Chapter 6 - TM Tools-S –curve

Course Contents: TM Tools-S –curve: Introduction, Where and why it is used, Process, Case study. [TB1: Ch. 8]

Contents

Introduction

An S Curve is defined as "a display of cumulative costs, labour hours or other quantities plotted against time. The name derives from the S-like shape of the curve, flatter at the beginning and end and steeper in the middle, which is typical of most projects. The beginning represents a slow, deliberate but accelerating start, while the end represents a deceleration as the work runs out".

Types of S Curves

An S Curve is graphed on an X-Y graph with the X axis representing time, and the Y axis representing a quantity, usually man hours and / or costs. The three basic types of S Curves include here are:

- **The Baseline S Curve.** This S Curve is generated from the Baseline Schedule and / or baseline fields in the Production Schedule.
- **The Target S Curve.** This S Curve is generated from the Production Schedule, assuming all tasks are completed as scheduled.
- **The Actual S Curve.** This S curve is also generated from the Production Schedule, using task percentage complete values to date. The Actual S Curve may also be referred to as the Progress or Progress To Date S Curve.

S Curve Quantities

Each of the above S Curves may include one or both of the following quantities on the quantity (Y) axis:

- Man Hours
- Costs

S Curve Quantity Units

In addition, each of the above S Curves may use one of the following units for the values on the quantity (Y) axis:

- Absolute Values for man hours and / or costs
- Percentage Values for man hours and / or costs

The Baseline S Curve

Prior to project commencement, a schedule is prepared outlining the proposed allocation of resources and the timing of tasks necessary to complete the project within a set time frame and budget. This schedule is referred to as the Baseline Schedule. Once all the tasks and their associated planned dates and values have been entered, the schedule should be base lined. In MS Project, base lining a project will copy the task dates and values to the appropriate baseline fields. When the Baseline Schedule is copied to create the Production Schedule, these baseline values will be available in the Production Schedule. This allows for the generation of the Baseline S Curve from the Production Schedule.

The Baseline Schedule may be used to generate a Baseline S Curve. This S Curve reflects the planned progress of the project. If the project requirements change prior to commencement (e.g. change of scope, delayed start, etc.), the Baseline Schedule may require revision and re-base lining to reflect the changed requirements. Once the project has commenced, the original Baseline Schedule should be left unchanged. Although it may be tempting to re-baseline the Baseline Schedule to cover changes in scope, delays, variations, etc. this should not be done. The Baseline Schedule is a fixed snap shot of the project's original timeframe and budget. Any changes that occur during the project's lifetime will be readily visible when the Production Schedule is compared to the Baseline Schedule. As such claims for variations, extensions of time, excusable delays, etc. may be raised as required, using the Baseline Schedule as evidence of the original project's scope and timing.
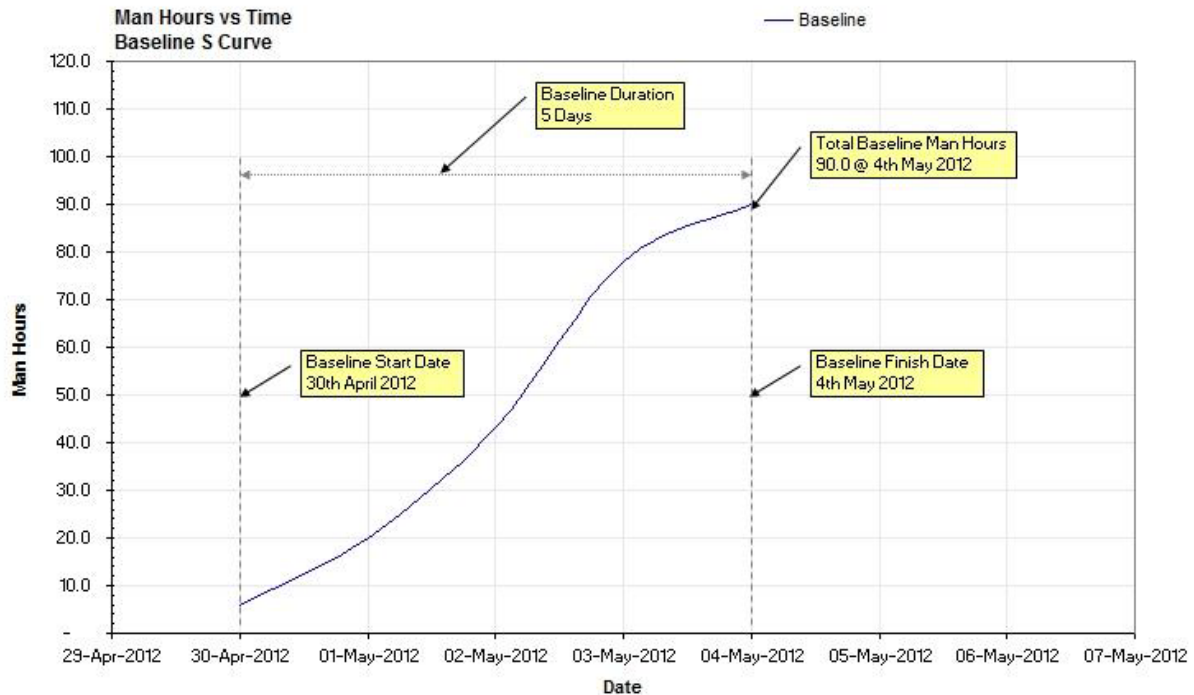
Figure 1: Baseline S Curve
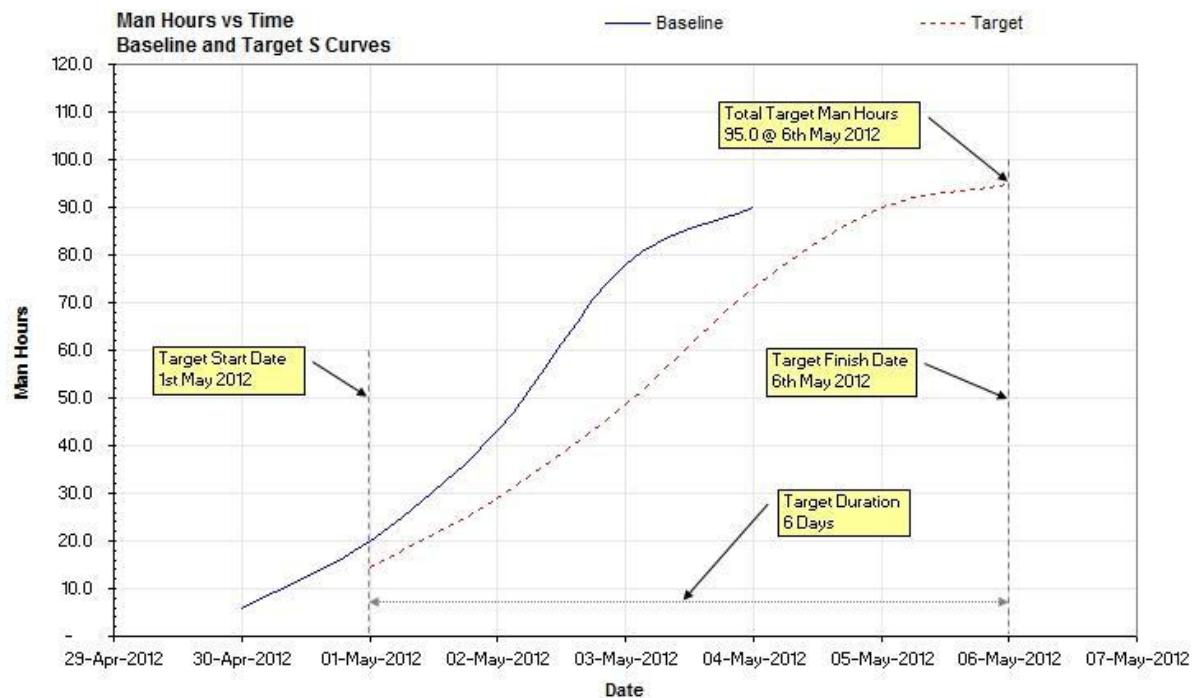
The Target S Curve

Following project commencement, the project's schedule will usually require changes. As the Baseline Schedule should not be changed once the project has commenced, these changes are instead made to the Production Schedule. The Production Schedule is created by making a copy of the Baseline Schedule. If the Baseline Schedule was base lined, the Production Schedule will include baseline dates and values for the original tasks as well as their planned production dates and values.

The Production Schedule reflects the actual progress of the project to date (task percentage complete to date), any tasks added to and / or removed from the project, any revisions made to tasks yet to commence or not yet finished, as well as actual dates and values for tasks that are ongoing or have finished.

Tasks that do not contain valid start and finish dates, and / or zero quantities for man hours and / or costs cannot be used to generate an S Curve. So it is important to note that the Production Schedule must contain valid dates and values for all tasks, regardless of whether the task has commenced or not. Originally these task dates and values will be the same as the Baseline Schedule (provided the Baseline Schedule was base lined, and copied to create the Production Schedule). Task dates and values may be amended as required using actual values (such as when the task actually started, finished, man hours / costs actually expended, etc.) or estimated dates and values for tasks that are yet to commence or have not finished.

The Production Schedule may be used to generate a Target S Curve, as well as the original Baseline S Curve if it contains baseline data. The Target S Curve reflects the progress of the project if all tasks are completed as currently scheduled. In an ideal world, the Target S Curve will meet the Baseline S Curve at the end of the project (On Time, On Budget) or finish below and to the left of the Baseline S Curve (Finished Early, Under Budget). In reality, it is not

uncommon for the Target S Curve to finish above and to the right of the Baseline S Curve (Finished Late, Over Budget). The Target S Curve will usually change over the duration of the project due to changes to task start and finish dates, man hours, and / or costs.

