"GANTT-LIKE" DSMS

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ABSTRACT
Design Structure Matrices (DSMs) can cater for both "feed-forward" and "feed-back" coupled task dependencies but typically do not include time or critical path information. In contrast, Gantt charts do convey time and critical path information but typically do not cater for feed-back task dependencies.

This paper explores new ways to combine the main benefits of DSMs and Gantt charts.

DSMs can be devised to display (i) more sophisticated task dependencies (ii) time and critical path information. Gantt charts can be devised to better handle feed-back task dependencies. The latter can be achieved by translating those feed-back dependencies into feed-forward dependencies to "inactive" tasks.

Keywords: DSM, Gantt chart

1 INTRODUCTION

Unlike Gantt charts, task-based DSMs traditionally have not included any time aspects but can cater for both "feed-forward" and "feed-back" task dependencies. In contrast, Gantt charts traditionally convey time and critical path information in the context of feed-forward dependencies but do not cater very well for feed-back task dependencies.

This paper explores new ways to combine the main benefits of DSMs and Gantt charts.

2 CURRENT APPROACH

2.1 Time-based DSMs

At the outset, the task-based DSM was not intended to replace critical path scheduling (Steward, 1981) but eventually its potential extension, "to tracking a project as well as planning it", was advocated (Steward, 2007).

In the interim, the idea of "stretching" a DSM horizontally "to obtain a notional Gantt chart" was referred to (Browning, 2001) while more recent DSM approaches have attempted to graphically capture time in the form of (actual versus planned) task durations (Minogue, 2008) and display the potential impact of an unplanned iteration by extracting the time aspect of each DSM task dependency in a more visually powerful way (Minogue, 2009).

2.2 DSM formats

There are two main conventions for capturing and displaying dependencies in sequenced task-based DSMs i.e. one convention where feed-back dependency "marks" are located above the diagonal (i.e. where rows capture "needs" and columns show "feeds") and the other convention where feed-back dependency marks are below the diagonal (i.e where rows indicate "feeds" and columns contain "needs"). This author favours the latter "sub-diagonal feed-back" convention (Browning, 2009) as the resultant DSM and associated dependencies are more Gantt-like.

3 NEW APPROACH

3.1 Task dependencies

When required, Gantt charts can encompass sophisticated task dependencies (e.g. Start-to-Start or SS, Finish-to-Finish or FF, Start-to-Finish or SF) in addition to the most regularly-used Finish-to-Start (FS). Furthermore, time lead and lag can be introduced into the dependency specification (Figure 1a).

By the adoption of "richer", more sophisticated, annotation of the "mark", these features can be incorporated into the DSM also (Figure 1b).

ID	Task Name	Duration	Start	Finish	Predecessors	Notes
1	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
2	Task B	1 day	Thu 04/08/11	Thu 04/08/11	1	Finish-To-Start
3						
4	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
5	Task B	1 day	Tue 02/08/11	Tue 02/08/11	4SS	Start-To-Start
6						
7	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
8	Task B	1 day	Mon 01/08/11	Tue 02/08/11	7SF	Start-To-Finish
9						
10	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
11	Task B	1 day	Wed 03/08/11	Wed 03/08/11	10FF	Finish-To-Finish
12						
13	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
14	Task B	1 day	Wed 03/08/11	Wed 03/08/11	13FS-1 day	Finish-To-Start with One Day Lead
15						
16	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
17	Task B	1 day	Fri 05/08/11	Fri 05/08/11	16FS+1 day	Finish-To-Start with One Day Lag

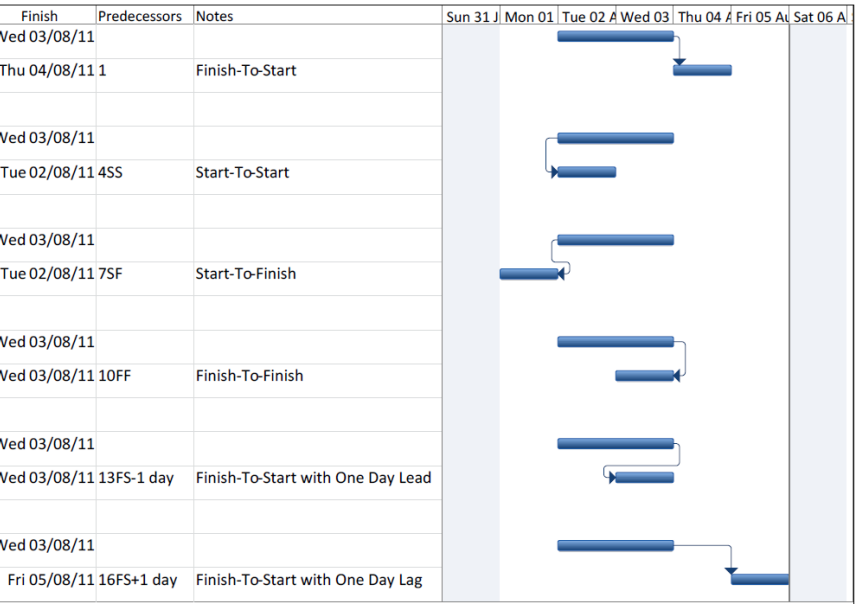

Figure 1a. Using sophisticated task dependencies in Gantt charts

Figure 1b. Handling more sophisticated task dependencies in DSMs

3.2 "Coupled tasks" handling

The main strength of the task-based DSM, versus a Gantt chart, is its ability to deal with and illustrate "feed-back" dependencies.

