ANALYSING PLAN CONTENT USING A MATRIX-BASED APPROACH

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1 INTRODUCTION

In this paper, we argue that aggregating highly-referenced plan content into a common planning document will minimise the inefficiencies of creating and using multiple plans. We further argue that doing so will enhance the overall planning system used to manage complex design projects. Our hypothesis will be tested using the results found from an industry case study conducted at a multi-national advanced scientific instrument manufacturing company referred to as Company X for this paper. Company X has implemented such a planning system. We will first determine what content should be included in the Master Project Plan. We will then compare this result to the content that is actually included in the Master Project Plan in use at Company X. The case study confirmed that the planning content referenced for a typical design project was extensive and somewhat varied amongst engineering personnel. Fourteen engineering employees, each with specific responsibilities supporting multiple design projects, from the R&D functional area were interviewed. Such a distribution of multi-project responsibilities is quite typical in work environments such as that of Company X. Turner and Speiser suggest that a vast majority of projects take place within programs of related small – to – medium sized projects (Turner and Speiser 1992). During the interviews, each respondent was asked to take an on-line planning survey (www.designplanningsurvey.com) and also encouraged to discuss the reasoning behind their answers. Each interview was recorded. As part of the survey, respondents were asked; "What is the content of the plans you use?" The plan content items were selected from a list provided in the survey, however, respondents were also able to write in others that were not listed. Figure 1 demonstrates the percentage of respondents that referenced each plan content item from the planning documents they use when carrying out their daily responsibilities.

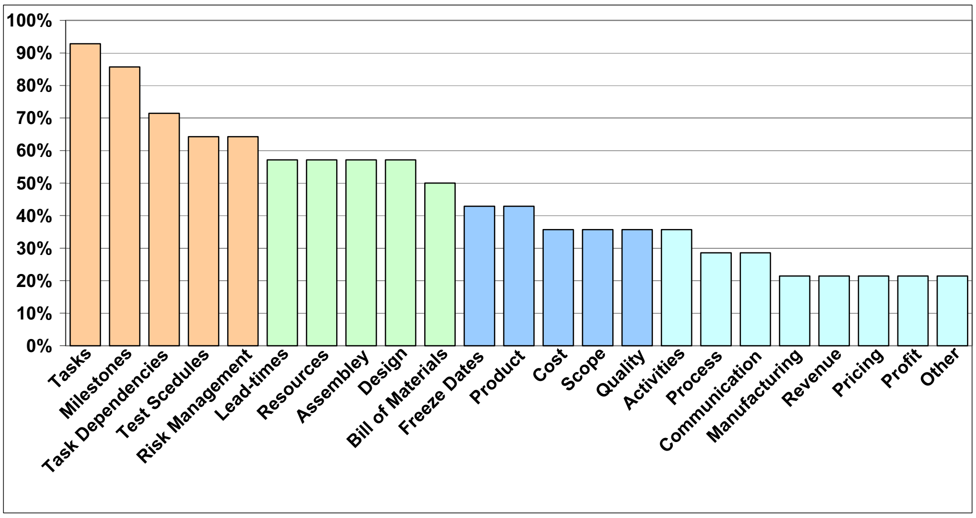

Figure 1. Referenced plan content

Though answers varied amongst interviewees the results identify the content items that were viewed most important across all respondents. This is demonstrated by the content items that were cited by over 50% of interviewees. Although not shown in Figure 1, the majority of interviewees used multiple plans to access the content they required. This is common in industry, according to earlier work in which De Lessio et al. found that over 90% of respondents to the same survey conducted across eleven organisations used multiple planning documents for a typical design project (De Lessio et al. 2009). Eckert and Clarkson reported similar findings, from a series of industrial case studies in a further four companies. They stated that many plans were used in these companies and that these were often departmentalised or even individualised (Eckert and Clarkson 2003).

Several authors have suggested that this fragmentation of plans may have significant impact upon project efficiency. For instance, Browning argues that a current issue in many companies is the use of non-integrated representations of how work gets done being maintained by various users (Browning 2002). Company X has begun to address this issue by implementing a planning system that utilises one Master Project Plan.

The graphical representation of the results shown above clearly identifies what plan content is important to the respondents. While the graph indicates the percentage of employees that are interested in a particular content item it does not indicate how many of the employees have a common interest in the same content item. A project planner could simply consider including content based on the order of importance as the colour code suggests. However, a more detailed analysis could affect what content is actually included. This paper proposes a method factoring in this commonality element by using a Dependency Structure Matrix (DSM) modelling technique. Doing so will identify what content items have the most common interest amongst members of the same workgroup and therefore, should be considered for inclusion in the same planning document.

2 MAXIMISING A DESIGN PLANS EFFICIENCY

Browning writes that products, processes and organisations are each a kind of "complex system" and further suggests that the classic approach to understanding complex systems is to model them [Browning 2001]. De Lessio et al. described planning as a complex system and used DSM modelling to analyse the content relationships amongst multiple plans used for the same project [De Lessio et al. 2010]. This concept is extended in this paper by showing how DSM modelling can be used to determine what content should be considered for inclusion in the same planning document. Based on the survey results of the fourteen individuals interviewed, Figure 2 shows the Plan-DSM model created to determine what content items should be included in the same planning document. The method used to construct the matrix is described below.

	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7	Respondent 8	Respondent 9	Respondent 10	Respondent 11	Respondent 12	Respondent 13	Respondent 14
Respondent 1														
Respondent 2														
Respondent 3														
Respondent 4														
Respondent 5														
Respondent 6														
Respondent 7														
Respondent 8														
Respondent 9														
Respondent 10														
Respondent 11														
Respondent 12														
Respondent 13														
Respondent 14														
Tasks	1	1	1	1	1	1		1	1	1	1	1	1	1
Mile-stones	1	1	1		1	1	1	1		1	1	1	1	1
Task Dependencies	1	1	1	1	1	1		1			1	1	1	1
Test schedules	1	1	1	1	1	1						1	1	1
Risk Management	1	1	1	1	1						1	1	1	1
Lead-times		1	1		1	1		1		1			1	1
Resources	1	1	1		1		1					1	1	1
Assembly	1	1			1		1	1		1		1		1
Design	1	1	1		1		1			1		1		1
Bill of Materials	1	1			1			1		1		1		1
Freeze dates		1	1		1		1			1				1
Product		1	1			1	1					1		1
Cost	1	1	1										1	1
Scope	1	1				1		1		1				
Quality	1				1	1	1				1			
Activities	1				1			1				1		1
Process	1	1					1							1
Communication		1		1								1		1
Manufacturing	1				1									1
Revenue	1	1								1				
Pricing	1	1										1		
Profit	1	1										1		
Specifications								1						
Personal Items									1					
Trend Analysis												1		