Figure 2: Target S Curve (Showing Baseline S Curve For Comparison)

The Actual S Curve

The Production Schedule is updated on a regular basis throughout the duration of the project. These updates include the revision of percentage complete for each task to date, revising of task start and finish dates, and updating of task percentage complete values. Using this information, an Actual S Curve may be generated. This S Curve reflects the actual progress of the project to date, and may be compared with the Baseline and Target S Curves to determine how the project is progressing as compared to the original Baseline Schedule, and the current Production Schedule. During the project, the Actual S Curve will terminate at the Cut Off Date.
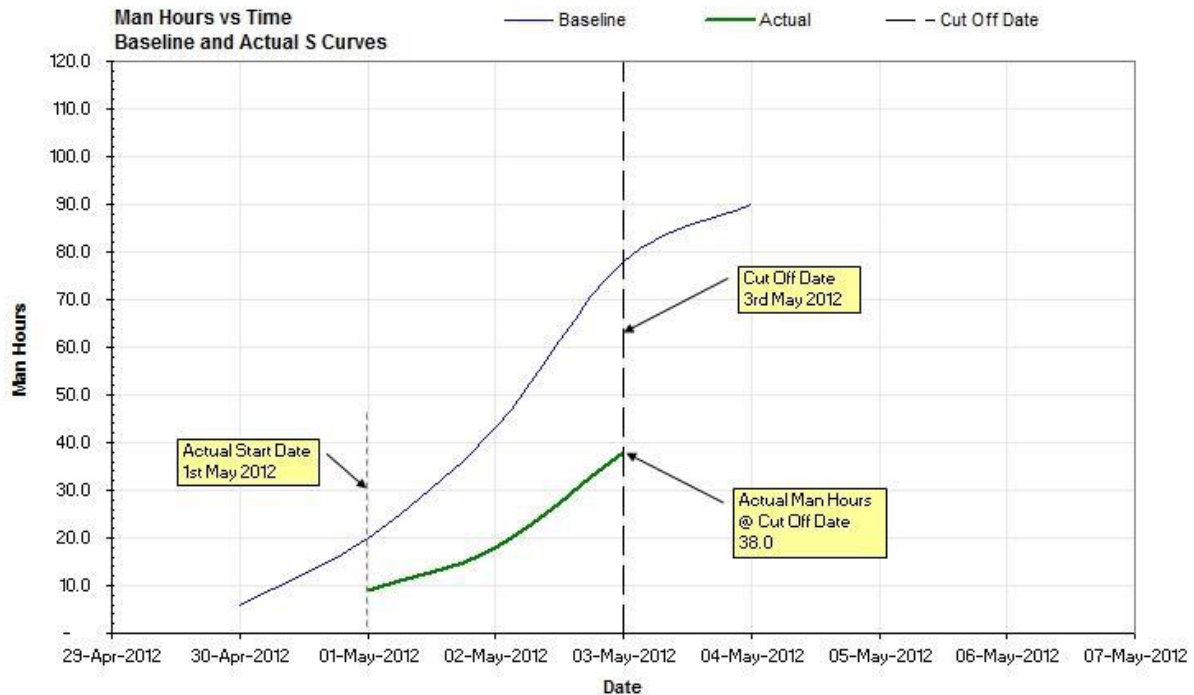
Figure 3: Actual S Curve (Showing Baseline S Curve For Comparison)

What Is The Cut Off Date?

The Cut Off Date is the date on which the tasks were physically inspected to determine their percentage complete values. For example, if the tasks were inspected on Thursday the 3rd of May 2012, the Production Schedule was updated on Friday the 4th of May 2012, and the Actual S Curve was generated on Saturday the 5th of May 2012, the Cut Off Date should be set to Thursday the 3rd of May 2012.

At the completion of the project, with all tasks 100% complete, the Actual S Curve will terminate at the project completion date, and be identical to the Target S Curve. The Actual S Curve will usually change over the duration of the project due to changes to task start and finish dates, man hours and / or costs, and percentage complete to date.

Changing the Cut Off Date After The Production Schedule Has Been Updated

If the Actual S Curve is to be accurate, the Cut Off Date must be set to the date the project's tasks were physically inspected. In the following figure, the project's tasks were physically inspected on the 3rd of May 2012. This is the Cut Off Date that should be used when generating the Actual S Curve. Using an earlier or later Cut Off Date can dramatically alter the shape of the Actual S Curve, as is shown in the following figure.
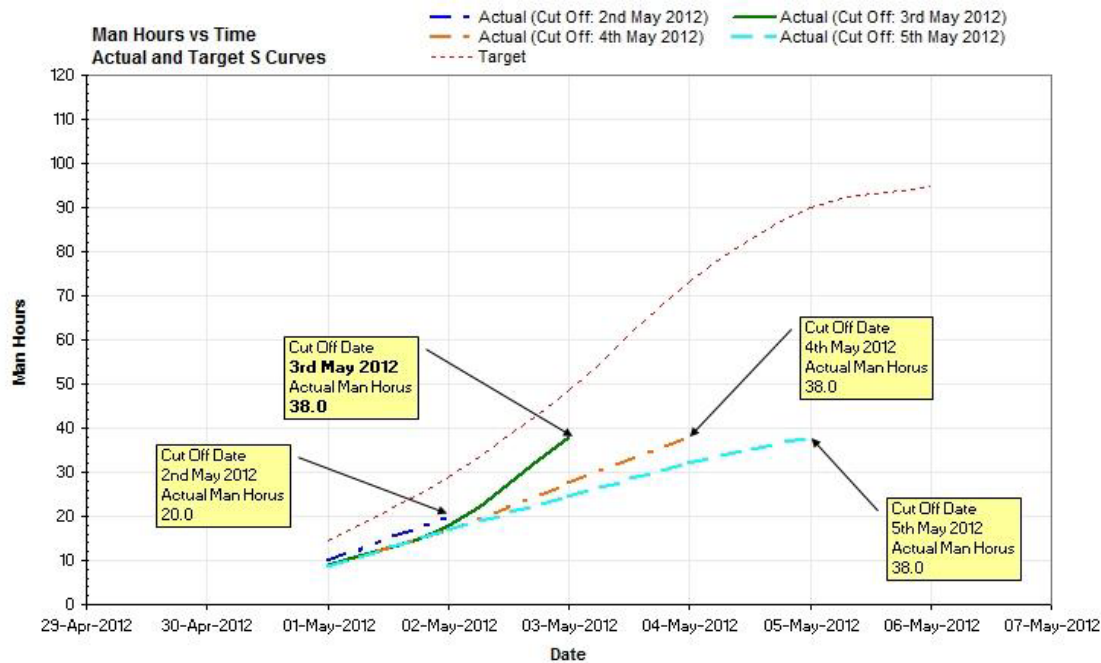
Figure 4: Example of Actual S Curves Using Different Cut Off Dates

The Man Hours versus Time S Curve

The Man Hours versus Time S Curve is appropriate for projects that are labour intensive. It shows cumulative man hours expended over time for the duration of the project. As man hours are a product of man power and working hours, these may be adjusted together or individually in an attempt to keep the project on track. Projects may require additional man hours to finish on time due to low productivity, weather or other delays and disruptions, rework, variations, change of scope, etc.

The Costs versus Time S Curve

The Costs versus Time S Curve is appropriate for projects that contain labour and non-labour (e.g. material supply / hire / subcontract) tasks. It shows cumulative costs expended over time for the duration of the project, and may be used to assist in the calculation of the project's cash flow, and cost to complete.

Value and Percentage S Curves

S Curves may be graphed as absolute values (i.e. Man Hours or Costs) versus Time, or as percentage values versus Time.

Value S Curves

Value S Curves are useful for determining the project's man hours or costs expended to date, and man hours or costs to complete.
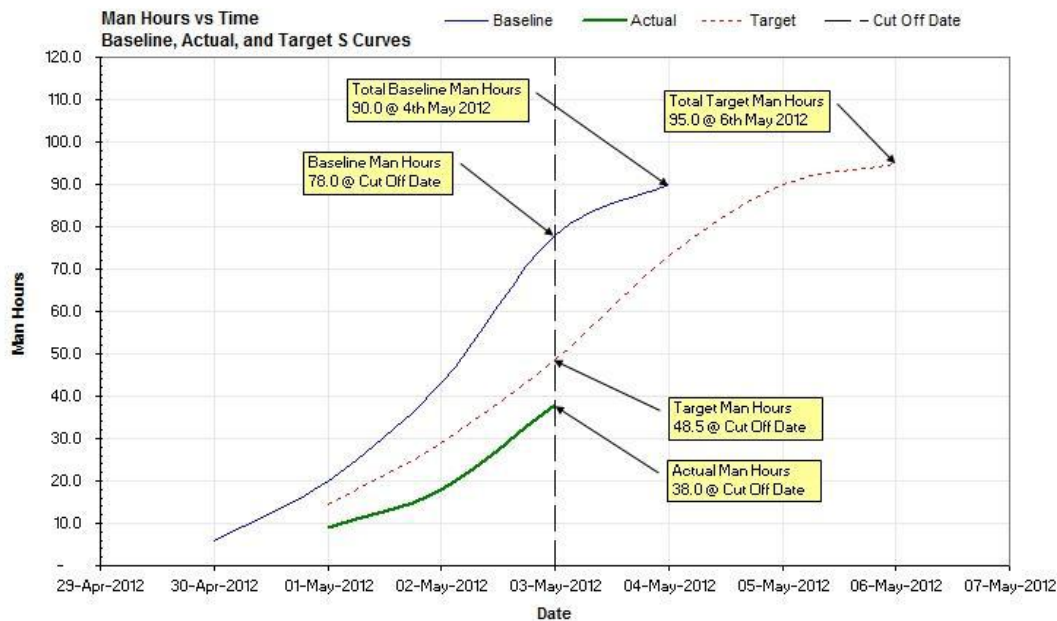
Figure 5: Value Man Hours versus Time Baseline, Actual, and Target S Curves

Analysis of the above S Curves reveals the project as of the 3rd of May 2012:
- Is 10.5 man hours behind schedule (48.5 – 38.0)
- Has grown in scope by 5.0 man hours (95.0 – 90.0)
- Has increased in duration by 1 day
- Started 1 day late
- Will finish 2 days late
- Will require 57.0 man hours to complete (95.0 – 38.0)

Percentage S Curves
Percentage S Curves are useful for comparing the project's performance to either the Baseline and / or Production Schedule.

Percentage S Curves (Baseline = 100%)
By setting the Baseline S Curve to finish at 100%, the project's percentage growth (or contraction) may be compared to the Baseline Schedule, and the Baseline Percentage Complete as of the Cut Off Date may be determined.
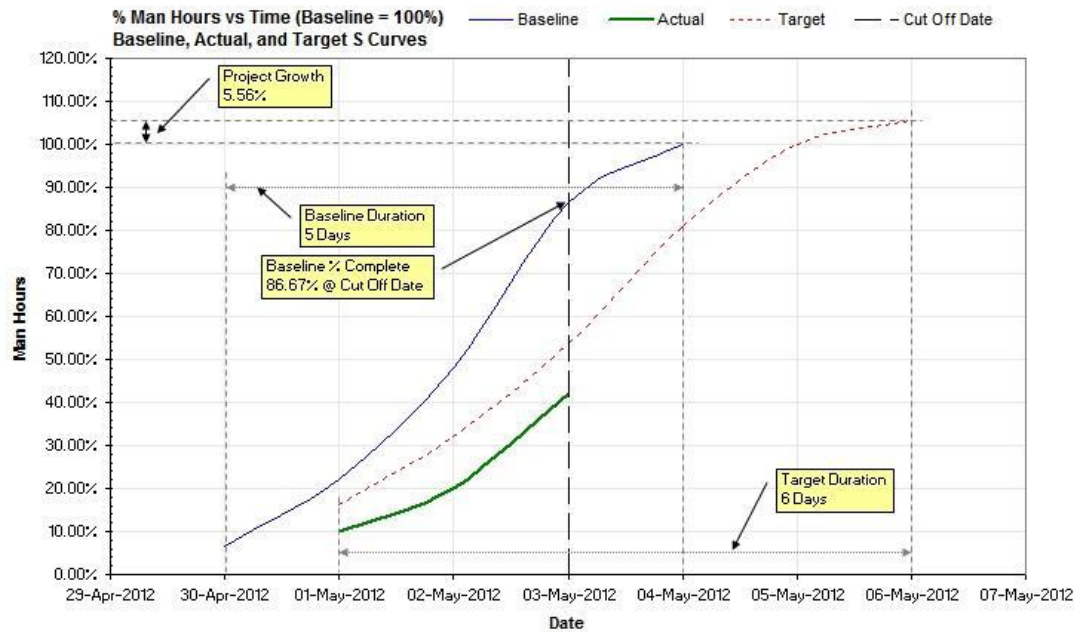
Figure 6: Percentage Man Hours versus Time (Baseline = 100%) S Curves

