

Developing a Scoring Model using the GAO's Schedule Assessment Best Practices

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Abstract

In today's economic environment, with Clients and supporting contracting companies tightening their purse strings to developing Oil and Gas projects, there is a definite requirement to enhance the quality of project schedules. It is the author's opinion that the tools are available but schedule quality continues to dwindle. By adopting the GAO's Schedule Assessment Guide as a basis, this paper develops a scoring template along with appropriate wording for inclusion in contractual documents, raising awareness to Project Management of the quality required. A scoring template was developed using multiple iterations of Multi-Attribute Decision Making methodology, and a case study performed to determine the quality of an old Oil & Gas project schedule. The result being benchmarked against two schedule quality software packages. A recommendation on the contractual wording, and cognizance to minimize delays by accepting schedules "subject to" implementation of corrections/improvements are a way ahead to getting schedule definition where it needs to be.

Keywords: Scoring model, planning and scheduling, GAO Schedule Assessment Guide, project management, multi attribute decision making

Introduction

In the current Oil and Gas (O&G) economic climate, the multi-national Oil giants are holding back development of new facilities, and those being sanctioned as viable need to be managed effectively and efficiently. These viable projects require a 'Best in class' schedule increasing their chances of success.

Research is based on the author's real-life experience dealing with numerous O&G projects, where analysis shows that the quality of the schedules being presented to clients is far from satisfactory, but accepted due to tight client imposed deadlines. Analysis demonstrates that current schedule development practices need to be reinforced by moving O&G scheduling practices towards the GAO's Scheduling Best Practices^[1] and to do so a scoring model needs to be developed to assist fellow practitioners.

The O&G industry recognizes that even with the tools and technology available to project planners and schedulers nowadays the quality of the resultant schedules produced fall well short of minimum requirements.

When it comes to cost and schedule, very few projects meet stakeholder's expectations. This paper proposes a scoring model to compliment the GAO's Scheduling Best Practices providing recommendations to management as to what changes need to be made to the Project Planning and Scheduling sections of the contractual documents.

Specifically, this paper wants to put forward a scoring model methodology that can be utilized by fellow professionals to:

1. Incorporate into Contracting documents.
2. Quickly assess the quality of a contractor's schedule being presented for review.
3. Provide the relevant contractors with a score card that can be used to enhance any subsequent submission(s).

Background

The GAO's Schedule Assessment Guide was developed by the US Government to address the numerous projects that were over-running in both schedule and cost, projects that were funded by public money. They solicited assistance from a team, both Owner's and Contractor's, of scheduling experts worldwide to develop the guide, 108 whom provided contributions and 148 who reviewed the guide and provided valuable feedback to complete the final product. Its purpose, is that it be used in conjunction with the Cost guide, as "*A cost estimate cannot be considered credible if it does not account for the cost effects of schedule slippage*"¹. The document raises awareness that a well-prepared schedule is a fundamental management tool and provides readers with several chapters and Appendix's with valuable checklists, auditor questions, and measures for assessing schedule quality. However, there is no scoring mechanism to determine the quality of schedules as presented by contractors to their respective clients.

Presently, crude oil is one of the most essential resources in everyday life, with the O&G industry being one, if not the most, powerful branches in the world economy, yet contractors providing services to the multi-nationals fall short in providing quality schedules to compliment the industry's status. Thus, this paper will use a real project (identified as "Project X") coming from the O&G sector as a "case study" to test the scoring model.

This subject will commence by identifying the appropriate MADM method, applying the available criteria to it, removing any ambiguous criteria, and developing a scoring template to be applied to a previous O&G project called 'Project X' to determine the quality of the schedule as presented. The result will then be benchmarked against results from two commercially available schedule analysis software packages 'Deltek Acumen' and 'XER Schedule Toolkit'.

Development of the Scoring Method

As the GAO checklists, and items shown in Appendices II and VI are extensive, using multi-attribute decision making methods was deemed appropriate. In using Multi-attribute decision making (MADM), there are two methods, Compensatory and Non-Compensatory.

¹ According to the GAO's Schedule Assessment Guide (2015), "*A cost estimate cannot be considered credible if it does not account for the cost effects of schedule slippage*" (P. i)

Compensatory MADM has two methods; Non-dimensional scaling and Additive Weighting Technique, while Non-Compensatory MADM has four methods; Dominance, Satisficing, Disjunctive Reasoning and Lexicography. Overall there were six techniques available to choose from.