	Tasks	Milestones	Task Dependencies	Test Schedules	Risk Management	Lead-times	Resources	Assembly	Design	Bill of Materials	Freeze dates	Product	Cost	Scope	Quality	Activities	Process	Communication	Manufaturing	Revenue	Pricing	Profit	Specifications	Personal Items	Trend Analysis
Respondent 1	1	1	1	1	1		1	1	1	1			1	1	1	1	1		1	1	1	1			
Respondent 2	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1		1	1	1			
Respondent 3	1	1	1	1	1	1	1		1		1	1	1												
Respondent 4	1		1	1	1													1							
Respondent 5	1	1	1	1	1	1	1	1	1	1	1				1	1			1						
Respondent 6	1	1	1	1		1						1		1	1										
Respondent 7		1					1	1	1		1	1			1	1									
Respondent 8	1	1	1			1		1		1				1		1							1		
Respondent 9	1																							1	
Respondent 10	1	1				1		1	1	1	1			1						1					
Respondent 11	1	1	1		1										1										
Respondent 12	1	1	1	1	1		1	1	1	1		1				1		1			1	1			1
Respondent 13	1	1	1	1	1	1	1						1												
Respondent 14	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1						
Tasks		11	11	9	9	8	7	7	7	7	5	5	5	5	4	5	3	4	3	3	3	3	1	1	1
Mile-stones	11		10	8	8	8	8	8	8	7	6	6	5	5	5	5	3	3	3	3	3	3	1	0	1
Task Dependencies	11	10		9	9	7	7	6	6	6	4	5	5	4	4	5	3	4	3	2	3	3	1	0	1
Test schedules	9	8	9		8	6	7	5	6	5	4	5	5	3	3	4	3	4	3	2	3	3	0	0	1
Risk Management	9	8	9	8		5	7	5	6	5	4	4	5	2	3	4	3	4	3	2	3	3	0	0	1
Lead-times	8	8	7	6	5		5	5	5	5	5	4	4	4	2	3	2	2	2	2	1	1	1	0	0
Resources	7	8	7	7	7	5		6	7	5	5	5	5	2	3	4	4	3	3	2	3	3	0	0	1
Assembly	7	8	6	5	5	5	6		7	7	5	4	3	4	3	5	4	3	3	3	3	3	1	0	1
Design	7	8	6	6	6	5	7	7		6	6	5	4	3	3	4	4	3	3	3	3	3	0	0	1
Bill of Materials	7	7	6	5	5	5	5	7	6		4	3	3	4	2	5	3	3	3	3	3	3	1	0	1
Freeze dates	5	6	4	4	4	5	5	5	6	4		4	3	2	2	2	2	2	2	2	1	1	0	0	0
Product	5	6	5	5	4	4	5	4	5	3	4		3	2	2	3	2	3	1	1	2	2	0	0	1
Cost	5	5	5	5	5	4	5	3	4	3	3	3		2	1	2	3	2	2	2	2	2	0	0	0
Scope	5	5	4	3	2	4	2	4	3	4	2	2	2		2	2	2	1	1	3	2	2	1	0	0
Quality	4	5	4	3	3	2	3	3	3	2	2	2	1	2		2	1	0	2	1	1	1	0	0	0
Activities	5	5	5	4	4	3	4	5	4	5	2	3	2	2	2		2	2	3	1	2	2	1	0	1
Process	3	3	3	3	3	2	4	4	4	3	2	2	3	2	1	2		2	2	2	2	2	0	0	0
Communication	4	3	4	4	4	2	3	3	3	3	2	3	2	1	0	2	2		1	1	2	2	0	0	1
Manufacturing	3	3	3	3	3	2	3	3	3	3	2	1	2	1	2	3	2	1		1	1	1	0	0	0
Revenue	3	3	2	2	2	2	2	3	3	3	2	1	2	3	1	1	2	1	1		2	2	0	0	0
Pricing	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2		3	0	0	1
Profit	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2	3		0	0	1
Specifications	1	1	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0		0	0
Personal Items	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Trend Analysis	1	1	1	1	1	0	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	0	0	

Figure 2. Desired plan content model – Modelling desired plan content

In the model, the results of each respondent's answer to the question "What plan content do you use" are visualised and compared. Each content item was then compared to every other content item to determine how many of the respondents have listed both as a desired content item. The content items were considered in order of suggested importance. The resulting commonality value was then plotted in the matrix. The logic proposed is that content items with the highest commonality amongst respondents should be considered for inclusion in the same project planning document. It is suggested that the items highlighted, with a commonality rating of nine or higher with at least one of the other content items in that category, should clearly be included in the same planning document if possible. For Company X tasks and task dependencies have a very high commonality with each other, as well as with, milestones, test schedules and risk management. The latter three do not have as high a commonality with each other but it is still above average (50% or higher) and therefore should still be considered for inclusion in the same plan. As all are quite typically referenced during design projects, this is not a surprising finding. With above average instances of commonality amongst interviewees, it is suggested that the content items highlighted with ratings of seven or eight should also be strongly considered for inclusion. Lead-times, resources, bill of materials, assembly and design all have above average commonality with at least one other content item. However, closer inspection indicates that only resources has above average commonality with all five of the content items already suggested for inclusion, as well as, one of the content items in its peer group. Lead-time has commonality with three in the original group. The other three have commonality with two in the original group and either one or two in their peer group. While it makes sense that resources should likely be included in the same project plan, caution should be taken to consider the tradeoffs of including each of the other four. Many of these content items clearly have compatibilities with those already suggested for inclusion but there is a real risk in creating a planning document that is unwieldy and difficult to maintain. The same argument holds true for those content items with ratings of five and six. There may be instances where a specific content item in this category should be included, particularly if it has commonality ratings of five or six with many of the content items already included.

To summarise, the objective of this analysis was to produce a planning document that satisfies the requirements of a majority of its users. Adding content that is specialised to a few personnel is likely to undermine this effort by adding unnecessary complexity. In addition, by including the optimum amount of plan content in the same well maintained planning document the instances of additional overlapping plans being produced is likely to be reduced, thus minimising the inefficiencies that often arise in a multi-plan environment.

Although this assessment may seem logical and straightforward, we argue that the outcome of such a modelling activity would be unique to a project, product being produced and the industry sector thus warranting such an exercise. We propose that additional work needs to be done to determine if such an aggregate plan would be effective, what it would look like and whether specialised tools would be needed to support it. To further explore this, we have applied the same modelling technique to the planning system used in Company X.