Analysis of the above S Curves reveals the project as of the 3rd of May 2012:

- Has grown in scope by 5.56% (105.56 – 100.00)
- Was planned to be 86.67% complete

Percentage S Curves (Target = 100%)

By setting the Target S Curve to finish at 100%, the project's Actual Percentage Complete may be compared to the Target Percentage Complete as of the Cut Off Date.
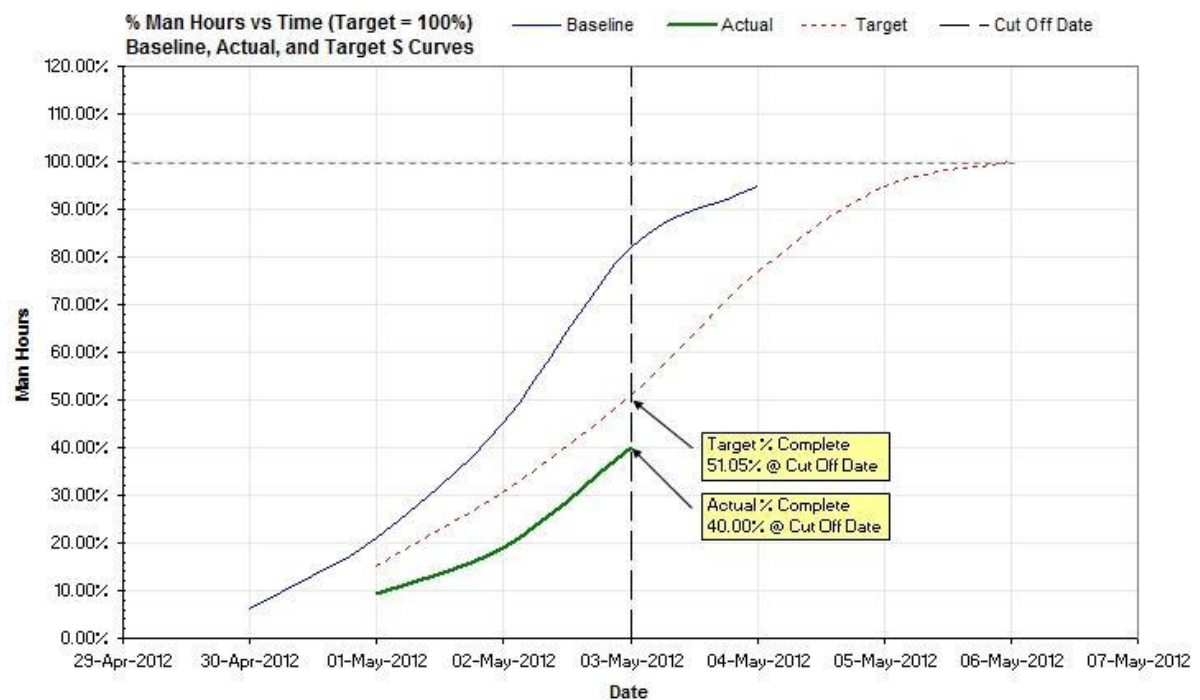
Figure 7: Percentage Man Hours versus Time (Target = 100%) S Curves

Analysis of the above S Curves reveals the project as of the 3rd of May 2012:
- Is 11.05% behind target (51.05 – 40.00)

Why Use an S Curve?

S Curves are an important project management tool. They allow the progress of a project to be tracked visually over time, and form a historical record of what has happened to date. Analysis of S Curves allows project managers to quickly identify:
- **Project Progress**
- **Project Growth or Contraction (Man Hours and / or Costs, Duration)**
- **Project Start and / or Finish Slippage**

Although Gantt Charts also display project information visually, they can quickly become cumbersome to work with, especially with projects having hundreds or even thousands of tasks.

Determining Project Progress

Comparison of the Target S Curve and Actual S Curve reveals the progress of the project over time. In most cases, the Actual S Curve will sit below the Target S Curve for the majority of the project, due to many factors, including under reporting of true task percentage complete values, etc. Only towards the end of the project will the curves converge and finally meet. Although the Actual S Curve may sit above the Target S Curve for a period during the project, it can never finish above the Target S Curve at project completion.
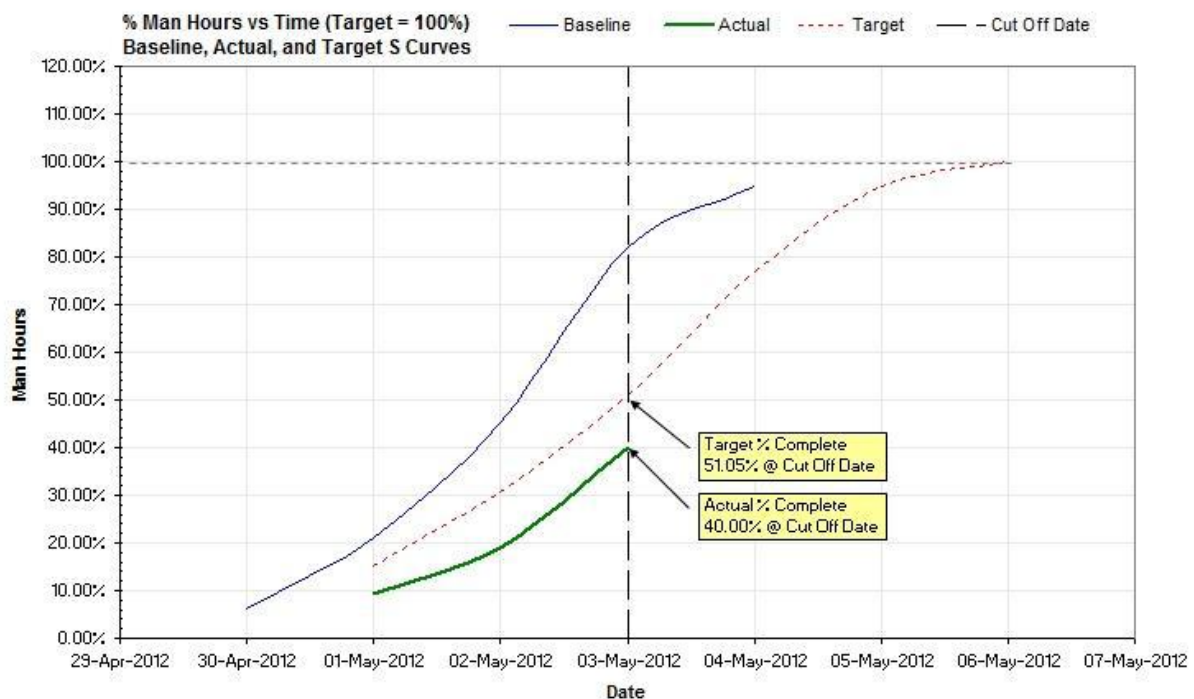
Figure 8: Calculating Project Progress using S Curves

Analysis of the above S Curves reveals the project as of the 3rd of May 2012:
- Is 11.05 % (51.05% - 40.00%) behind target
- Has been behind target since it commenced

Ahead Of Schedule?

If the Actual S Curve sits above the Target S Curve, the Production Schedule should be examined to determine if the project is truly ahead of schedule, or if the Production Schedule contains unrealistic or incorrect percentage complete values for ongoing tasks.

The Target S Curve calculations assume man hours and / or costs will be distributed evenly for each day of the task. For example, a task with a 5 day duration and 100 man hours will be assumed to be completed at a rate of 20 man hours per day, as shown in the following table.

Target S Curve	5 Days Duration, 100 Man Hours				
Date	01-May-2012	02-May-2012	03-May-2012	04-May-2012	05-May-2012
Totals Per Day	20	20	20	20	20
YTD Totals	20	40	60	80	100
% Complete	20%	40%	60%	80%	100%

Table 1: Task Target S Curve Data (Showing Man Hours Distributed Evenly per Day)

If a task has the majority of the man hours and / or costs completed at the beginning, in the middle, or at the end of the task duration, the Actual S Curve may be pushed higher than the Target S Curve (depending on other tasks ongoing within the same time period).

The planned task in the following table has the majority of the man hours scheduled to be completed at the beginning of the task.

Planned Task	5 Days Duration, 100 Man Hours				
Date	01-May-2012	02-May-2012	03-May-2012	04-May-2012	05-May-2012
Totals Per Day	35	40	0	15	10
YTD Totals	35	75	75	90	100
% Complete	35%	75%	75%	90%	100%

Table 2: Planned Task Details

Using a Cut Off Date set to the 3rd of May 2012, and a task percentage complete value of 75%, the Actual S Curve calculations for the planned task are shown in the following table.

Actual S Curve	Cut Off Date: 3rd May 2012		
Date	01-May-2012	02-May-2012	03-May-2012
Totals Per Day	25	25	25
YTD Totals	25	50	75
% Complete	25%	50%	75%

Table 3: Task Actual S Curve Data

The following figure illustrates how such a task can result in the Actual S Curve sitting above the Target S Curve.
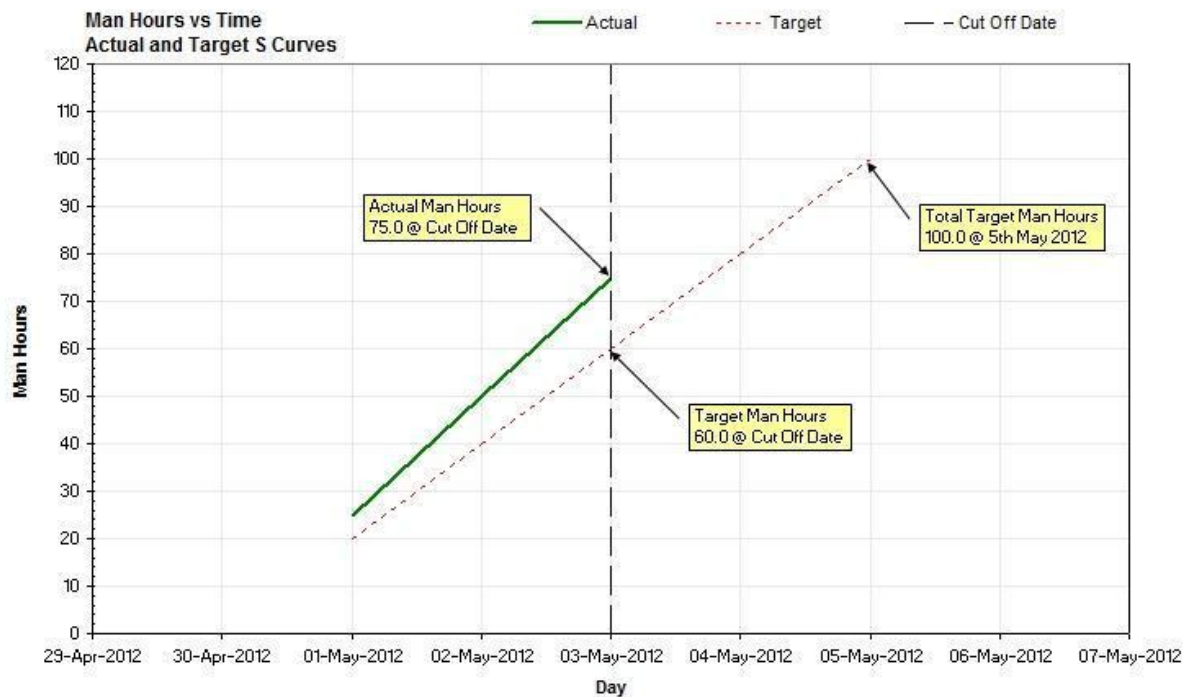
Figure 9: Actual and Target S Curves (Actual S Curve sits above Target S Curve)

The accuracy of the Production Schedule and any S Curves generated from it may be improved in this instance by splitting the planned task into two tasks.