On the other hand, traditional Gantt charts have struggled to handle such feed-back dependencies. In fact, popular software packages, such as Microsoft Project, do not allow such "circular" task relationships to be directly specified.

However, with the advent of Microsoft Project 2010 Professional and its "active/inactive" task specification capability, it is now at least possible to visualise the latent or potential effect of such a feed-back dependency (Figure 2a).

In the same way, DSMs could also "translate" feed-back task dependencies into "what-if" feed-forward scenarios that would help to illustrate more clearly the potential effect of an iteration loop (Figure 2b).

ID	Notes	Task Name	Duration	Start	Finish	Predecessors
1	Active Task	Task A	5 days	Mon 01/08/11	Fri 05/08/11	3
2	Active Task	Task B	5 days	Mon 08/08/11	Fri 12/08/11	1
3	~~Inactive Task~~	~~Task B'~~	~~0 days~~	~~Mon 15/08/11~~	~~Mon 15/08/11~~	
4	Active Task	Task C	5 days	Mon 15/08/11	Fri 19/08/11	2
5						
6	Active Task	Task A1	5 days	Mon 01/08/11	Fri 05/08/11	
7	Active Task	Task B1	5 days	Mon 08/08/11	Fri 12/08/11	6
8	~~Inactive Task~~	~~Task A2~~	~~5 days~~	~~Mon 15/08/11~~	~~Fri 19/08/11~~	~~7~~
9	~~Inactive Task~~	~~Task B2~~	~~5 days~~	~~Mon 22/08/11~~	~~Fri 26/08/11~~	~~8~~
10	Active Task	Task C	5 days	Mon 15/08/11	Fri 19/08/11	7,9
11						
12	Active Task	Task A1	5 days	Mon 01/08/11	Fri 05/08/11	
13	Active Task	Task B1	5 days	Mon 08/08/11	Fri 12/08/11	12
14	Active Task	Task A2	5 days	Mon 15/08/11	Fri 19/08/11	13
15	Active Task	Task B2	5 days	Mon 22/08/11	Fri 26/08/11	14
16	Active Task	Task C	5 days	Mon 29/08/11	Fri 02/09/11	13,15

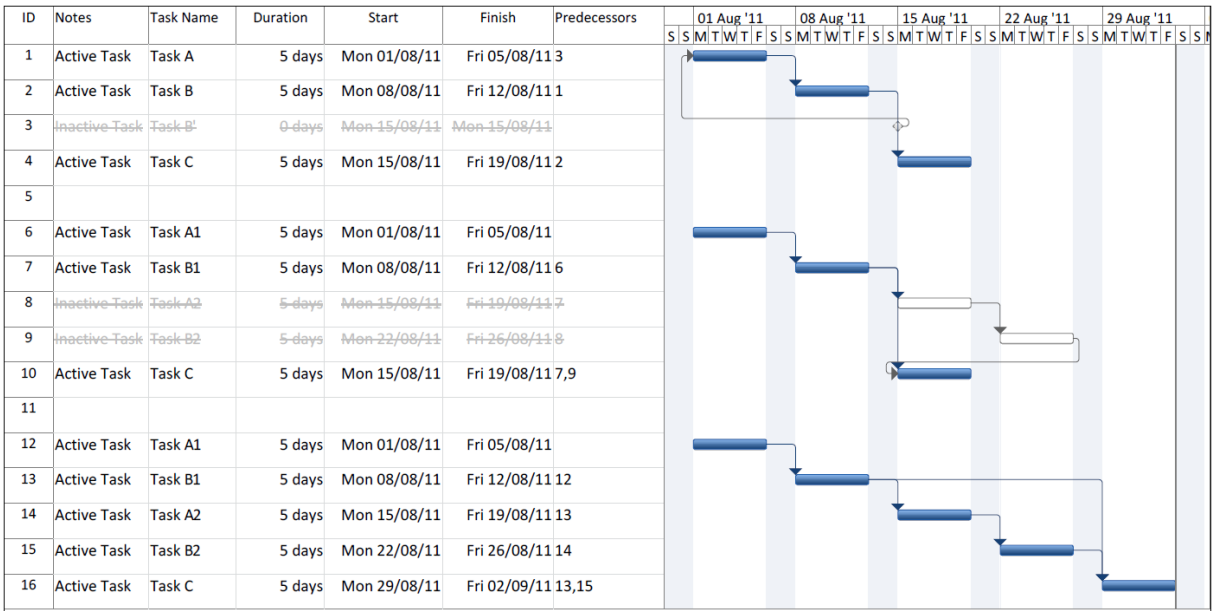

Figure 2a. Handling "feed-back" coupled tasks as active/inactive tasks in Gantt charts