Wheelwright and Clark state that in order to minimise development malaise and reinvigorate the process companies should put together an aggregate project plan [Wheelwright and Clark 1992]. To this effort and as stated above, Company X has established a uniform planning system for all design projects in progress using a single MS Project / Excel based Master Project Plan which is updated on a weekly basis. From the Master Project Plan, individual work packages are determined and distributed to each individual engineer at the beginning of each week. If the engineer has to make changes to the work packages received they are charged with bringing it to the attention of the project leader for resolution. The following section uses the same modelling technique discussed previously to assess the effectiveness of the current planning system based on the feedback of the individual employees.

3 MEASURING PLAN EFFECTIVENESS

Figure 3 shows the content items desired plotted on the left against the content items the interviews indicated are included in the Master Project Plan on the right. The graph demonstrates the discrepancies between the two. These results can be verified and shown in greater detail by using a DSM model similar to that used above.

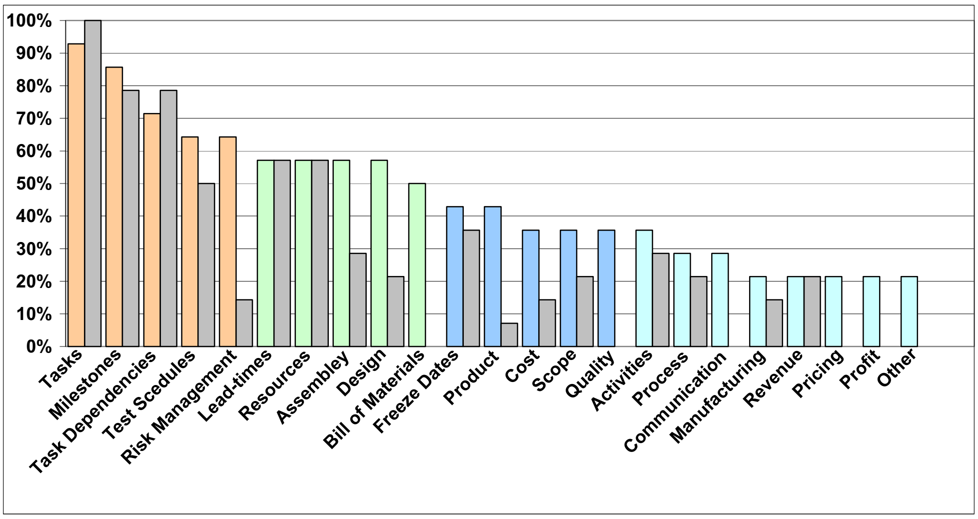

Figure 3. Actual plan content referenced in master project plan

Figure 4 shows a plan-DSM constructed for the current planning system being utilised at Company X. In this model, the content items that each engineer stated they reference in the Master Project Plan were plotted. Commonalities between respondents were then measured and placed in the matrix while maintaining the highlighted blocks from the previous model. The values in each cell of this matrix were then subtracted from the values in corresponding cells of Figure 2.

	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7	Respondent 8	Respondent 9	Respondent 10	Respondent 11	Respondent 12	Respondent 13	Respondent 14	Tasks	Milestones	Task Dependencies	Test Schedules	Risk Management	Lead-times	Resources	Assembly	Design	Bill of Materials	Freeze dates	Product	Cost	Scope	Quality	Activities	Process	Communication	Manufaturing	Revenue	Pricing	Profit	Specifications	Personal Items	Trend Analysis
Respondent 1															1	1	1	1	1		1	1					1	1		1	1		1						
Respondent 2															1	1	1	1		1	1	1	1		1						1	1							
Respondent 3															1	1	1	1		1	1				1														
Respondent 4															1		1	1														1							
Respondent 5															1	1	1			1	1	1			1					1			1						
Respondent 6															1	1	1			1																			
Respondent 7															1						1		1																
Respondent 8															1	1	1			1								1											
Respondent 9															1																								
Respondent 10															1	1				1					1														
Respondent 11															1	1	1																						
Respondent 12															1	1	1	1	1		1									1									
Respondent 13															1	1	1	1		1	1							1											
Respondent 14															1	1	1	1		1	1	1	1		1	1	1				1		1						
Tasks	1	1	1	1	1	1	1	1	1	1	1	1	1	1		0	0	2	7	0	-1	3	4	7	0	4	3	2	4	2	0	2	0	3	3	3	1	1	1
Milestones	1	1	1		1	1		1		1	1	1	1	1	0		0	2	6	0	1	4	6	7	1	5	3	2	5	2	0	2	0	3	3	3	1	0	1
Task Dependencies	1	1	1	1	1	1		1			1	1	1	1	0	0		2	7	0	0	2	4	6	0	4	3	1	4	2	0	2	0	2	3	3	1	0	1
Test Schedules	1	1	1	1								1	1	1	2	2	2		6	2	1	2	4	5	1	4	3	1	3	2	0	2	1	2	3	3	0	0	1
Risk Management	1											1			7	6	7	6		5	5	4	6	5	4	4	4	1	3	2	2	4	2	2	3	3	0	0	1
Lead-times		1	1		1	1		1		1			1	1	0	0	0	2	5		0	2	3	5	0	3	3	2	2	2	0	1	0	2	1	1	1	0	0
Resources	1	1	1		1		1					1	1	1	-1	1	0	1	5	0		2	4	5	1	4	3	0	3	1	1	2	0	2	3	3	0	0	1
Assembly	1	1			1									1	3	4	2	2	4	2	2		5	7	2	3	1	3	3	3	1	2	0	3	3	3	1	0	1
Design		1					1							1	4	6	4	4	6	2	4	5		6	3	4	3	2	3	1	2	2	2	3	3	3	0	0	1
Bill of Materials															7	7	6	5	5	5	5	7	6		4	3	3	4	2	5	3	3	3	3	3	3	1	0	1
Freeze dates		1	1		1					1				1	0	1	0	1	4	0	1	2	3	4		3	2	2	2	1	0	0	0	2	1	1	0	0	0
Product														1	4	5	4	4	4	3	4	3	4	3	3		2	1	2	3	1	3	0	1	2	2	0	0	1
Cost	1													1	3	3	3	3	4	3	3	1	3	3	2	2		1	1	1	1	2	0	2	2	2	0	0	0
Scope	1							1					1		2	2	1	1	1	2	0	3	3	4	2	2	1		2	1	1	1	0	3	2	2	1	0	0
Quality															4	5	4	3	3	2	3	3	3	2	2	2	1	2		2	1	0	2	1	1	1	0	0	0
Activities	1				1							1			2	2	2	2	2	2	1	3	1	5	1	3	1	1	2		1	2	1	1	2	2	1	0	1
Process	1	1												1	0	0	0	0	2	0	1	1	2	3	0	1	1	1	1	1		1	1	2	2	2	0	0	0
Communication		1		1											2	2	2	2	4	1	2	2	2	3	0	3	2	1	0	2	1		1	1	2	2	0	0	1
Manufacturing	1				1									1	0	0	0	1	2	0	0	0	2	3	0	0	0	0	2	1	1	1		1	1	1	0	0	0
Revenue															3	3	2	2	2	2	2	3	3	3	2	1	2	3	1	1	2	1	1		2	2	0	0	0
Pricing															3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2		3	0	0	1
Profit															3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2	3		0	0	1
Specifications															1	1	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0		0	0
Personal Items															1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Trend Analysis															1	1	1	1	1	0	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	0	0	

