager – Chargé de projet	RCM – G C R	Prepared by – Préparé par / Date	Approved – Approuvé / Date

58-252 (7-84) 7530-21-036-8994

6. DEVELOPMENT OF LARGER SCHEDULES

6.1 General Remarks

A project which has 25-30 activities and lasts less than one year can usually be scheduled on one form.

However, for larger projects or programs which have more activities or long schedules it is necessary to develop a hierarchy of schedules.

6.2 Hierarchy of Schedules

A schedule is developed for each activity which forms the raw data that the project manager uses to develop the project schedule.

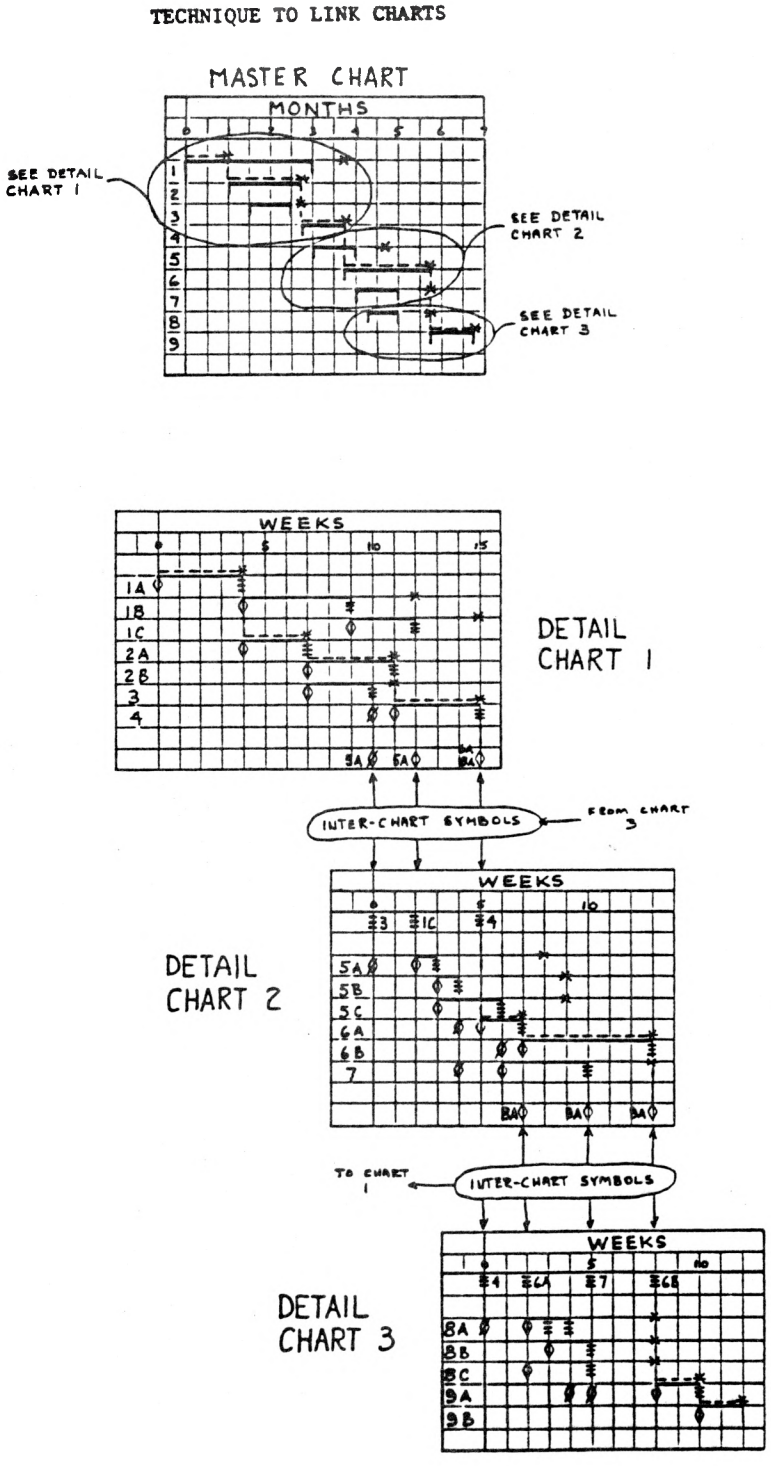
Because of the size and detail contained on the project level schedule, it is often not practical to use it for upward reporting or communications to more senior management or the client. For this purpose a more appropriate schedule is one which summarizes several activities with one bar and therefore shows a schedule with say 20 summary bars, with each bar representing a group of activities. For example, if the project were to build a residential subdivision, each bar on the summary schedule could represent particular streets, each of which is under the control of a particular manager.