The original task should be revised to have a duration of 2 days, 75 man hours, and be set to 100% complete.

Revised Task	2 Days Duration, 75 Man Hours, 100% Complete, Cut Off Date: 3rd May 2012				
Date	01-May-2012	02-May-2012	03-May-2012	04-May-2012	05-May-2012
Totals Per Day	35	40			
YTD Totals	35	75			
% Complete	46.67%	100%			

Table 4: Revised Task Details

A new task with a duration of 2 days, 25 man hours, and set at 0% complete should be added.

New Task	2 Days Duration, 25 Man Hours, 0% Complete, Cut Off Date: 3rd May 2012				
Date	01-May-2012	02-May-2012	03-May-2012	04-May-2012	05-May-2012
Totals Per Day				15	10
YTD Totals				15	25
% Complete				0%	0%

Table 5: New Task Details

Determining Project Growth or Contraction

Comparison of the Baseline and Target S Curves quickly reveals if the project has grown (Target S Curve finishes above Baseline S Curve) or contracted (Target S Curve finishes below Baseline S Curve) in scope. A change in the project's scopes implies a re-allocation of resources (increase or decrease), and the very possible requirement to raise contract variations. If the resources are fixed, then the duration of the project will increase (finish later) or decrease (finish earlier), possibly leading to the need to submit an extension of time claim if the project will finish late.
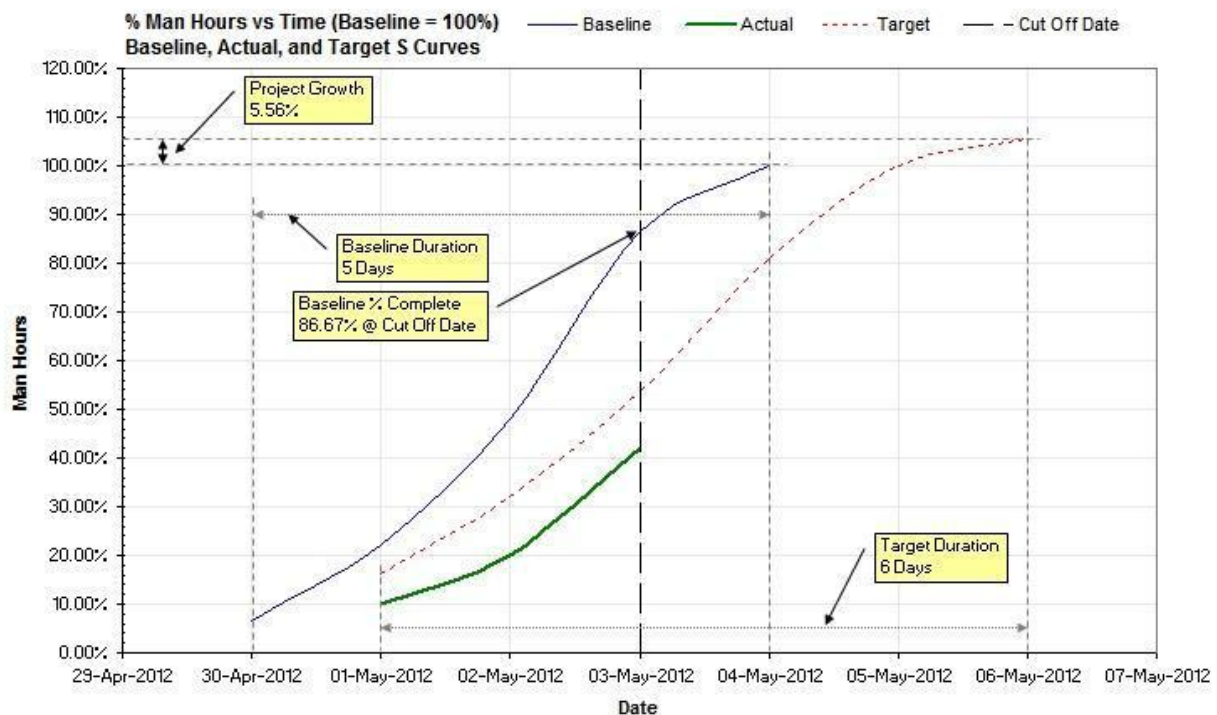
Figure 10: Calculating Project Growth using S Curves

Analysis of the above S Curves reveals the project as of the 3rd of May 2012:
- Has grown in man hours by 5.56% (105.56 – 100.00)
- Has grown in duration by 1 day (6 days – 5 days)

Determining Slippage

Slippage is defined as "*the amount of time a task has been delayed from its original baseline schedule. The slippage is the difference between the scheduled start or finish date for a task and the baseline start or finish date. Slippage can occur when a baseline plan is set and the actual dates subsequently entered for tasks are later than the baseline dates or the actual durations are longer than the baseline schedule durations*".

[1]

There are two types of slippage: Start Slippage, and Finish Slippage.

Start Slippage

Start Slippage occurs when the estimated / actual start date of the project / task is later than the baseline start date. In other words, the project / task has started later than planned. If the project has already commenced, nothing can be done to eliminate or reduce the project's start slippage. An extension of time claim and / or variation may need to be submitted depending on the reasons why the project started later than planned.

Finish Slippage

Finish Slippage occurs when the estimated / actual finish date of the project / task is later than the baseline finish date. In other words, the project / task will finish / has finished later than planned, either because the project / task started late, or the project / task duration has increased. Obviously if a project / task experiences start slippage, finish slippage will also occur if the project / task duration remains the same. Additional resources will need to be allocated or additional hours worked in order to eliminate (or at least reduce) the project's finish slippage. An extension of time claim may need to be submitted if the finish slippage cannot be eliminated or reduced to an acceptable level.

Comparison of the Baseline S Curve and Target S Curve quickly reveals if project start and / or finish slippage has occurred. (i.e. the Target S Curve starts and / or finishes to the right of the Baseline S Curve).

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[1] Source: Wideman Comparative Glossary of Common Project Management Terms v2.1
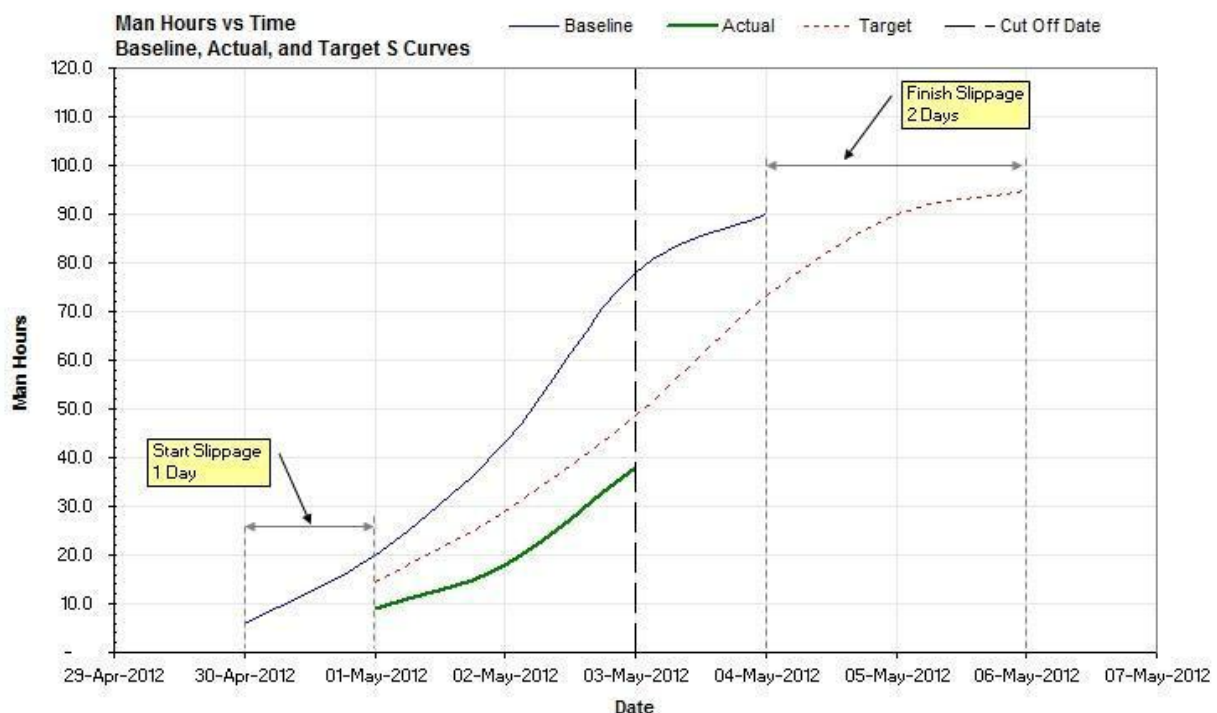Copyright R. Max Wideman, May 2001

Figure 11: Calculating Project Start / Finish Slippage

Analysis of the above S Curves reveals the project as of the 3rd of May 2012:
- Started 1 day late
- Will finish 2 days late

How is an S Curve Generated?

To generate a Baseline S Curve, a Baseline Schedule is required, or a Production Schedule containing the baseline dates and values of the original tasks.

The Baseline Schedule / Production Schedule should contain the following information for each task...

- **Baseline Start Date, Finish Date**
- **Baseline Man Hours** and / or **Costs**

To generate Actual and Target S Curves, a Production Schedule is required.

The Production Schedule should contain the following information for each task...

- **Start Date**, **Finish Date** (if actual dates are unknown, baseline / estimated dates should be used)
- **Man Hours** and / or **Costs** (if actual values are unknown, baseline / estimated values should be used)
- **Percentage Complete** (as of the Cut Off Date)

If a Baseline S Curve is also to be generated with the Actual and / or Target S Curves, the Production Schedule should also contain baseline dates and values for each original task in the appropriate baseline fields. This is usually the case if the Baseline Schedule was base lined, and copied to create the original Production Schedule.

Schedule Integrity

The accuracy of any S Curve generated from either a Baseline or Production Schedule is dependent on the integrity of the schedule. This means every task must contain valid start and finish dates (baseline, actual, or estimated) so that the task's duration may be calculated. In addition, each task should contain a non-zero value for man hours and / or costs, as tasks with zero values for these quantities have no bearing on the final S Curve. Negative values for man hours and / or costs may be assigned if required (this usually occurs with a variation task that de-scopes an existing task). Finally, tasks that have not yet commenced as of the Cut Off Date cannot have a non-zero percentage complete value, and tasks that have finished as of the Cut Off Date must have a 100% percentage complete value.