Figure 4. Master project plan model – Modelling actual plan content referenced

Therefore, a score of zero or less suggest that the interviewees perceive the Master Project Plan as adequately providing the plan content they need. In this case the results indicate that from the perspective of the plan users the Master Project Plan very satisfactorily provides the content items of milestones, task and task dependencies. It also performs well when considering test schedules but there is some indication that improvements can be made. It does not perform well at all regarding the content item of Risk Management. This was actually somewhat expected, as many of the interviewees indicated they do conduct a separate risk management analysis for each project, but that this is not incorporated into the Master Project Plan. This suggests that perhaps some consideration should be made in incorporating risk management into the current Master Project Plan as it is clearly very important to a majority of the interviewees. The results also indicated that the Master Project Plan satisfactorily met the user requirements regarding the other content items that were considered for inclusion such as lead-times and resources. In other cases, such as that for bill of materials, assembly and design, the model indicates that the Master Project Plan is not currently meeting all of the content requirements of the respondents. Considering that all three of these were identified for cautious inclusion in the original analysis may suggest that the content item just does not logically fit into the aggregate plan. This may be the case with design where several of the interviewees cited separate schematic diagrams they use as plans for design content. It may also suggest that the content item just has not been addressed properly in the plan or understood clearly by the plan users. For content not included but still required, it is likely that the employees are obtaining this information from other sources such as, other plans or other documents they do not categorise as plans or simply via word of mouth including personal discussion, meetings, e-mails or telephone calls. All seem to be the case for Company X. While the value of conducting a DSM model for this analysis may be questioned, it does further validate the findings suggesting that many members of the same workgroup share an opinion of where the Master Project Plan may be deficient.

As a comparison, Figure 5 uses the same modelling technique to analyse the plan content not just for the Master Project Plan, but considering all of the plans utilised by the respondents. This model clearly shows that when modelling the content for all of the plans used by the respondents the content included comes much closer to that of the actual desired content than the Master Project Plan does alone. Many of the deficiencies identified in the previous model with the highly referenced plan content items are shown to have been addressed here. Even those highlighted items with the lowest commonality ratings, which perhaps should or should not be included in the Master Project Plan, are shown to be mostly addressed by other plans that the interviewees are using. Those instances where the results are falling short of what was suggested as the actual content referenced indicates that the respondents are probably using some of the other methods stated to get the information they need or simply not recognising the content they reference in the plans they use.

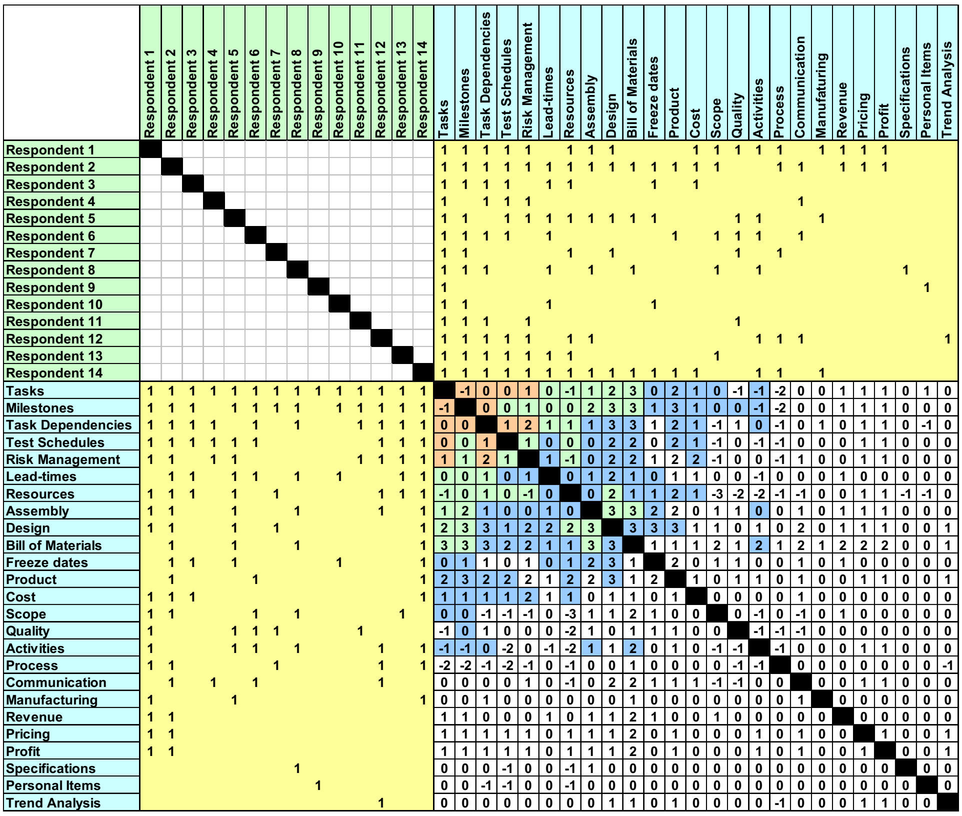

Figure 5. Total planning system model – Modelling all plan content referenced

This study has demonstrated that Company X's current planning system is well on its way to meeting the requirements of its user community, as it includes a large proportion of the planning content required by its users. In their paper on multi-project management, Platje and Seidal (1993) state that a key element of success is delegating responsibilities to the lowest possible levels of the organisation, and the improvement of communications between the parties involved in the multi-project organisation. We would suggest that the planning system implemented at Company X, with its single Master Project Plan and updating responsibilities delegated to the engineers themselves has enabled this to occur. This has been demonstrated by the measurable project performance improvement that resulted after the new planning system was implemented. However, our findings did suggest room for improvement, including possibilities where desired content could be included into the existing Master Project Plan or, if already included, better communicated to the user community. Doing so would make the Master Project Plan an even more powerful tool than it already is and minimise the inefficiencies and possible project interruptions often introduced by obtaining required information from multiple sources.