6.3 Technique To Link Schedule Charts

In a project with a large number of activities another problem experienced by the project manager is correcting the detailed charts together to be able to reflect changes through the critical path.

The example in Figure 24 illustrates the use of a summary chart or board using detailed schedules. Earliest possible start symbols (◇) and interfaces (≡) appear at the top and bottom of each detailed chart to show overlap.

Figure 24


TECHNIQUE TO LINK CHARTS
MASTER CHART
MONTHS
SEE DETAIL CHART 1
SEE DETAIL CHART 2
SEE DETAIL CHART 3
WEEKS
DETAIL CHART 1
INTER-CHART SYMBOLS
FROM CHART 3
DETAIL CHART 2
TO CHART 1
DETAIL CHART 3

Appendix

EXAMPLE ACTIVITY LIST

The following is an example activity list prepared for the design stage of a hypothetical school construction project.

DESIGN STAGE

ACTIVITY SCHEDULE LIST

ACTIVITY NAME	NUMBER	SPAN (WEEKS)	INTERFACE REQUIREMENTS
Terms of Reference	1	1	——
Call for Proposals	2A	4	100% 1
Select Consultant	2B	1	100% 2A
Contract Award	2C	1	100% 2B
Preliminary Design	3A	8	100% 2C
Band/R.O. Approval	3B	4	100% 3A
Class 'B' Estimate	4	4	100% 3B
Specs. & Dwgs. 30%	5A1	8	100% 3B
Approval (30%)	5B1	4	100% 5A1
Specs. & Dwgs. 60%	5A2	8	100% 5A1,5B1 must complete one week ahead of 5A2
Approval (60%)	5B2	2	100% 5A2
Specs. & Dwgs. 90%	5A3	8	100% 5A2,5B2 must complete one week ahead of 5A3
Approval (90%)	5B3	2	100% 5A3
Specs. & Dwgs. 100%	5A4	4	100% 5A3,5B3 must complete one week ahead of 5A4
Approval (100%)	5B4	4	100% 5A4
Class 'A' Estimate	6	13	100% 4, 75% of 5A2
T.B.D. Eff. Approval	7	26	100% 4
Design Reviewed			Milestones: Approvals (30%) (60%) (90%) (100%)

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

PROJECT SCHEDULE — CALENDRIER DE PROJET

Legend / Légende

- Activity / Activité
- Earliest Possible Start / Démarrage le plus avancé possible
- Secondary Start (Prior Interface) / Démarrage secondaire (dépendance antérieure)
- Interface Point (Dependancy) / Point d'interface (dépendance)
- Continuous Relationship / Lien de continuité
- Critical Path / Chemin critique
- Slack / Écart

Project Name – Titre du projet	Date of Original Plan – Date du plan initiale
Project Number – Numéro du projet	Date as of Present Period – Date à ce jour