Task Name	Start Date	Finish Date	Man Hours	Cost	% Complete	Reason Task Is Invalid
Task No. 1	N/A	N/A	10	100.00	0%	Invalid start, finish dates. Unable to calculate task duration.
Task No. 2	N/A	04-May-2012	100.00		0%	Invalid start date. Unable to calculate task duration.
Task No. 3	01-May-2012	N/A	10	100.00	0%	Invalid finish date. Unable to calculate task duration.
Task No. 4	01-May-2012	04-May-2012	0	100.00	0%	Zero man hours. Does not affect Man Hours S Curves.
Task No. 5	01-May-2012	04-May-2012	10	0.00	0%	Zero cost. Does not affect Cost S Curves.
Task No. 6	01-May-2012	02-May-2012	10	100.00	90%	Task has finished, but is only 90% complete.
Task No. 7	05-May-2012	08-May-2012	10	100.00	5%	Task has not started, but is 5% complete.
Cut Off Date	3rd May 2012					

Table 6: Examples of Invalid Tasks

To use the above tasks to generate an Actual and / or Target S Curve, the following changes are required:

Task No. 1: Valid start and finish dates should be used.
If actual values are unknown, baseline or estimated values may be used.

Task No. 2: A valid start date should be used.
If the actual start date is unknown, the baseline start date or an estimated start date should be used.

Task No. 3: A valid finish date should be used.
If the actual finish date is unknown, the baseline finish date or an estimated finish date should be used.

Task No. 4: A non-zero quantity for man hours should be used.
If the actual amount of man hours is unknown, baseline man hours or estimated man hours should be used.

Task No. 5: A non-zero quantity for costs should be used.
If the actual costs are unknown, baseline costs or estimated costs should be used.

Task No. 6: If the task has finished, the percentage complete value should be set to 100%.
If the task is still in progress, the finish date should be moved right to or beyond the Cut Off Date.

Task No. 7: If the task has not started, the percentage complete value should be set to 0%.
If the task has started, the start date should be moved left to or before the Cut Off Date.

Start Dates, Finish Dates, Percentage Complete, And The Cut Off Date

When generating an Actual S Curve, it is important to ensure tasks contain valid planned / estimated / actual start and finish dates along with accurate percentage complete values. When

updating a Production Schedule containing numerous tasks, it is easy to overlook tasks that contain invalid dates and / or percentage complete values. Two of the most common issues found are:

Tasks that have finished prior to the Cut Off Date yet are not 100% complete

Task A1 shown below is an example of a task that should have finished before the Cut Off Date (indicated by the dashed red line), but is not 100% finished. Such tasks either need to have the finish date pushed right to or beyond the Cut Off Date if they are not finished (e.g. Task A2), or have their percentage complete value set to 100% if they are finished (e.g. Task A3).

Tasks scheduled to start after the Cut Off Date yet have a non-zero percentage complete value

Task B1 shown below is an example of a task that is scheduled to start after the Cut Off Date (indicated by the dashed red line), but has a non-zero percentage complete value assigned. Such tasks either need to have their start date moved left to or before the Cut Off Date if the task has already started (e.g. Task B2), or have their percentage complete value set to 0% if they have not started (e.g. Task B3).
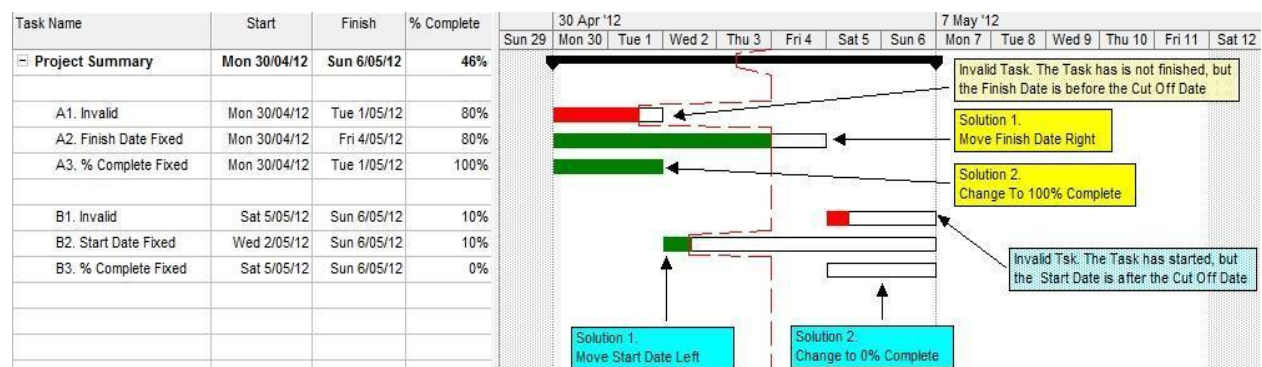

Figure 12: Examples of Tasks with Invalid Start Dates, Finish Dates, and / or Percentage Complete values.

5.2 Summary and Detail Tasks

It is common for both the Baseline and Production Schedules to contain a combination of Summary and Detail tasks. It is important to note that only detail tasks should be considered when generating an S Curve. Summary tasks must be ignored. For example, a project has 1 summary task, 4 details tasks, and a total of 90 man hours. If the summary task is included in the Baseline S Curve calculations, the total man hours are doubled, as the summary task contains the total man hours of the 4 detail tasks.

Task Name	Baseline Start	Baseline Finish	Baseline Man Hours	Baseline [1] Duration	Baseline [2] MH per Day
Project Summary	30-Apr-2012	04-May-2012	90.0	5	18
Task No. 1	30-Apr-2012	01-May-2012	12.0	2	6
Task No. 2	01-May-2012	03-May-2012	24.0	3	8
Task No. 3	02-May-2012	03-May-2012	30.0	2	15
Task No. 4	03-May-2012	04-May-2012	24.0	2	12
Totals			180.0		

Task / Date	30-Apr-2012	01-May-2012	02-May-2012	03-May-2012	04-May-2012
Project Summary	18.0	18.0	18.0	18.0	18.0
Task No. 1	6.0	6.0	-	-	-
Task No. 2	-	8.0	8.0	8.0	-
Task No. 3	-	-	15.0	15.0	-
Task No. 4	-	-	-	12.0	12.0
Totals per Day [3]	24.0	32.0	41.0	53.0	30.0
YTD Totals [4]	24.0	56.0	97.0	150.0	180.0

**Table 7: Baseline S Curve Calculations, Including Summary Task**

Milestone Tasks

As milestone tasks have zero duration, they are not included when generating S Curves.

Worked Example

To better understand how S Curves are generated, consider a simple project comprising five tasks. The first task is a summary task, and thus must be ignored. The remaining four tasks are detail tasks. Please note that although this worked example will only consider man hours, the calculations shown below are identical if costs are used in lieu of man hours.

A Baseline Schedule prepared using MS Project for the example project is shown below.
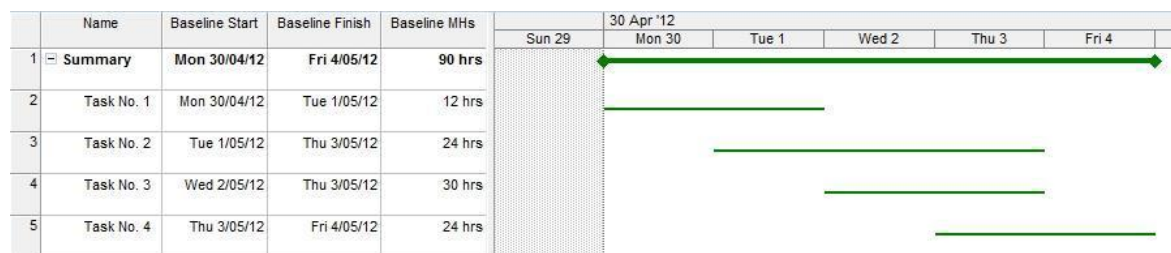
Figure 13: Sample Baseline Schedule

Man Hours versus Time Baseline S Curve

To generate a Baseline Man Hours versus Time S Curve, two sets of calculations are required.

The first set of calculations are performed for each task in the Baseline Schedule.

(1) Calculate the duration in days for each task.

Baseline Duration = Baseline Finish Date – Baseline Start Date + 1

(2) Calculate Man Hours per day for each task.

Baseline Man Hours per Day = Baseline Man Hours / Baseline Duration

These calculations are shown in the following table.

Task Name	Baseline Start	Baseline Finish	Baseline Man Hours	Baseline [1] Duration	Baseline [2] MH per Day
Task No. 1	30-Apr-2012	01-May-2012	12.0	2	6
Task No. 2	01-May-2012	03-May-2012	24.0	3	8
Task No. 3	02-May-2012	03-May-2012	30.0	2	15
Task No. 4	03-May-2012	04-May-2012	24.0	2	12
Totals			90.0		

Table 8: Baseline S Curve Calculation 1 of 2

The second set of calculations are performed for each day in the Baseline Schedule.

(3) Calculate the total Man Hours per Day for all tasks.

(4) Calculate the Year To Date Total for Man Hours per Day for all tasks. These calculations are shown in the following table.

Task / Date	30-Apr-2012	01-May-2012	02-May-2012	03-May-2012	04-May-2012
Task No. 1	6.0	6.0	-	-	-
Task No. 2	-	8.0	8.0	8.0	-
Task No. 3	-	-	15.0	15.0	-
Task No. 4	-	-	-	12.0	12.0
Totals per Day [3]	6.0	14.0	23.0	35.0	12.0
YTD Totals [4]	6.0	20.0	43.0	78.0	**90.0**

Table 9: Baseline S Curve Calculation 2 of 2

The Baseline S Curve is constructed by assigning the Baseline dates to the X Axis, and the Year To Date (YTD) values to the Y Axis. The resulting Baseline Man Hours versus Time S Curve is shown below.
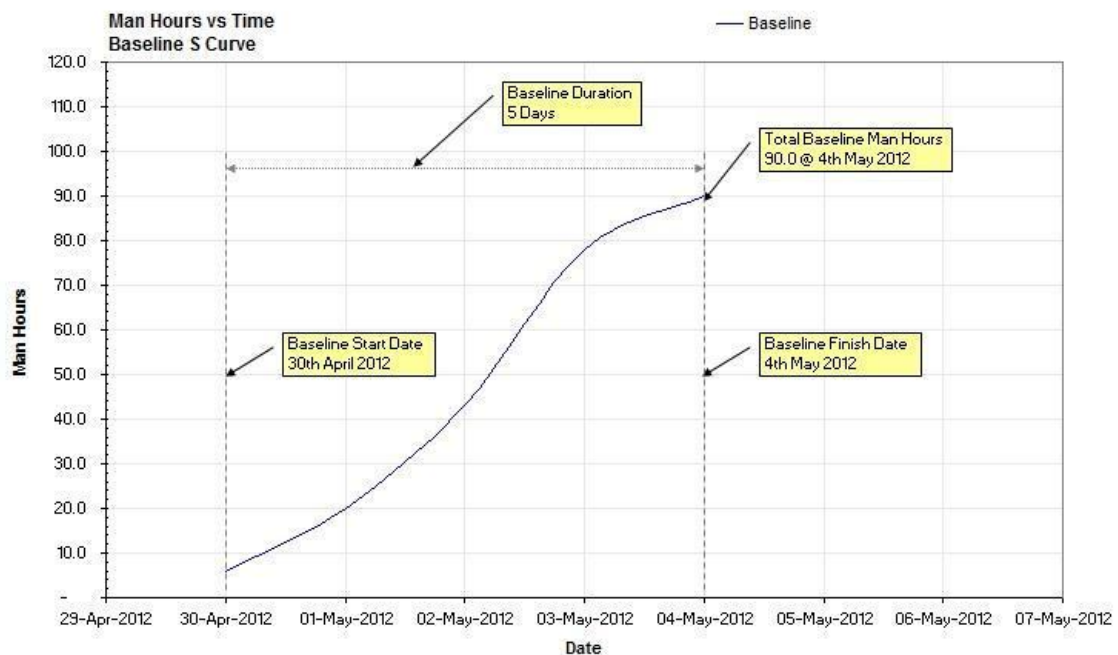
Figure 14: Man Hours versus Time Baseline S Curve

Please note that the Totals per Day values may be used to generate a Baseline Man Hours Histogram by assigning the dates to the X Axis, and the Totals per Day values to the Y Axis.