4 SUMMARY AND FUTURE WORK

Planning is an integral part of the complex product development system. This paper proposes and demonstrates how a DSM-based approach could be used as a complementary tool to analyse and help design an optimal planning system as determined by the community that will be managed by it. It has also demonstrated how similar techniques could be used to evaluate an existing planning system. By understanding the content requirements of the user community, it is suggested the overall planning system can be optimised to both communicate the information desired and minimise potential project error. Company X has clearly shown this, as demonstrated by the improvements that have been made, to date, despite still not having rolled out the new planning system to all potential users.

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Analysing Plan Content Using a Matrix-Based Approach

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- Organization Profile
- Methodology
- Graphical Result
- DSM Model Introduction
- DSM Model Results
- Summary

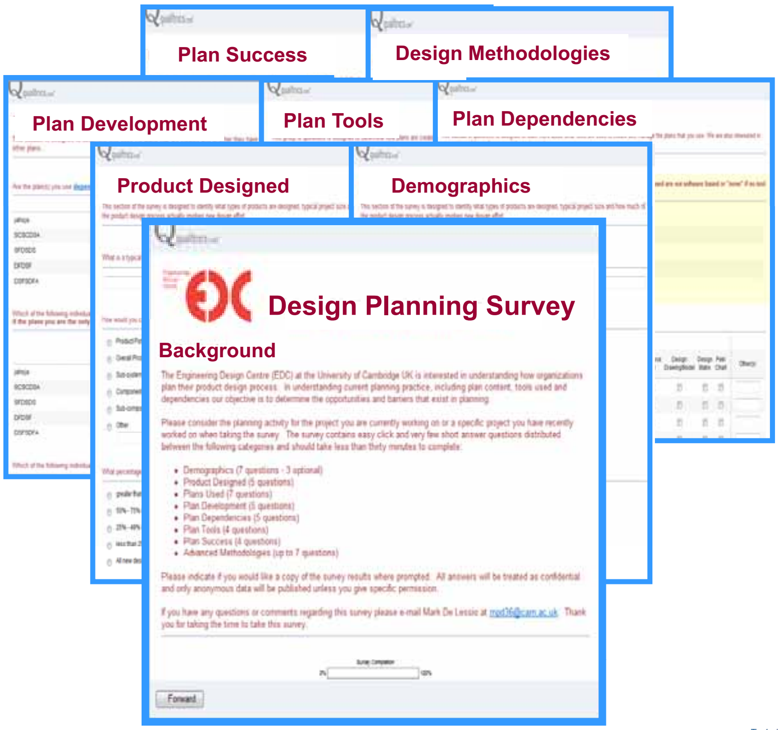
Introduction

- This paper presents a Matrix-Based approach for analyzing a Design Process planning system
- The proposal uses the Design Structure Matrix (DSM)
- Proposal is based on industry interviews based on an planning survey
- www.designplanningsurvey.com

Case Study Organization Profile

- Advanced scientific instrument manufacturing company
- Multi-national
- R&D engineering group
- Fifteen employees
- Three levels of responsibility
- Diverse responsibilities
- Unique planning system

Survey – www.designplanningsurvey.com



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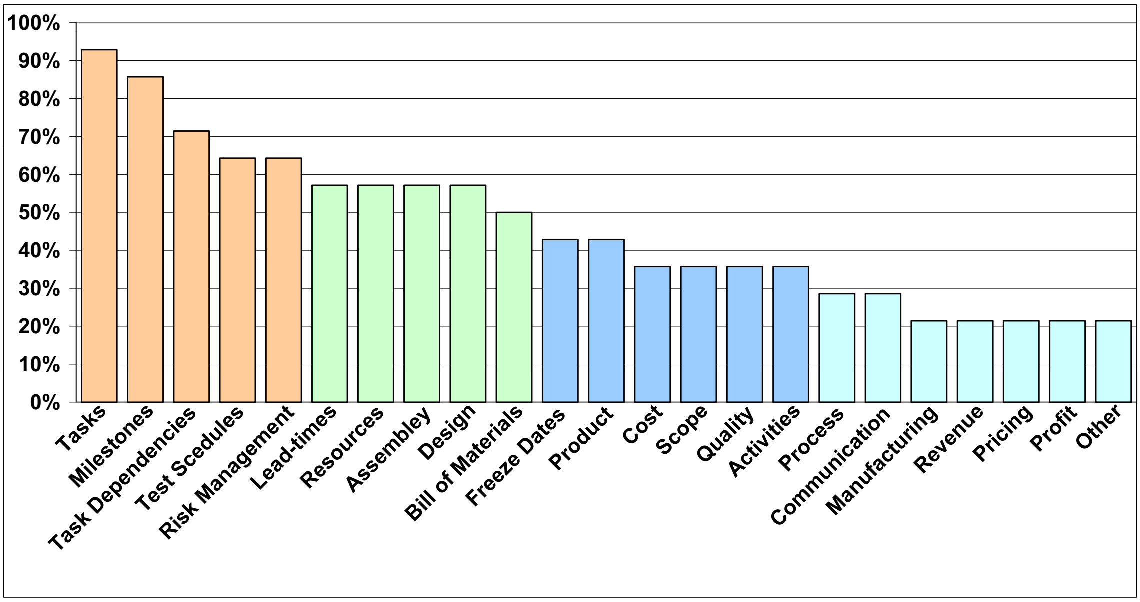
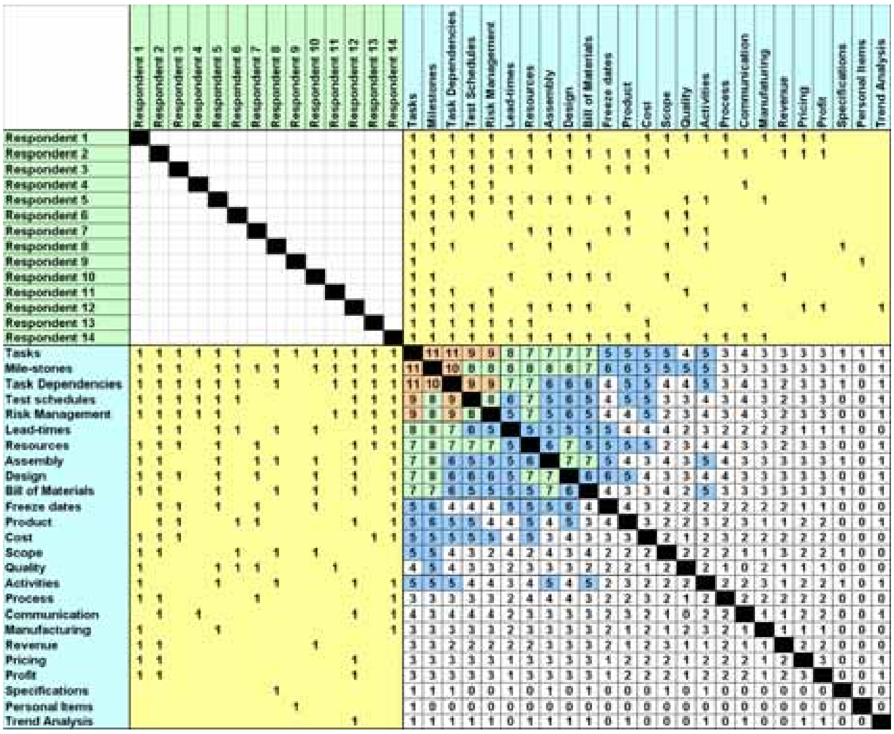