Activity / Activité		Time Span / Délais d'ex. (MO.)	CALENDAR – CALENDRIER	Resources / Ressources	
Name / Nom	Number / Numéro			Planned / Prévues	Actual / Réelles
			1982 J F M A M J J A S O N D 1983 J F M A M J J A S O N D 1984 J F M A M J J A S O N D 1985 J F M A M J J A S O N D 1986 J F M A M J J 5 10 15 20 25 30 35 40 45 50 55		
IDENTIFICATION	PHASE 1				
TERMS OF REFERENCE	1.1	4.5			
CLASS 'C' ESTIMATE	1.2	1.5			
APPROVE TERMS	1.3	2			
TREAS. BD. SUBMISSION	1.4	4			
BAND + R.O. APPROVAL	1.5	1			
TREAS. BD. APPROVAL	1.6	5			
PLANNING	PHASE 2				
STUDIES	2.1	4			
DEVELOPMENT PLAN	2.2	2			
DESIGN BRIEF	2.3	3			
BAND + R.O. APPROVAL	2.4	1			
SCHEDULE DESIGN	2.5	2			
DESIGN	PHASE 3				
PRELIMINARY DESIGN	3.1	3			
CLASS 'B' ESTIMATE	3.2	1			
TREAS. BD. SUBMISSION	3.3	4			
DETAIL DESIGN	3.4	7.5			
CLASS 'A' ESTIMATE	3.5	3			
TREAS. BD. EFF. APPROVAL	3.6	6			
CONSTRUCTION	PHASE 4				
PREPARE TENDERS	4.1	4			
TENDERING	4.2	3.5			
SCHEDULE CONST'N.	4.3	1			
CONSTRUCTION	4.4	11.5			

MASTER SCHEDULE

2

Project Manager – Chargé de projet	RCM – G.C.R.	Prepared by – Préparé par	Date	Approved – Approuvé	Date

56 252 (7-84) 7530-21-036-8994

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

PROJECT SCHEDULE — CALENDRIER DE PROJET

Legend / Légende

- Activity / Activité
- Earliest Possible Start / Démarrage le plus avancé possible
- Secondary Start (Prior Interface) / Démarrage secondaire (dépendance antérieure)
- Interface Point (Dependancy) / Point d'interface (dépendance)
- Continuous Relationship / Lien de continuité
- Critical Path / Chemin critique
- Slack / Écart

Project Name – Titre du projet	Date of Original Plan – Date du plan initiale
Project Number – Numéro du projet	Date as of Present Period – Date a ce jour

Activity / Activité		Time Span / Délais d'ex. (wk.)	CALENDAR – CALENDRIER	Resources / Ressources	
Name / Nom	Number / Numéro			Planned / Prévues	Actual / Réelles
TERMS OF REFERENCE	1	1			
CALL FOR PROPOSALS	2A	4			
SELECT CONSULTANT	2B	1			
CONTRACT AWARD	2C	1			
PRELIM. DESIGN	3A	8			
BAND/R.O. APPROVAL	3B	4			
CLASS 'B' ESTIMATE	4	4			
SPECS. + DWGS. 30%	5A1	8			
APPROVAL (30%)	5B1	4			
SPECS. + DWGS. 60%	5A2	8			
APPROVAL (60%)	5B2	2			
SPECS. + DWGS. 90%	5A3	8			
APPROVAL (90%)	5B3	2			
SPECS. + DWGS. 100%	5A4	4			
APPROVAL (100%)	5B4	4			
CLASS 'A' ESTIMATE	6	13			
T. BD. EFF. APPROVAL	7	26			
DESIGN REVIEWED					

SEPT. 9 16 23 30 | OCT. 7 14 21 28 | NOV. 4 11 18 25 | DEC. 2 9 16 23 30 | JAN. 6 13 20 27 | FEB. 3 10 17 24 | MAR. 2 9 16 23 30 | APR. 6 13 20 27 | MAY 4 11 18 25 | JUNE 1 8 15 22 29 | JULY 6 13 20 27 | AUG. 3 10 17 24 31

5 10 15 20 25 30 35 40 45 50 55

DESIGN STAGE

3

Project Manager – Chargé de projet	RCM – G.C.R.	Prepared by – Préparé par / Date	Approved – Approuvé / Date

56-252 (7-84) 7530-21-036-8994