Man Hours versus Time Target S Curve

To generate the Actual and Target S Curves, a Production Schedule is required.

For the purpose of this example, the Production Schedule will contain the same five tasks (one summary task, four detail tasks) as the Baseline Schedule. Once again, the summary task must be ignored to ensure the calculations are accurate.

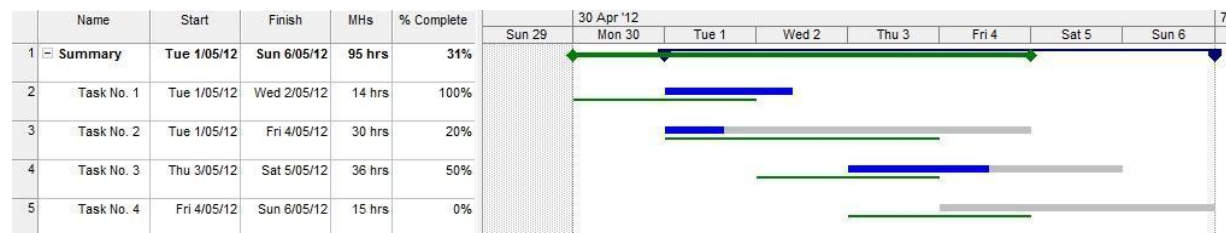A Production Schedule for the example project is shown below.

	Name	Start	Finish	MHs	% Complete
1	Summary	Tue 1/05/12	Sun 6/05/12	95 hrs	31%
2	Task No. 1	Tue 1/05/12	Wed 2/05/12	14 hrs	100%
3	Task No. 2	Tue 1/05/12	Fri 4/05/12	30 hrs	20%
4	Task No. 3	Thu 3/05/12	Sat 5/05/12	36 hrs	50%
5	Task No. 4	Fri 4/05/12	Sun 6/05/12	15 hrs	0%

Figure 15: Sample Production Schedule

Note this schedule contains the baseline data from the Production Schedule. This allows the Production Schedule to be used to generate Baseline S Curves.

Man Hours and / or Costs: Task Total or Expended To Date

The following example uses man hours, but is applicable to costs as well.

Man Hours may be entered and updated in the Production Schedule in one of two ways:

- **Total Task Man Hours**, or
- **Expended Man Hours To Date**

Total Task Man Hours

The man hours assigned to the task are the total man hours the task will require to be completed.

Expended Task Man Hours To Date

The man hours assigned to the task are the man hours expended to date, along with a percentage complete value. The total man hours the task will require will vary as the expended man hours and percentage complete values are changed as the task progresses. Initially the task will be 0% complete, and zero man hours will have been expended. When the task is finished, it will be 100% complete, and it will contain the total man hours expended.

Please note that if the Production Schedule contains expended task man hours and / or costs to date, the Target S Curve may be adversely affected. If the project has not commenced, all tasks will be at 0% completion and contain zero man hours and / or costs. Thus the Target S Curve will be a flat line sitting on the X axis. If the project has commenced, the Target S Curve will flat line from the finish date of the latest task that has non-zero man hours and / or costs and a non-zero percentage complete value assigned. Caution should be exercised when analysing the Target S Curve to determine the project's progress, and / or growth (man hours and / or costs) when using expended man hours and / or costs.

The following calculations require the total man hours for the task, so if the second method (expended man hours to date) is used, these expended man hours to date will require an additional calculation to determine the total man hours for the task as follows:

Total Task Man Hours = Expended Man Hours To Date / Task Percentage Complete

For example, a task has 20.0 man hours expended, and is 40% complete.

Total Task Man Hours = 20.0 / 40%
= 50.0

In this worked example, the Production Schedule contains total task man hours.

To generate a Target Man Hours versus Time S Curve, two sets of calculations are performed.

The first set of calculations are performed for each task in the Production Schedule.

(1) Calculate the duration in days for each task.

Duration = Finish Date – Start Date + 1

(2) Calculate Man Hours per day for each task.

Man Hours per Day = Man Hours / Duration

The required calculations are shown in the following table.

Task Name	Start	Finish	Man Hours	% Complete	Duration [1]	MH per Day [2]
Task No. 1	01-May-2012	02-May-2012	14.0	100%	2	7.0
Task No. 2	01-May-2012	04-May-2012	30.0	20%	4	7.5
Task No. 3	03-May-2012	05-May-2012	36.0	50%	3	12.0
Task No. 4	04-May-2012	06-May-2012	15.0	0%	3	5.0
Totals			**95.0**			

Table 10: Target S Curve Calculation 1 of 2

The second set of calculations are performed for each day in the Production Schedule.

(3) Calculate the total Man Hours per Day for all tasks.
(4) Calculate the Year To Date Total for Man Hours per Day for all tasks.

Task / Date	01-May-2012	02-May-2012	03-May-2012	04-May-2012	05-May-2012	06-May-2012
Task No. 1	7.0	7.0	-	-	-	-
Task No. 2	7.5	7.5	7.5	7.5	-	-
Task No. 3	-	-	12.0	12.0	12.0	-
Task No. 4	-	-	-	5.0	5.0	5.0
Totals per Day [3]	14.5	14.5	19.5	24.5	17.0	5.0
YTD Totals [4]	14.5	29.0	48.5	73.0	90.0	**95.0**

Table 11: Target S Curve Calculation 2 of 2

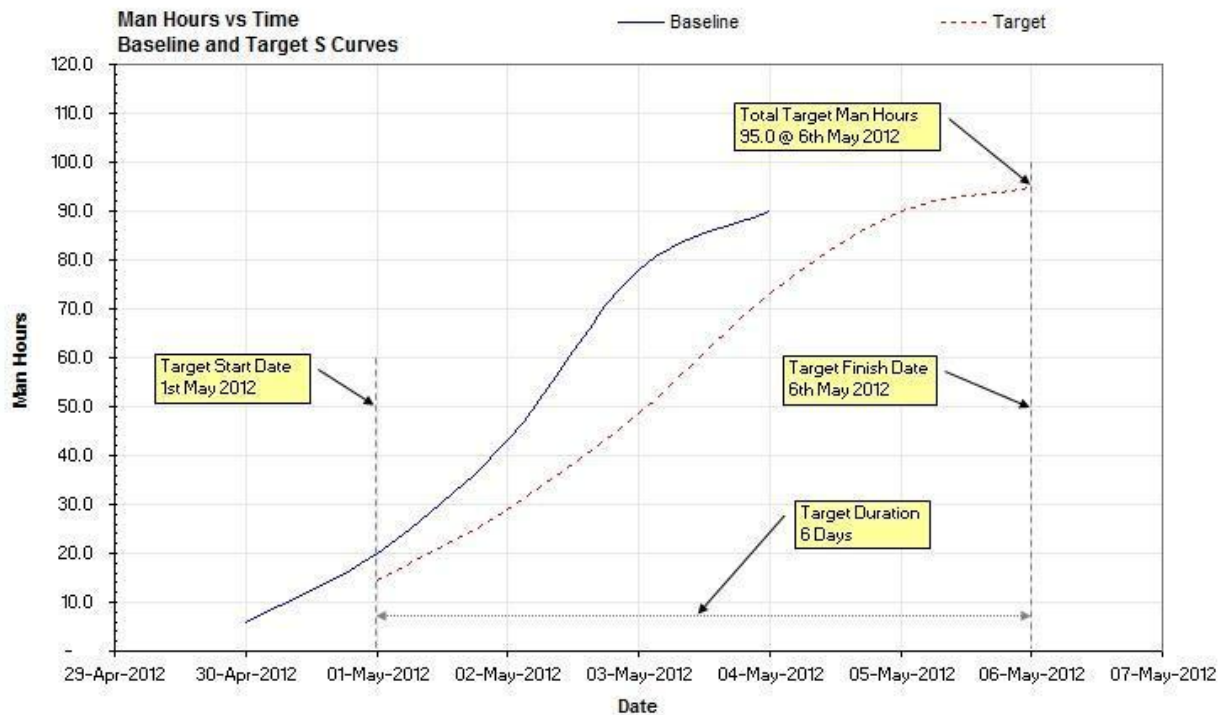The resulting Target Man Hours versus Time S Curve is shown below.

Figure 16: Man Hours versus Time Target S Curve (Showing Baseline S Curve For Comparison)

Please note that the Totals per Day values may be used to generate a Target Man Hours Histogram.

Man Hours versus Time Actual S Curve

To generate an Actual Man Hours versus Time S Curve, two sets of calculations are performed. Before these calculations may be performed, the Cut Off Date needs to be defined. This is the date the project's tasks were last physically inspected to determine their percentage complete status. For this example a Cut Off Date of the 3rd of May, 2012 will be used.

The first set of calculations are performed for each task in the Production Schedule.

(1) Determine the Task Status: **Finished**, **In Progress**, **Not Started**.

- o **Finished**: Tasks that have a Finish Date prior to the Cut Off Date.
- o **In Progress**: Tasks that have started and have a Finish Date on or after the Cut Off Date.
- o **Not Started**: Tasks that have a Start Date after the Cut Off Date.

(2) Calculate the Duration to Date based on the Task Status.

- o **Finished:** *Duration To Date = Finish Date - Start Date + 1*
- o **In Progress:** *Duration To Date = Cut Off Date - Start Date + 1*
- o **Not Started:** *Duration To Date = 0*

(3) Calculate Man Hours to Date for Finished and Ongoing tasks.

Man Hours to Date = (Man Hours x % Complete) / Duration to Date

As discussed above in the Target S Curve calculations, the total task man hours to complete the task are required. If the Production Schedule contains expended task man hours to date, these values will need to be converted to total task man hours before continuing.

In this worked example, the Production Schedule contains total task man hours.

The required calculations are shown in the following table.

Task Name	Start	Finish	Man Hours	% Complete	Status [1]	Duration To Date [2]	MH x % Complete [3] Duration To Date
Task No. 1	01-May-2012	02-May-2012	14.0	100%	Finished	2	7.0
Task No. 2	01-May-2012	04-May-2012	30.0	20%	In Progress	3	2.0
Task No. 3	03-May-2012	05-May-2012	36.0	50%	In Progress	1	18.0
Task No. 4	04-May-2012	06-May-2012	15.0	0%	Not Started	0	0.0
Totals			**95.0**				

Table 12: Actual S Curve Calculation 1 of 2

The second set of calculations are performed for each day in the Production Schedule up to the Cut Off Date.