Modelling Desired Plan Content



Model Results

	Tasks	Milestones	Task Dependencies	Test Schedules	Risk Management	Lead-times	Resources	Assembly	Design	Bill of Materials	Freeze dates	Product	Cost	Scope	Quality	Activities	Process	Communication	Manufaturing	Revenue	Pricing	Profit	Specifications	Personal Items	Trend Analysis
Tasks		11	11	9	9	8	7	7	7	7	5	5	5	5	4	5	3	4	3	3	3	3	1	1	1
Mile-stones	11		10	8	8	8	8	8	8	7	6	6	5	5	5	5	3	3	3	3	3	3	1	0	1
Task Dependencies	11	10		9	9	7	7	6	6	6	4	5	5	4	4	5	3	4	3	2	3	3	1	0	1
Test schedules	9	8	9		8	6	7	5	6	5	4	5	5	3	3	4	3	4	3	2	3	3	0	0	1
Risk Management	9	8	9	8		5	7	5	6	5	4	4	5	2	3	4	3	4	3	2	3	3	0	0	1
Lead-times	8	8	7	6	5		5	5	5	5	5	4	4	4	2	3	2	2	2	2	1	1	1	0	0
Resources	7	8	7	7	7	5		6	7	5	5	5	5	2	3	4	4	3	3	2	3	3	0	0	1
Assembly	7	8	6	5	5	5	6		7	7	5	4	3	4	3	5	4	3	3	3	3	3	1	0	1
Design	7	8	6	6	6	5	7	7		6	6	5	4	3	3	4	4	3	3	3	3	3	0	0	1
Bill of Materials	7	7	6	5	5	5	5	7	6		4	3	3	4	2	5	3	3	3	3	3	3	1	0	1
Freeze dates	5	6	4	4	4	5	5	5	6	4		4	3	2	2	2	2	2	2	2	1	1	0	0	0
Product	5	6	5	5	4	4	5	4	5	3	4		3	2	2	3	2	3	1	1	2	2	0	0	1
Cost	5	5	5	5	5	4	5	3	4	3	3	3		2	1	2	3	2	2	2	2	2	0	0	0
Scope	5	5	4	3	2	4	2	4	3	4	2	2	2		2	2	2	1	1	3	2	2	1	0	0
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Communication	4	3	4	4	4	2	3	3	3	3	2	3	2	1	0	2	2		1	1	2	2	0	0	1
Manufacturing	3	3	3	3	3	2	3	3	3	3	2	1	2	1	2	3	2	1		1	1	1	0	0	0
Revenue	3	3	2	2	2	2	2	3	3	3	2	1	2	3	1	1	2	1	1		2	2	0	0	0
Pricing	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2		3	0	0	1
Profit	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2	3		0	0	1
Specifications	1	1	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0		0	0
Personal Items	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Trend Analysis	1	1	1	1	1	0	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	0	0	

Model Results

	Tasks	Milestones	Task Dependencies	Test Schedules	Risk Management	Lead-times	Resources	Assembly	Design	Bill of Materials	Freeze dates	Product	Cost	Scope	Quality	Activities	Process	Communication	Manufaturing	Revenue	Pricing	Profit	Specifications	Personal Items	Trend Analysis
Tasks		11	11	9	9	8	7	7	7	7	5	5	5	5	4	5	3	4	3	3	3	3	1	1	1
Mile-stones	11		10	8	8	8	8	8	8	7	6	6	5	5	5	5	3	3	3	3	3	3	1	0	1
Task Dependencies	11	10		9	9	7	7	6	6	6	4	5	5	4	4	5	3	4	3	2	3	3	1	0	1
Test schedules	9	8	9		8	6	7	5	6	5	4	5	5	3	3	4	3	4	3	2	3	3	0	0	1
Risk Management	9	8	9	8		5	7	5	6	5	4	4	5	2	3	4	3	4	3	2	3	3	0	0	1
Lead-times	8	8	7	6	5		5	5	5	5	5	4	4	4	2	3	2	2	2	2	1	1	1	0	0
Resources	7	8	7	7	7	5		6	7	5	5	5	5	2	3	4	4	3	3	2	3	3	0	0	1
Assembly	7	8	6	5	5	5	6		7	7	5	4	3	4	3	5	4	3	3	3	3	3	1	0	1
Design	7	8	6	6	6	5	7	7		6	6	5	4	3	3	4	4	3	3	3	3	3	0	0	1
Bill of Materials	7	7	6	5	5	5	5	7	6		4	3	3	4	2	5	3	3	3	3	3	3	1	0	1
Freeze dates	5	6	4	4	4	5	5	5	6	4		4	3	2	2	2	2	2	2	2	1	1	0	0	0
Product	5	6	5	5	4	4	5	4	5	3	4		3	2	2	3	2	3	1	1	2	2	0	0	1
Cost	5	5	5	5	5	4	5	3	4	3	3	3		2	1	2	3	2	2	2	2	2	0	0	0
Scope	5	5	4	3	2	4	2	4	3	4	2	2	2		2	2	2	1	1	3	2	2	1	0	0
Quality	4	5	4	3	3	2	3	3	3	2	2	2	1	2		2	1	0	2	1	1	1	0	0	0
Activities	5	5	5	4	4	3	4	5	4	5	2	3	2	2	2		2	2	3	1	2	2	1	0	1
Process	3	3	3	3	3	2	4	4	4	3	2	2	3	2	1	2		2	2	2	2	2	0	0	0
Communication	4	3	4	4	4	2	3	3	3	3	2	3	2	1	0	2	2		1	1	2	2	0	0	1
Manufacturing	3	3	3	3	3	2	3	3	3	3	2	1	2	1	2	3	2	1		1	1	1	0	0	0
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Pricing	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2		3	0	0	1
Profit	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2	3		0	0	1
Specifications	1	1	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0		0	0
Personal Items	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Trend Analysis	1	1	1	1	1	0	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	0	0	

