“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).

<table>
<thead>
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<th>ID</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
<th>Notes</th>
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<td>Tue 02/08/11</td>
<td>Wed 03/08/11</td>
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<tr>
<td>2</td>
<td>Task B</td>
<td>1 day</td>
<td>Thu 04/08/11</td>
<td>Thu 04/08/11</td>
<td>Finish-To-Start</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Tue 02/08/11</td>
<td>Wed 03/08/11</td>
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<td>5</td>
<td>Task B</td>
<td>1 day</td>
<td>Tue 02/08/11</td>
<td>Tue 02/08/11</td>
<td>Start-To-Finish</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Tue 02/08/11</td>
<td>Wed 03/08/11</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Task B</td>
<td>1 day</td>
<td>Mon 01/08/11</td>
<td>Tue 02/08/11</td>
<td>Start-To-Finish</td>
</tr>
<tr>
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</tr>
<tr>
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<td>Tue 02/08/11</td>
<td>Wed 03/08/11</td>
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<td>11</td>
<td>Task B</td>
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<td>Wed 03/08/11</td>
<td>Wed 03/08/11</td>
<td>Finish-To-Finish</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>2 days</td>
<td>Tue 02/08/11</td>
<td>Wed 03/08/11</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Task B</td>
<td>1 day</td>
<td>Wed 03/08/11</td>
<td>Wed 03/08/11</td>
<td>Finish-To-Start with One Day Lead</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Task A</td>
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<td>Tue 02/08/11</td>
<td>Wed 03/08/11</td>
<td></td>
</tr>
<tr>
<td>17</td>
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<td>1 day</td>
<td>Fri 05/08/11</td>
<td>Fri 05/08/11</td>
<td>Finish-To-Start with One Day Lag</td>
</tr>
</tbody>
</table>

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).

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**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.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
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<td>Yes</td>
<td>3 days</td>
<td>Task A</td>
<td>5 days</td>
<td>Mon 31/08/11</td>
<td>Fri 05/09/11</td>
<td></td>
<td>2 days</td>
<td>2 days</td>
<td>2 days</td>
</tr>
<tr>
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<td>No</td>
<td>3 days</td>
<td>Task B</td>
<td>5 days</td>
<td>Wed 10/09/11</td>
<td>Sat 14/09/11</td>
<td></td>
<td>3 days</td>
<td>3 days</td>
<td>3 days</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>3 days</td>
<td>Task C</td>
<td>5 days</td>
<td>Fri 05/09/11</td>
<td>Fri 12/09/11</td>
<td></td>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>3 days</td>
<td>Task D</td>
<td>5 days</td>
<td>Fri 12/09/11</td>
<td>Fri 19/09/11</td>
<td></td>
<td>5 days</td>
<td>5 days</td>
<td>5 days</td>
</tr>
</tbody>
</table>

**Figure 3a. Displaying the Critical Path in Gantt charts**

![Gantt Chart](image)

**Figure 3b. Highlighting the Critical Path in DSMs**

![DSM](image)

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).
REFERENCES


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“Gantt-Like” DSMs

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Index

• Introduction
• Current Approaches
  – Time-based DSMs
    • Planning
    • Tracking
    • Dependency Visualisation
  – Feed-back Representation
    • Above-Diagonal & Below-Diagonal Feed-back
• New Approach
  – Dependencies – Gantt Chart & DSM
  – Feed-back Representation – Gantt Chart & DSM
  – Critical Path Visualisation – Gantt Chart & DSM
• Summary
**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 feedback dependencies.

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

**Current Approaches – Time-based DSMs – Planning**

- “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:
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

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:

Reference:
INVEST ON VISUALIZATION

Current Approaches – Feed-back Representation

Reference:

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

New Approach – Dependencies – Gantt Chart

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

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.
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.

**In-Process DSM & Gantt**

- Task A1
- Task B1
- Task A2
- Task B2
- Task C

![Gantt Chart for DSM and Gantt](image)

**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.

**In-Process DSM & Gantt**

- Task A1
- Task B1
- Task A2
- Task B2
- Task C

![Gantt Chart for DSM and Gantt](image)
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

**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