(4) Calculate the total Man Hours to Date per Day for all tasks.

(5) Calculate the Year To Date Total for Man Hours to Date per Day for all tasks. These

calculations are shown in the following table.

Task / Date	01-May-2012	02-May-2012	03-May-2012
Task No. 1	7.0	7.0	-
Task No. 2	2.0	2.0	2.0
Task No. 3	-	-	18.0
Task No. 4	-	-	-
Totals per Day [4]	9.0	9.0	20.0
YTD Totals [5]	9.0	18.0	38.0

| Cut Off Date	03-May-2012

Table 13: Actual S Curve Calculation 2 of 2

The resulting Actual Man Hours versus Time S Curve is shown below.
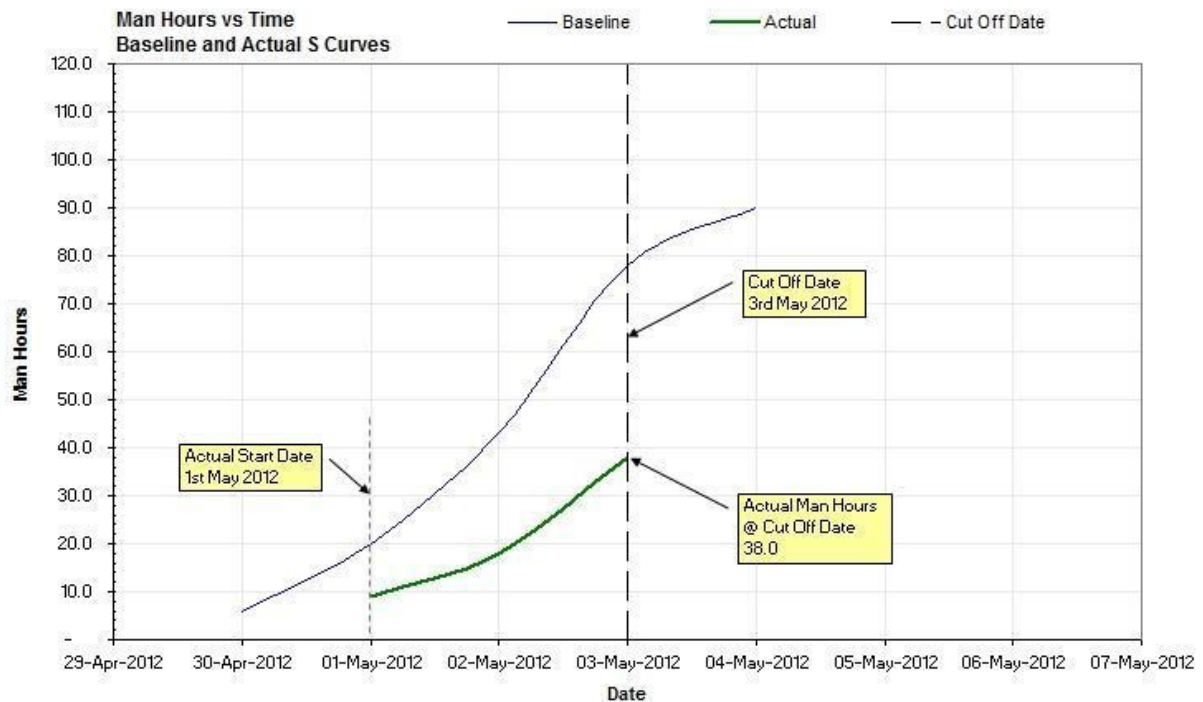
Figure 17: Man Hours versus Time Actual S Curve (Showing Baseline S Curve For Comparison)

Please note that the Totals per Day values may be used to generate an Actual Man Hours Histogram. The Baseline, Actual, and Target S Curves may be combined, as shown below.
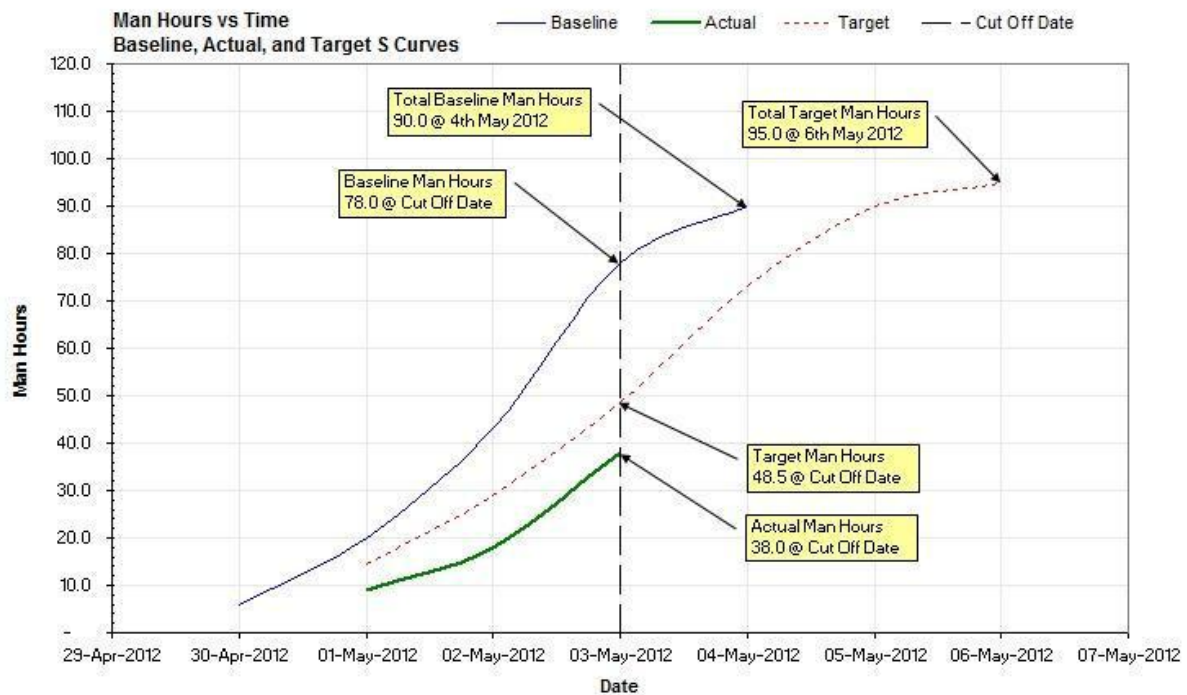
Figure 18: Man Hours versus Time S Curves

Generating Percentage S Curves

Percentage S Curves may be generated by dividing the Year To Date (YTD) daily totals for each day for each S Curve (Baseline, Actual, Target) by either the total Baseline man hours (Baseline = 100%) or Target man hours (Target = 100%).

Generating Percentage S Curves (Baseline = 100%)

To generate percentage S Curves with the Baseline = 100%, divide the Year To Date (YTD) daily totals for each curve by the Baseline total man hours for each day of the project.

Baseline YTD % = Baseline YTD Total / Baseline Total Man Hours x 100%

Actual YTD % = Actual YTD Total / Baseline Total Man Hours x 100%

Target YTD %   = Target YTD Total / Baseline Total Man Hours x 100%

The calculations for each S Curve are shown in the following table.

100% Baseline	30-Apr-2012	01-May-2012	02-May-2012	03-May-2012	04-May-2012	05-May-2012	06-May-2012
Baseline YTD	6.0	20.0	43.0	78.0	90.0		
Baseline YTD %	6.67%	22.22%	47.78%	86.67%	100.00%		
Actual YTD %		9.0	18.0	38.0			
Actual YTD %		10.00%	20.00%	42.22%			
Target YTD %		14.5	29.0	48.5	73.0	90.0	95.0
Target YTD %		16.11%	32.22%	53.89%	81.11%	100.00%	105.56%

Table 14: Calculation of Percentage S Curves, Baseline = 100%

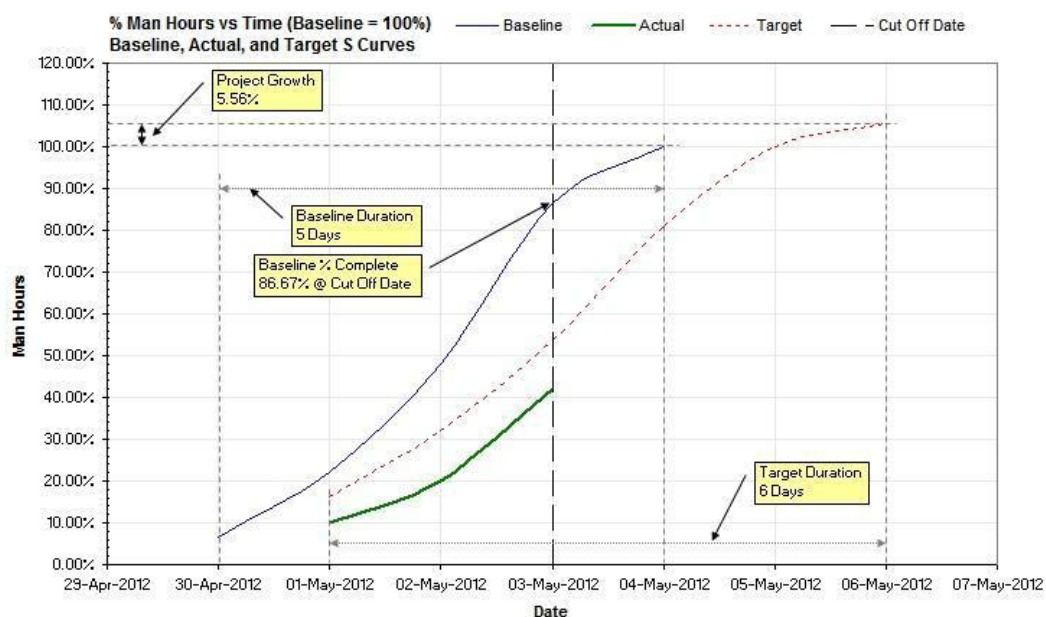The resulting S Curves are shown in the following figure.

Figure 19: Percentage S Curves (Baseline = 100%)

Generating Percentage S Curves (Target = 100%)

To generate percentage S Curves with the Target = 100%, divide the Year To Date (YTD) daily totals for each curve by the Target total man hours for each day of the project.

Baseline YTD % = Baseline YTD Total / Target Total Man Hours x 100% Actual YTD % =

*Actual YTD Total / Target Total Man Hours x 100% Target YTD % = Target YTD Total /*

Target Total Man Hours x 100%

The calculations for each S Curve are shown in the following table.