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MANAGING COMPLEXITY
BY MODELLING DEPENDENCIES

Model Results

	Tasks	Milestones	Task Dependencies	Test Schedules	Risk Management	Lead-times	Resources	Assembly	Design	Bill of Materials	Freeze dates	Product	Cost	Scope	Quality	Activities	Process	Communication	Manufaturing	Revenue	Pricing	Profit	Specifications	Personal Items	Trend Analysis
Tasks		11	11	9	9	8	7	7	7	7	5	5	5	5	4	5	3	4	3	3	3	3	1	1	1
Mile-stones	11		10	8	8	8	8	8	8	7	6	6	5	5	5	5	3	3	3	3	3	3	1	0	1
Task Dependencies	11	10		9	9	7	7	6	6	6	4	5	5	4	4	5	3	4	3	2	3	3	1	0	1
Test schedules	9	8	9		8	6	7	5	6	5	4	5	5	3	3	4	3	4	3	2	3	3	0	0	1
Risk Management	9	8	9	8		5	7	5	6	5	4	4	5	2	3	4	3	4	3	2	3	3	0	0	1
Lead-times	8	8	7	6	5		5	5	5	5	5	4	4	4	2	3	2	2	2	2	1	1	1	0	0
Resources	7	8	7	7	7	5		6	7	5	5	5	5	2	3	4	4	3	3	2	3	3	0	0	1
Assembly	7	8	6	5	5	5	6		7	7	5	4	3	4	3	5	4	3	3	3	3	3	1	0	1
Design	7	8	6	6	6	5	7	7		6	6	5	4	3	3	4	4	3	3	3	3	3	0	0	1
Bill of Materials	7	7	6	5	5	5	5	7	6		4	3	3	4	2	5	3	3	3	3	3	3	1	0	1
Freeze dates	5	6	4	4	4	5	5	5	6	4		4	3	2	2	2	2	2	2	2	1	1	0	0	0
Product	5	6	5	5	4	4	5	4	5	3	4		3	2	2	3	2	3	1	1	2	2	0	0	1
Cost	5	5	5	5	5	4	5	3	4	3	3	3		2	1	2	3	2	2	2	2	2	0	0	0
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Process	3	3	3	3	3	2	4	4	4	3	2	2	3	2	1	2		2	2	2	2	2	0	0	0
Communication	4	3	4	4	4	2	3	3	3	3	2	3	2	1	0	2	2		1	1	2	2	0	0	1
Manufacturing	3	3	3	3	3	2	3	3	3	3	2	1	2	1	2	3	2	1		1	1	1	0	0	0
Revenue	3	3	2	2	2	2	2	3	3	3	2	1	2	3	1	1	2	1	1		2	2	0	0	0
Pricing	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2		3	0	0	1
Profit	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2	3		0	0	1
Specifications	1	1	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0		0	0
Personal Items	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
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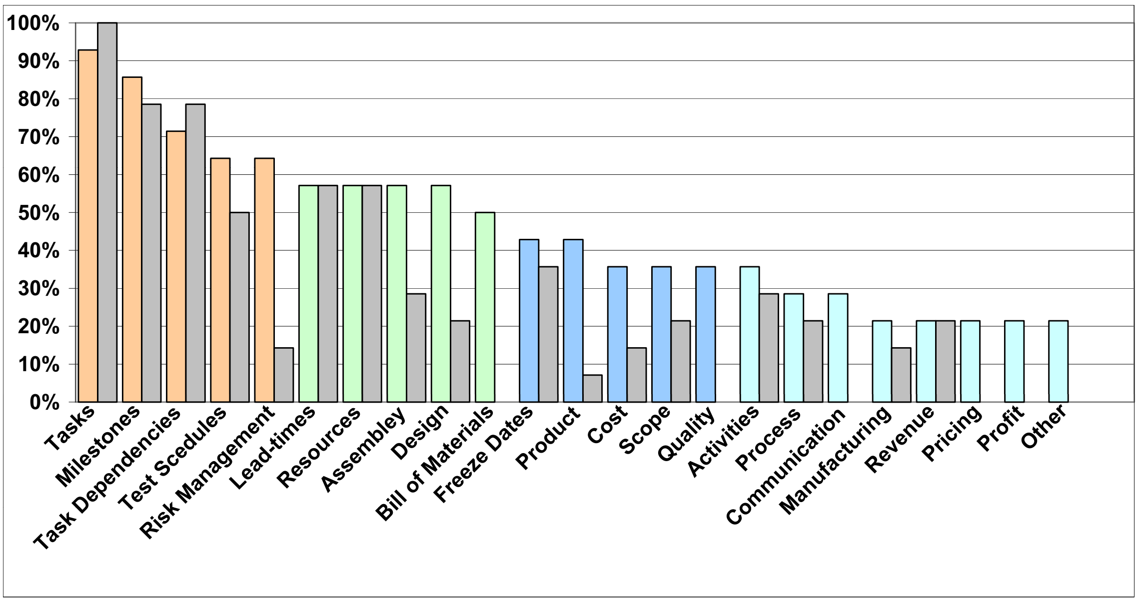
Modelling Results