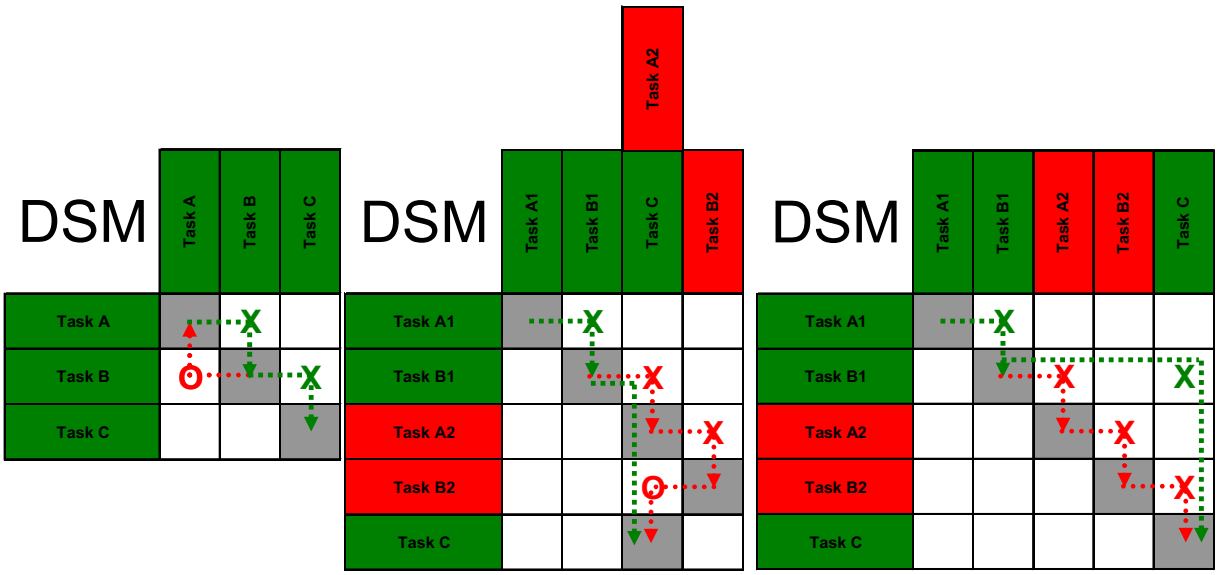

Figure 2b. Translation of "feed-back" coupled tasks into "feed-forward" tasks in DSMs

3.3 "Critical path" highlighting

It is quite usual and normal to use Gantt charts to highlight and display "critical paths" (Figure 3a).

Similarly, DSMs could be used to illustrate the sequence of tasks that form the critical path (Figure 3b).

In this methodology, the critical path tasks and dependencies are highlighted in red, with the finish slack of each task specified along the diagonal.

ID	Critical	Finish Slack	Task Name	Duration	Start	Finish	Predecessors
1	Yes	0 days	Task A	5 days	Mon 01/08/11	Fri 05/08/11	
2	No	2 days	Task B	3 days	Mon 08/08/11	Wed 10/08/11	1
3	Yes	0 days	Task C	5 days	Mon 08/08/11	Fri 12/08/11	1
4	Yes	0 days	Task D	5 days	Mon 15/08/11	Fri 19/08/11	2,3