100% Target	30-Apr-2012	01-May-2012	02-May-2012	03-May-2012	04-May-2012	05-May-2012	06-May-2012
Baseline YTD	6.0	20.0	43.0	78.0	90.0		
Baseline YTD %	6.32%	21.05%	45.26%	82.11%	94.74%		
Actual YTD %		9.0	18.0	38.0			
Actual YTD %		9.47%	18.95%	40.00%			
Target YTD %		14.5	29.0	48.5	73.0	90.0	95.0
Target YTD %		15.26%	30.53%	51.05%	76.84%	94.74%	100.00%

Table 15: Calculation of Percentage S Curves, Target = 100%

The resulting S Curves are shown in the following figure.
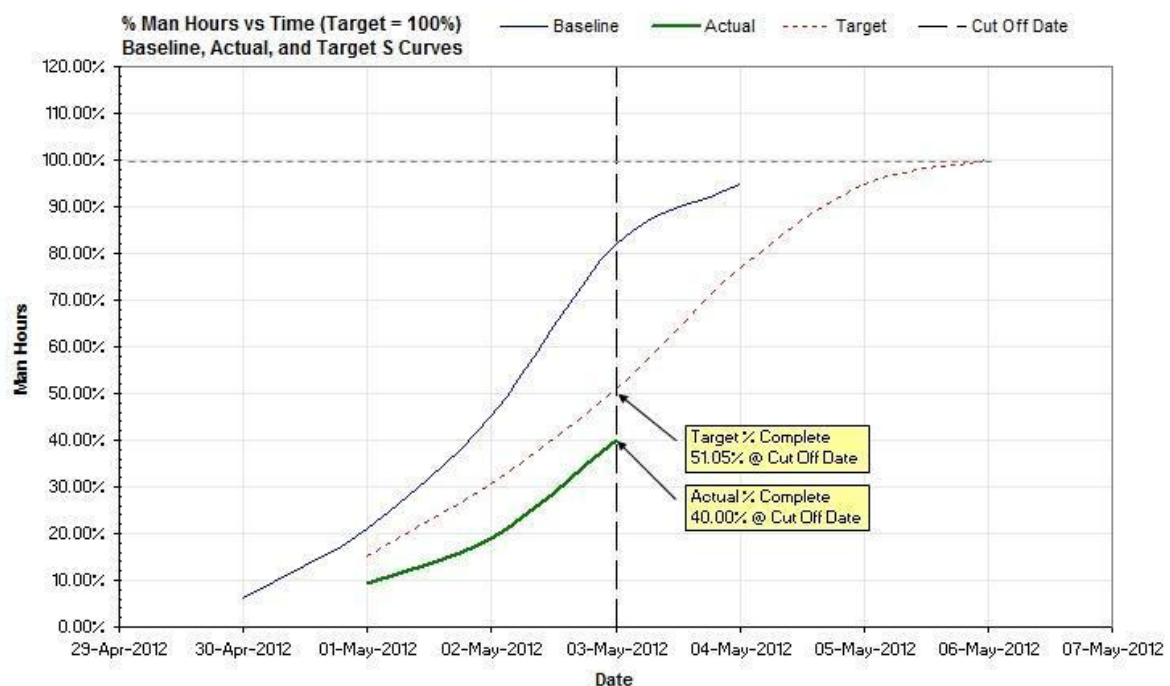
Figure 20: Percentage S Curves (Target = 100%)

S Curve Analysis

Initial analysis of the S Curves generated above reveal the following about the status of the project...

- **The progress of the project is behind target**
  The Actual S Curve sits below the Target S Curve at the Cut Off Date.

- **The project has grown in man hours**
  The Target S Curve finishes above the Baseline S Curve.

- **The project has grown in duration**
  The Target S Curve duration is longer than the Baseline S Curve duration.

- **The project has experienced start slippage, and thus started later than planned**
  The Target S Curve starts to the right of the Baseline S Curve.

- **The project has experienced finish slippage, and thus will finish later than planned**
  The Target S Curve finishes to the right of the Baseline S Curve

Project Progress

According to MS Project, based on the Production Schedule the project is 31% complete. MS Project calculates percentage complete based on durations, and does not take into account man hours and / or costs assigned to each task. Analysis of the Actual and Target S Curve data reveals the project is 40.00% complete as of the Cut Off Date, while the project should be 51.05% complete.

$$\textit{Actual \% Complete} = \textit{Actual YTD Man Hours @ Cut Off Date / Target Man Hours x 100\%}$$
$$= 38.0 / 95.0 \times 100\%$$
$$= 40.00\%$$

$$\textit{Target \% Complete} = \textit{Target YTD Man Hours @ Cut Off Date / Target Man Hours x 100\%}$$
$$= 48.5 / 95.0 \times 100\%$$
$$= 51.05\%$$

Project Growth (Man Hours and / or Costs, Duration)

The project may grow (or contract) in terms of man hours and / or costs, and in duration.

Project Growth (Man Hours)

Analysis of the Baseline and Target S Curve data at project completion reveals the project has grown in scope by 5.0 man hours, or 5.56% as compared to the Baseline Schedule.

$$\textit{Project Growth (Man Hours)} = \textit{Total Target Man Hours – Total Baseline Man Hours}$$
$$= 95.0 – 90.0$$
$$= 5.0$$

$$Project\ \%\ Growth\ (Man\ Hours)\ = ((Target\ Man\ Hours\ /\ Baseline\ Man\ Hours)\ -\ 1)\ x\ 100\%$$
$$= ((95.0\ /\ 90.0)\ -\ 1)\ x\ 100\%$$
$$= 5.56\%$$

Project Growth (Duration)

Growth in the project's duration may be determined by comparing the baseline duration with the target duration.

Analysis of the Baseline and Target S Curve data reveals the project has experience a growth in duration of 1 day, or 20.00% as compared to the Baseline Schedule.

$$Project\ Growth\ (Duration)\ = Target\ Duration\ -\ Baseline\ Duration$$
$$= 6\ days\ –\ 5\ days$$
$$= 1\ day$$

$$Project\ \%\ Growth\ (Duration)\ = ((Target\ Duration\ /\ Baseline\ Duration)\ -\ 1)\ x\ 100\%$$
$$= ((6\ days\ /\ 5\ days)\ -\ 1)\ x\ 100\%$$
$$= 20.00\%$$

Project Slippage

The project may experience start slippage (starting later than planned) and / or finish slippage (finishing later than planned).

Project Start Slippage

Analysis of the Baseline and Target S Curve data reveals the project has a start slippage of 1 day, or 20.00% as compared to the Baseline Schedule.

$$Start\ Slippage\ = Target\ Start\ Date\ –\ Baseline\ Start\ Date$$
$$= 1^{st}\ May\ 2012\ –\ 30^{th}\ April\ 2012$$
$$= 1\ day$$

$$Start\ Slippage\ \%\ = Start\ Slippage\ /\ Baseline\ Duration\ x\ 100\%$$
$$= 1\ day\ /\ 5\ days\ x\ 100\%$$
$$= 20.00\%$$

Project Finish Slippage

Analysis of the Baseline and Target S Curve data reveals the project has a finish slippage of 2 days, or 40.00% as compared to the Baseline Schedule.

$$Finish\ Slippage\ = Target\ Finish\ Date\ -\ Baseline\ Finish\ Date$$
$$= 6^{th}\ May\ 2012\ –\ 4^{th}\ May\ 2012$$
$$= 2\ days$$

$$Finish\ Slippage\ \%\ = Finish\ Slippage\ /\ Baseline\ Duration\ x\ 100\%$$
$$= 2\ days\ /\ 5\ days\ x\ 100\%$$
$$= 40.00\%$$

Project Summary

The project's progress to date (i.e. the Cut Off Date) is behind target compared to both the Production and Baseline Schedules. The Production Schedule may need to be reviewed to ensure tasks have been updated accurately (especially with respect to true percentage complete values), and ongoing and future tasks may require rescheduling.

The project has grown in scope and will finish over budget.

Project growth may be due to a number of factors, including underestimation of effort in the Baseline Schedule, low productivity, rework, variations (approved or not), unexpected weather or other delays, etc. In this example, variations may need to be raised to account for the extra man hours.

The project has grown in duration, started late, and will finish late compared to the Baseline Schedule.

Project duration growth, and start / finish slippage may be due to a number of factors, including unexpected delays, low productivity, rework, variations (approved or not), etc. In this example, a claim for an extension of time and / or excusable delay may need to be raised for the later than planned start and / or completion dates.

In summary a detailed analysis of the project is required to determine why the project will be completed late and over budget as currently scheduled.

## Something For Nothing: Histograms

In the process of generating an S Curve, daily totals are calculated for man hours and / or costs. This data may be used to construct value and percentage man hour and / or cost per day histograms.

Daily Man Hours	30-Apr-2012	01-May-2012	02-May-2012	03-May-2012	04-May-2012	05-May-2012	06-May-2012
Baseline Histogram	6.0	14.0	23.0	35.0	12.0		
Actual Histogram		9.0	9.0	20.0			
Target Histogram		14.5	14.5	19.5	24.5	17.0	5.0

Table 16: Histogram Daily Man Hours Totals

The resulting Man Hours versus Time Histogram is shown below.
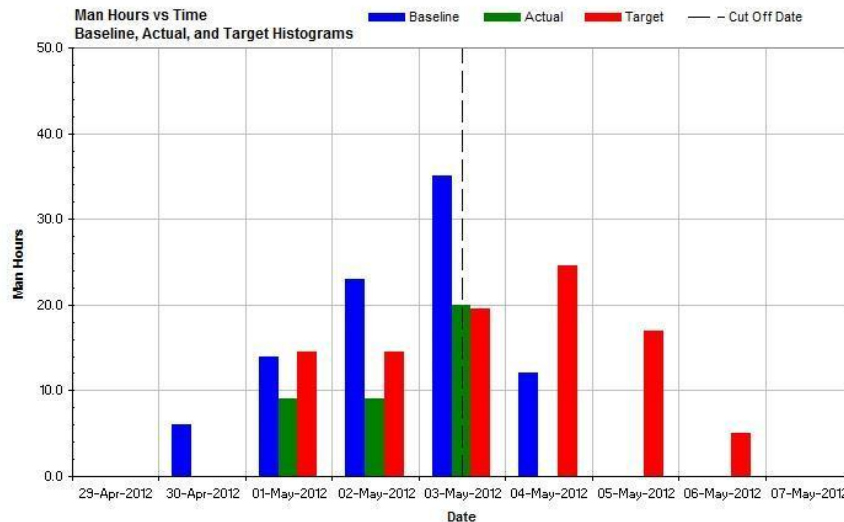
Figure 21: Man Hours per Day Histogram

A Man Hours per Day Histogram may be used to assist in the planning of manning levels on a day by day basis. For example, on the 4th of May 2012 in the example Production Schedule, 24.5 man hours are scheduled to be expended. Assuming each person works an 8 hour shift, 3 people will be required, with one person working 0.5 hours of overtime. This compares to a baseline total of 12 man hours that was planned to be expended on the same day.

Conclusion

The S Curve is an important but often overlooked and misunderstood project management tool. Although a variety of S Curves exist, the most common are Man Hours versus Time and Costs versus Time. By creating a Baseline Schedule, a Baseline S Curve may be generated. Baseline S Curves provide a basis on which to compare a project's actual status to its planned status. They may also assist in the planning of manpower and financial resources required to complete the project. A Production Schedule allows Actual and Target S Curves to be generated. These allow the progress of a project to be monitored, and quickly reveal any divergence from the Baseline Schedule. S Curves may be used to determine project progress to date, growth (duration, man hours and / or costs), and start and / or finish slippage.