	Tasks	Milestones	Task Dependencies	Test Schedules	Risk Management	Lead-times	Resources	Assembly	Design	Bill of Materials	Freeze dates	Product	Cost	Scope	Quality	Activities	Process	Communication	Manufaturing	Revenue	Pricing	Profit	Specifications	Personal Items	Trend Analysis
Tasks		11	11	9	9	8	7	7	7	7	5	5	5	5	4	5	3	4	3	3	3	3	1	1	1
Mile-stones	11		10	8	8	8	8	8	8	7	6	6	5	5	5	5	3	3	3	3	3	3	1	0	1
Task Dependencies	11	10		9	9	7	7	6	6	6	4	5	5	4	4	5	3	4	3	2	3	3	1	0	1
Test schedules	9	8	9		8	6	7	5	6	5	4	5	5	3	3	4	3	4	3	2	3	3	0	0	1
Risk Management	9	8	9	8		5	7	5	6	5	4	4	5	2	3	4	3	4	3	2	3	3	0	0	1
Lead-times	8	8	7	6	5		5	5	5	5	5	4	4	4	2	3	2	2	2	2	1	1	1	0	0
Resources	7	8	7	7	7	5		6	7	5	5	5	5	2	3	4	4	3	3	2	3	3	0	0	1
Assembly	7	8	6	5	5	5	6		7	7	5	4	3	4	3	5	4	3	3	3	3	3	1	0	1
Design	7	8	6	6	6	5	7	7		6	6	5	4	3	3	4	4	3	3	3	3	3	0	0	1
Bill of Materials	7	7	6	5	5	5	5	7	6		4	3	3	4	2	5	3	3	3	3	3	3	1	0	1
Freeze dates	5	6	4	4	4	5	5	5	6	4		4	3	2	2	2	2	2	2	2	1	1	0	0	0
Product	5	6	5	5	4	4	5	4	5	3	4		3	2	2	3	2	3	1	1	2	2	0	0	1
Cost	5	5	5	5	5	4	5	3	4	3	3	3		2	1	2	3	2	2	2	2	2	0	0	0
Scope	5	5	4	3	2	4	2	4	3	4	2	2	2		2	2	2	1	1	3	2	2	1	0	0
Quality	4	5	4	3	3	2	3	3	3	2	2	2	1	2		2	1	0	2	1	1	1	0	0	0
Activities	5	5	5	4	4	3	4	5	4	5	2	3	2	2	2		2	2	3	1	2	2	1	0	1
Process	3	3	3	3	3	2	4	4	4	3	2	2	3	2	1	2		2	2	2	2	2	0	0	0
Communication	4	3	4	4	4	2	3	3	3	3	2	3	2	1	0	2	2		1	1	2	2	0	0	1
Manufacturing	3	3	3	3	3	2	3	3	3	3	2	1	2	1	2	3	2	1		1	1	1	0	0	0
Revenue	3	3	2	2	2	2	2	3	3	3	2	1	2	3	1	1	2	1	1		2	2	0	0	0
Pricing	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2		3	0	0	1
Profit	3	3	3	3	3	1	3	3	3	3	1	2	2	2	1	2	2	2	1	2	3		0	0	1
Specifications	1	1	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0		0	0
Personal Items	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Trend Analysis	1	1	1	1	1	0	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	0	0	

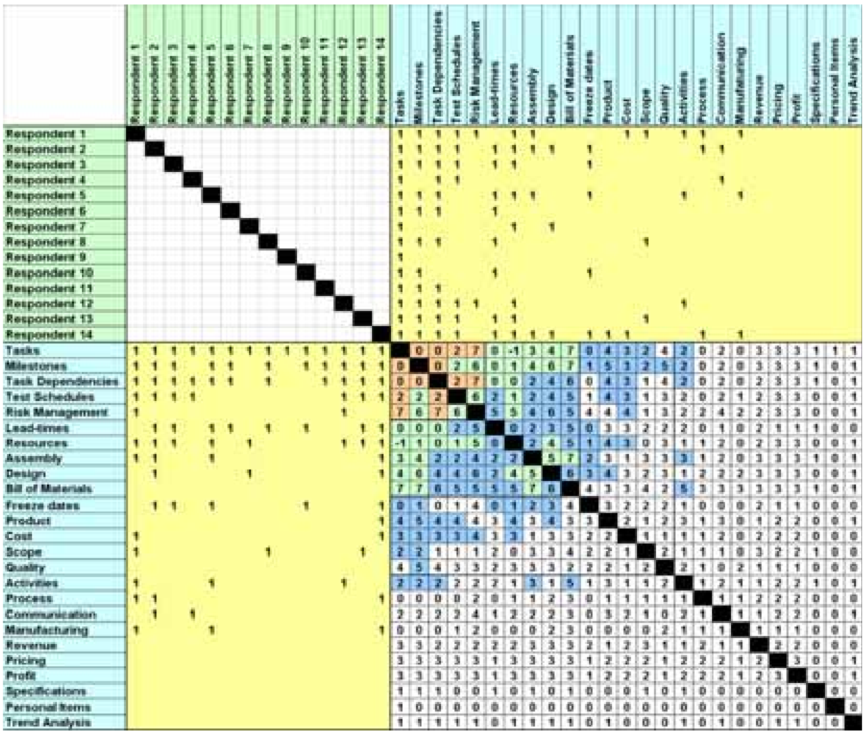
Actual Master Project Plan Content



MANAGING COMPLEXITY

BY MODELLING DEPENDENCIES

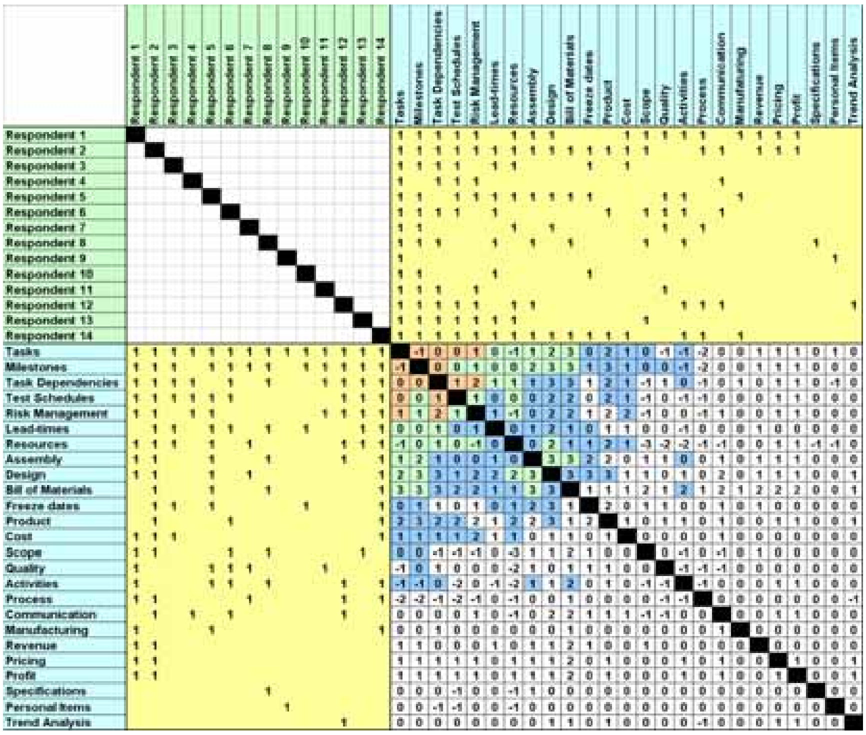
Master Project Plan Results



MANAGING COMPLEXITY

BY MODELLING DEPENDENCIES

All Plan Results



Summary

- Identifying an optimum planning system
- DSM Modelling Benefits
- Other DSM Modelling Opportunities
- Future Work