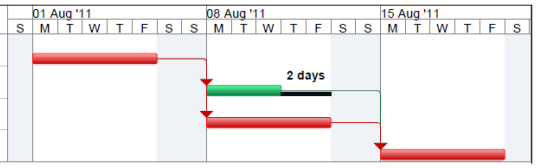

Figure 3a. Displaying the Critical Path in Gantt charts

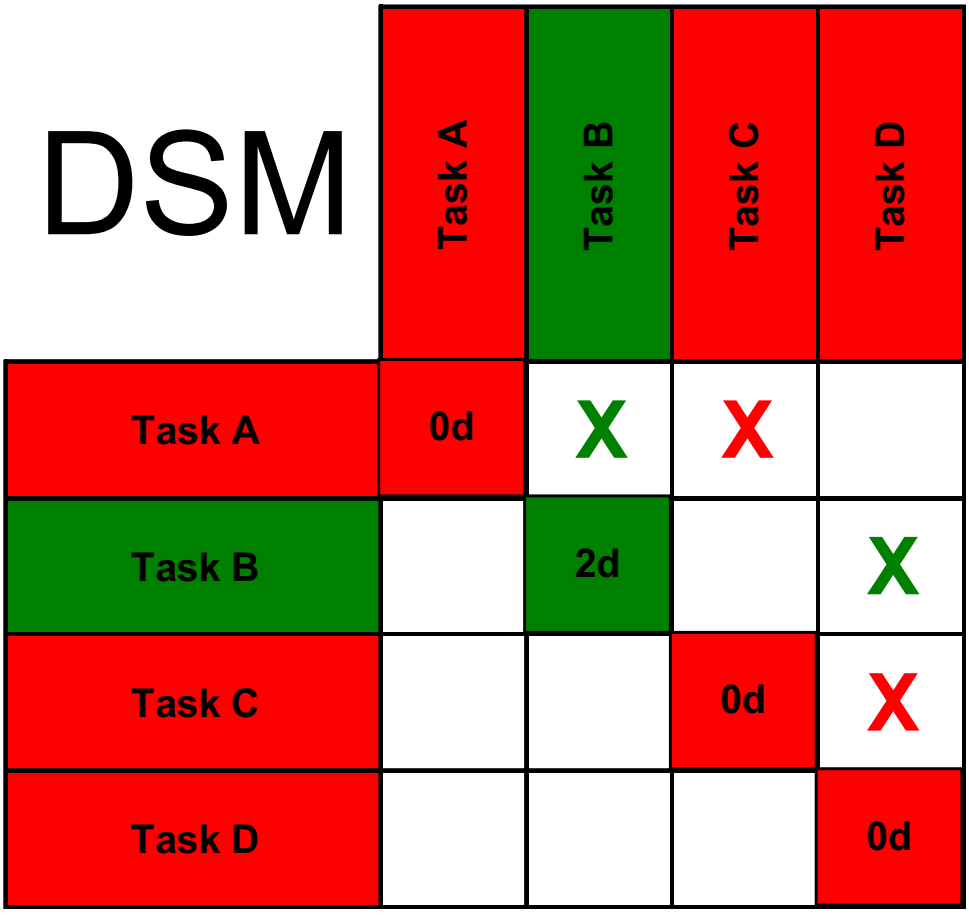

Figure 3b. Highlighting the Critical Path in DSMs

4 SUMMARY/CONCLUSION

Integration of the best features of two powerful "visualisation" tools, task-based DSMs and Gantt charts, is possible, by the introduction of more sophisticated task dependencies, time and critical path into the DSM and the illustration of coupled task dependencies into the Gantt chart by exploiting an "active/inactive" task specification capability (of Microsoft Project 2010 Professional).

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Introduction

- Task-based DSMs traditionally have not included any time aspects but can cater for both feed-forward and feed-back task dependencies
- Gantt charts traditionally convey time and critical path information in the context of feed-forward task dependencies but do not cater very well for feed-back dependencies
- This presentation explores new ways to combine the main benefits of DSMs and Gantt charts

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Current Approaches – Time-based DSMs – Planning

DSM

Task	Time	Task2	Task3	Task1	Task11	Task12	Task10	Task6	Task9	Task5	Task4	Task8	Task7
	Time	0.7	1.1	0.9	1.3	1.2	0.8	0.75	1.5	1.4	1.5	2.1	0.95
Task2	0.7	0											
Task3	1.1	x	0										
Task1	0.9		x	0									
Task11	1.3	x	x		0								
Task12	1.2			x	x	0	x		⊗				
Task10	0.8	x	x		x	x	0						
Task6	0.75	x				x		0	x				
Task9	1.5		x				x	x	0				
Task5	1.4				x			x		0		x	
Task4	1.5					x		x		x	0		
Task8	2.1			x	x				x		x	0	
Task7	0.95	x			x								0

- "Time" i.e. Task Duration is included in task-based DSMs by scaling the relative dimension of the matrix cells accordingly
- In this way, *planned* durations are captured

Reference:
Minogue, P. (2008). Applying Apollo to DSM for Schedule Adherence Visualisation. In *Proceedings of the 10th International Design Structure Matrix Conference,* Stockholm, Swenden, November, 2008 (pp. 131-142) (Munich: Hanser)

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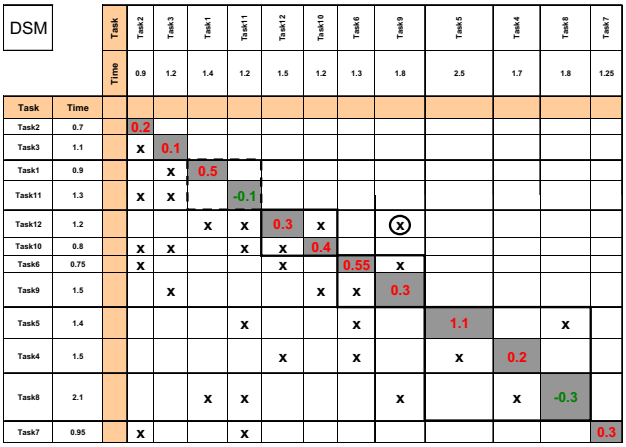
Current Approaches – Time-based DSMs – Tracking



- Planned Task Duration is displayed on the “y-axis” of the DSM, by means of the row height
- Actual Task Duration is displayed on the “x-axis” of the DSM, by means of the column width
- In this way, actual versus *planned* durations are captured
- Slippage can be visualised as drifting or stretching to the right

Reference:
Minogue, P. (2008). Applying Apollo to DSM for Schedule Adherence Visualisation.
In *Proceedings of the 10th International Design Structure Matrix Conference,*
Stockholm, Sweden, November, 2008 (pp. 131-142) (Munich: Hanser)

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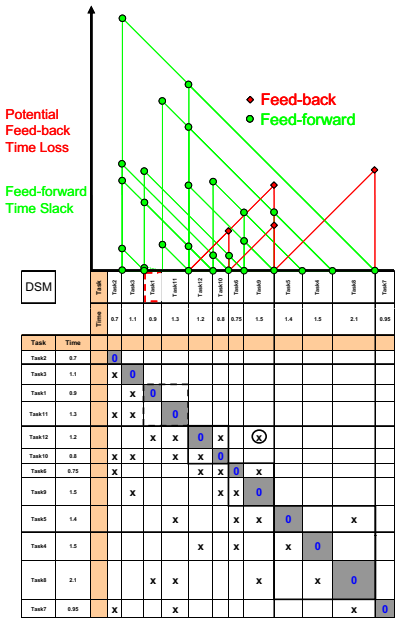
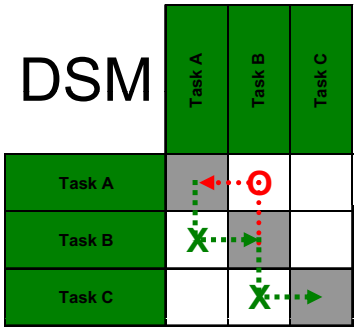
Current Approaches – Time-based DSMs – Dependency Visualisation



- Dependencies, both feed-back and feed-forward, are plotted above the DSM
- Time slack or margin is visualised for feed-forward dependencies
- Potential time loss is visualised for feed-back dependencies

Reference:
Minogue, P. (2009). Enhanced Visualisation of Potential Unplanned Iteration Time in Task-based DSMs.
In *Proceedings of the 11th International Design Structure Matrix Conference,*
Greenville, South Carolina, U.S.A., October, 2009 (pp. 155-166) (Munich: Hanser)

Current Approaches – Feed-back Representation

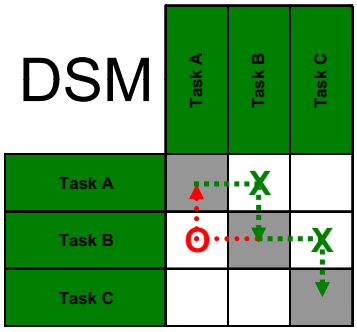


Feed-back
"above Diagonal"

Feed-forward
"below Diagonal"

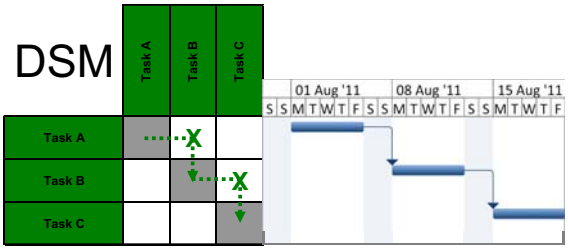
Reference:
Browning, T.R. (2009). The Design Structure Matrix: Introduction and Applications. Tutorial given prior to the *11th International Design Structure Matrix Conference,* Greenville, South Carolina, U.S.A., October 11th, 2009.

- Two equivalent representations or conventions
- Feed-forward "above Diagonal" convention is more "Gantt-like"



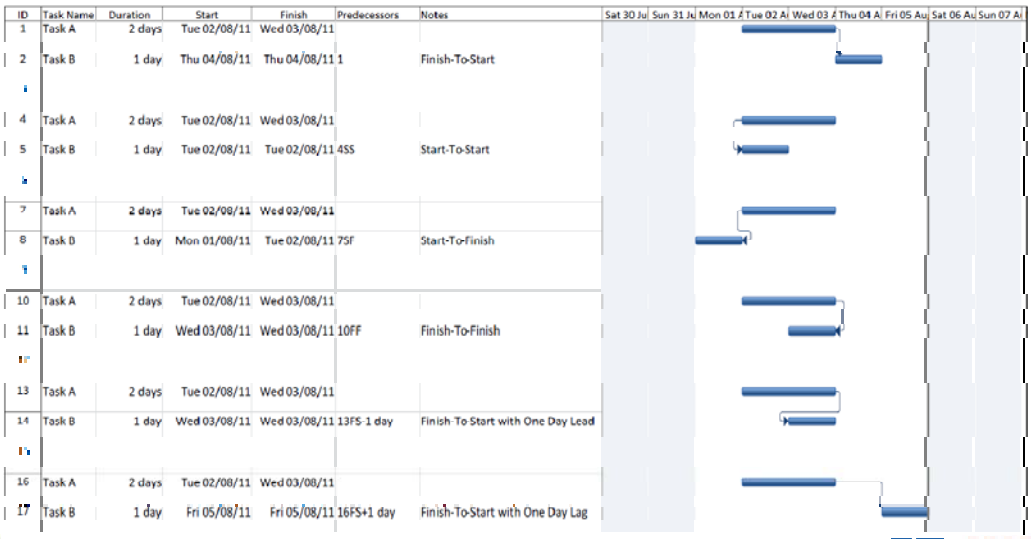
Feed-forward
"above Diagonal"

Feed-back
"below Diagonal"



New Approach – Dependencies – Gantt Chart

- Various types of dependencies can be shown on a Gantt chart
- FS, SS, SF, FF, Lead, Lag



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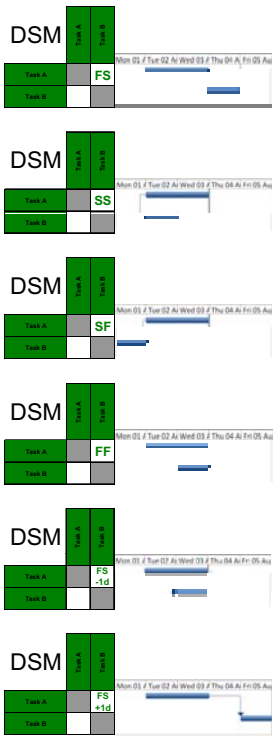
2	Task B	1 day	Thu 04/08/11	Thu 04/08/11	1	Finish-To-Start
4	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
5	Task B	1 day	Tue 02/08/11	Tue 02/08/11	4SS	Start-To-Start
7	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
8	Task B	1 day	Mon 01/08/11	Tue 02/08/11	7SF	Start-To-Finish
10	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
11	Task B	1 day	Wed 03/08/11	Wed 03/08/11	10FF	Finish-To-Finish
13	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
14	Task B	1 day	Wed 03/08/11	Wed 03/08/11	13FS-1 day	Finish-To-Start with One Day Lead
16	Task A	2 days	Tue 02/08/11	Wed 03/08/11		
17	Task B	1 day	Fri 05/08/11	Fri 05/08/11	16FS+1 day	Finish-To-Start with One Day Lag

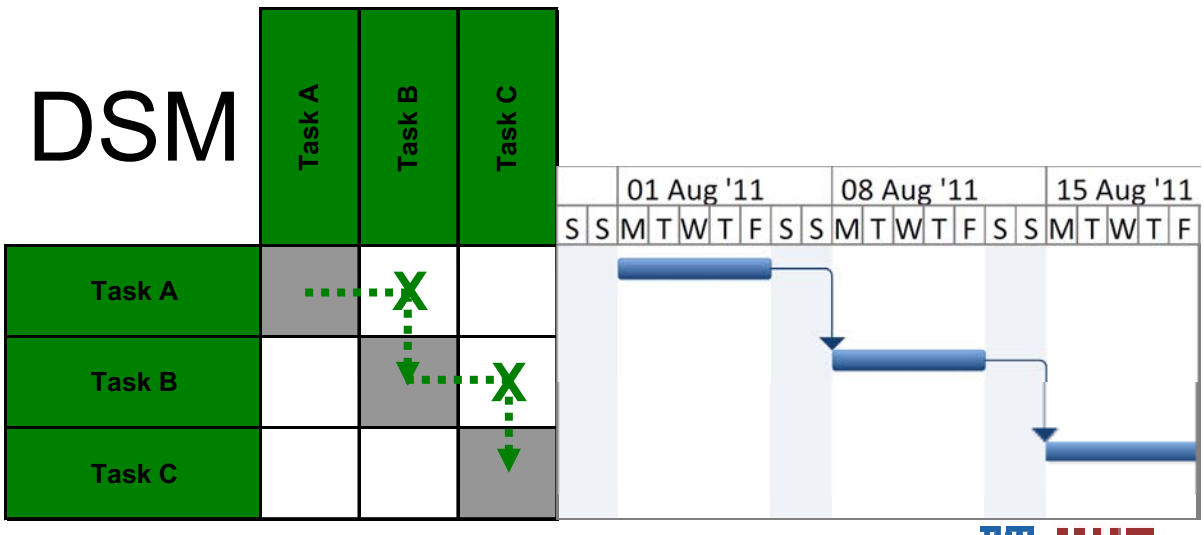
New Approach – Dependencies – DSM & Gantt



- Such task dependencies can be specified on a DSM also, instead of, or in addition to, a simple "mark"

New Approach – Feed-back Representation – DSM & Gantt

- Above-Diagonal Feed-forward-only DSMs are already "Gantt-like" in appearance



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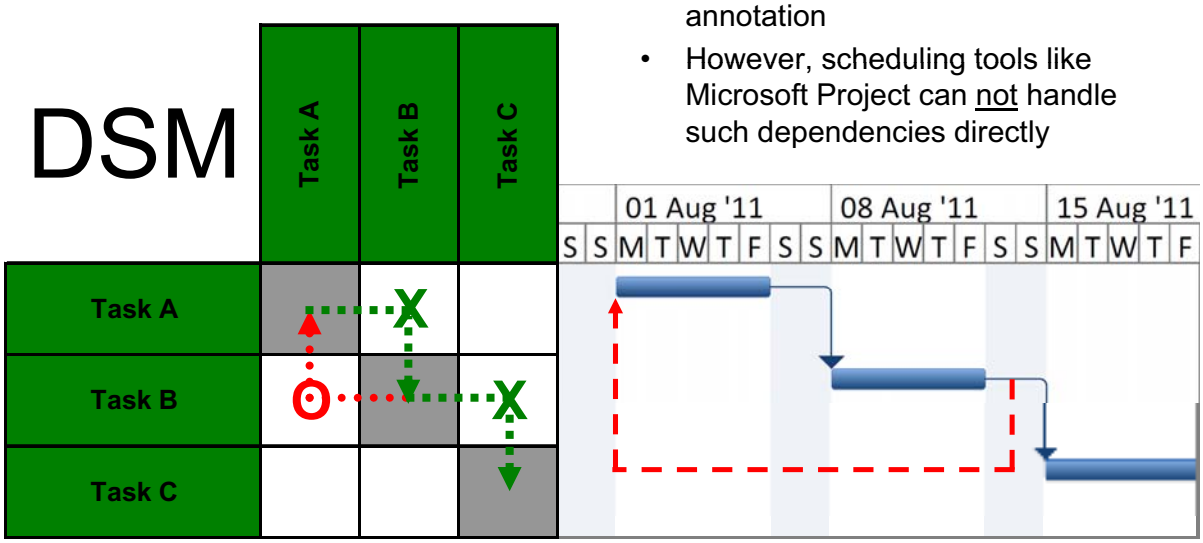
New Approach – Feed-back Representation – DSM & Gantt

- Below-Diagonal Feed-back task dependencies of a DSM can be *illustrated* on a Gantt by explicit annotation
- However, scheduling tools like Microsoft Project can not handle such dependencies directly



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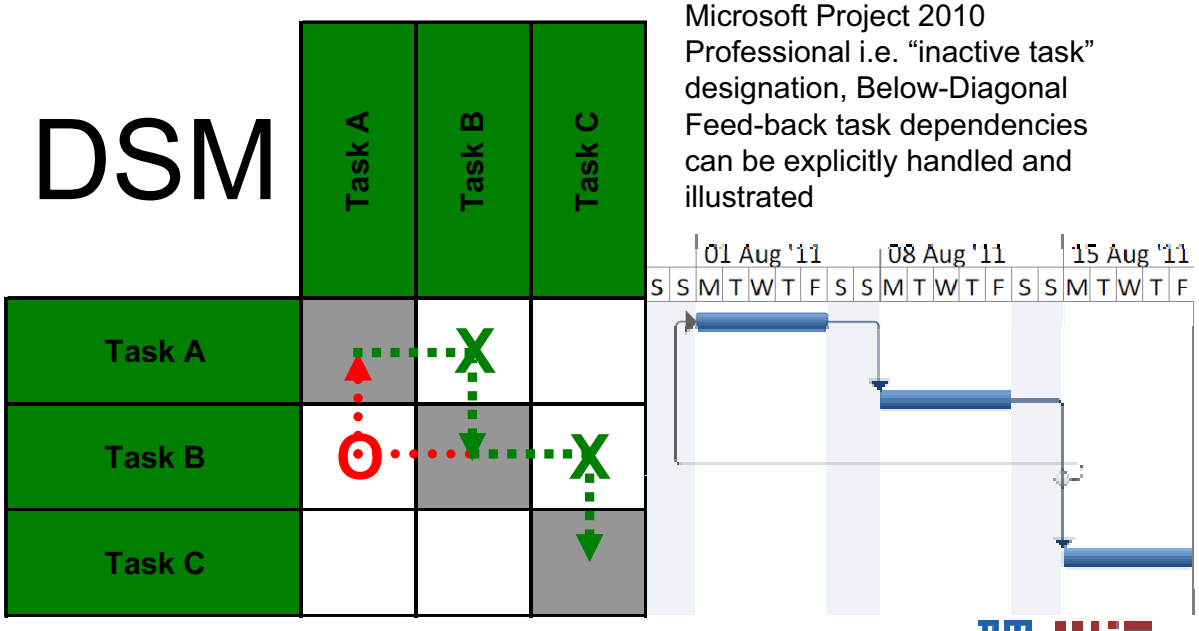
New Approach – Feed-back Representation – DSM & Gantt

- By utilising a new feature of Microsoft Project 2010 Professional i.e. “inactive task” designation, Below-Diagonal Feed-back task dependencies can be explicitly handled and illustrated



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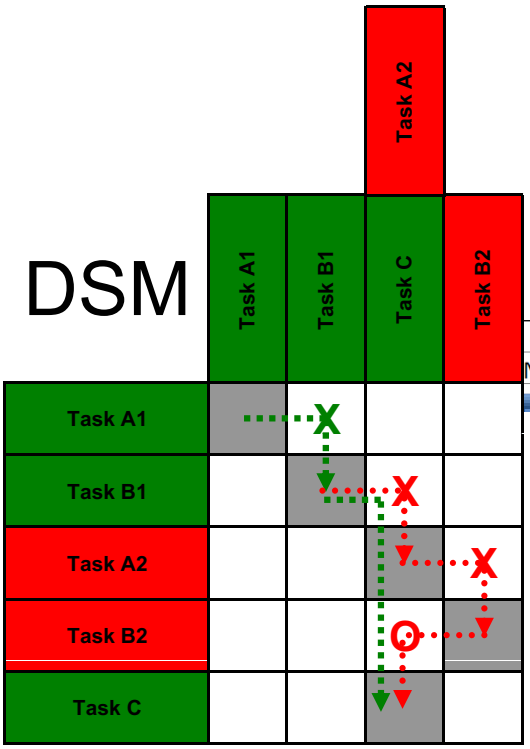
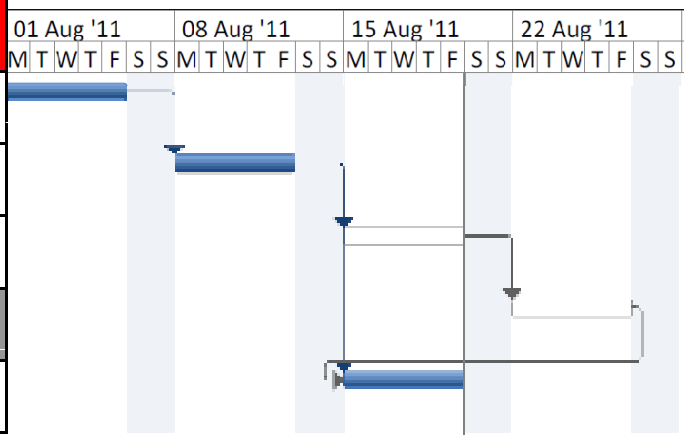
New Approach – Feed-back Representation – DSM & Gantt



- *Potential* schedule delay implications of any Below-Diagonal Feed-back can be illustrated in the (Microsoft) Gantt using the “inactive” task feature
- Similarly, DSMs could be extended to illustrate latent delay



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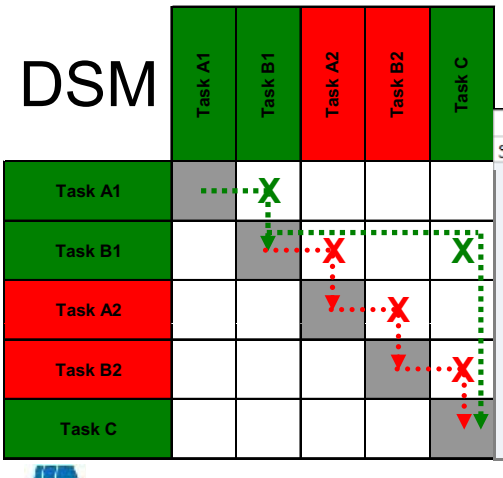
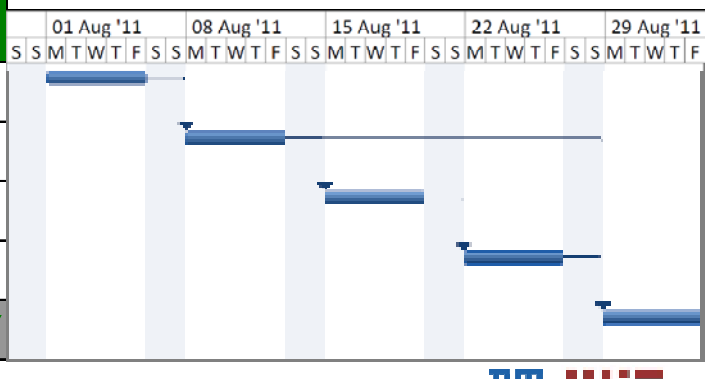
New Approach – Feed-back Representation – DSM & Gantt



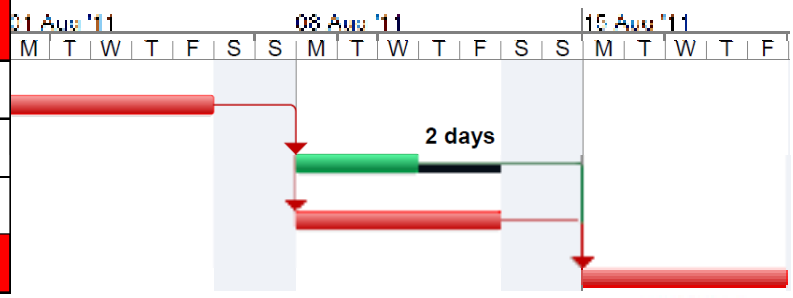
- *Actual* schedule delay due to any Below-Diagonal Feed-back can be shown in the (Microsoft) Gantt by switching tasks from “inactive” to “active”
- Similarly, DSMs could be extended to illustrate actual delay



New Approach – Critical Path Visualisation – DSM & Gantt

- Critical path visualisation is readily achieved in the (Microsoft) Gantt
- Similarly, tasks (and dependencies) on the critical path could be highlighted (in red) in the DSM, with the “finish slack” time of each task annotated along the diagonal

DSM	Task A	Task B	Task C	Task D
Task A	0d	X	X	
Task B		2d		X
Task C			0d	X
Task D				0d



Summary

- Task-based DSMs traditionally have not included any time aspects but can cater for both feed-forward and feed-back task dependencies
- Gantt charts traditionally convey time and critical path information in the context of feed-forward task dependencies but do not cater very well for feed-back dependencies

- Gantt charts can be devised to better handle feed-back dependencies
  - By utilising the new (Microsoft Project 2010 Professional) feature of “inactive” task designation and
  - By translating those feed-back task dependencies into feed-forward dependencies to “inactive” tasks

- “Gantt-Like” DSMs can be devised to display
  - More sophisticated task dependencies
  - Time and critical path information
  - Both latent and actual delay (due to feed-back task dependencies)

- Thus, integration of the best features of two powerful “visualisation” tools, task-based DSMs and the Gantt chart, is possible