Challenged with the opportunity to develop a scoring model to support the GAO's Schedule Assessment Guide's Best Practices. Using the Multi Attribute Decision Making (MADM) process the development of such a scoring model need to have several iterative steps:

- 1) What model was best suited for use?
- 2) What GAO criteria set should be used?
- 3) What, if any, acceptance should be used?

With these three specific questions, augmented with the need to keep the process simple and transparent for Project Management to understand, further research commenced.

The initial question: What model is best suited? Review of the GPCCAR Module 10-3 – Managing Change – The Owner's perspective, identified the MADM methods available to me, but the initial choice needed to be made between the Non-Compensatory method and the Compensatory method.

There were benefits to using either method, see table 1 below.

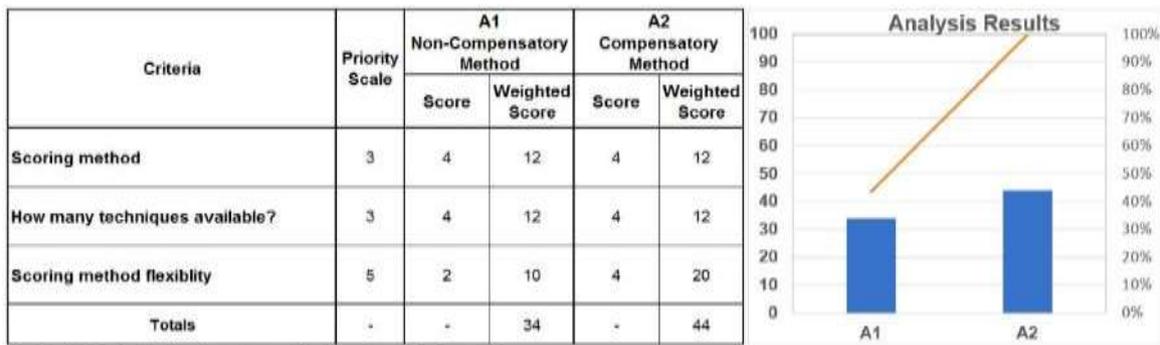
Criteria	A1 Non-Compensatory Method	A2 Compensatory Method
Scoring method	All attributes are equally weighted	Weight the different variables
How many techniques available?	Five	Two
Scoring method flexibility	Can rank order results from best to worst but unable to measure SCORE RELATIVE TO ONE ANOTHER	Two (or three) step process, normalising, ranking and scoring

Table 1 MADM Method Benefits²

The benefits for each scoring model type were then analyzed by allocating a priority scale for the criteria and then a 'meeting requirement' score applied. The priority scale was applied to show the importance of the item – low importance (1) / important (3) / essential (5). Then the "Meeting requirement" score applied to each criteria item; Did not Meet (0) / Partially Met (2) / Met Requirements (4) / Exceeded Requirements (6).

The 'Weighted score' is determined by multiplying the 'Score' by the 'Priority Scale'.

² By Author



1. Priority Scale: 1 = Low importance / 3 = Important / 5 = Essential
2. Score: 0 = Does not meet requirement / 2 = Meets some of requirement / 4 = Meets requirement / 6 = Exceeds Requirement
3. Weighted Score = Priority Scale x Weight Factor

Figure 1 MADM Method Selection Analysis^{3 4}

The results of analysis answered the first question “What model was best suited for use?” was to use a weighted scoring model. This may sound like a perfectly simple conclusion, but this in turn raises the question what kind of weighting should be used.

The scoring model to be developed needs to weight the criteria, and provide quantitative acceptance limits to provide a final score i.e. for example Best Practice 1 ‘capturing all activities’ what determines the pass criteria for the schedule to meet GAO guidelines; 100%, 90%...thoughts anybody, it does not appear that ‘one rule suits all’.

The solution requires to be determined in two parts; a) Vertical scoring achievement, and b) horizontal scoring achievement.

Vertical scoring has two alternatives; i) a system that treats all the criteria as being equal, or ii) a system that imposes rankings against the criteria. The benefits for each are shown in table 2.

Benefits	A1 All items weighted equally	A2 Specific Items ranked	Comments
GAO Best Practices used	Yes	Yes	
Level where weighting determined	User determined, but can be down to Lowest criteria level	User determined, but can be down to Lowest criteria level	Levels: 4 Characteristics, 10 Best Practices, individual checklist / questions / measures
Scoring method	All Items equal	Items ranked	
Determination of Ranking	Not applicable	Criteria reviewed and ranking allocated	Ranking should be determined by the team
Scoring method flexibility	No	Yes	
Can results be influenced?	No	Yes	Ranking could potentially distort results?

Table 2 Vertical Scoring Choices⁵

³ Source: 10.3.3.7 Multi-Attribute Decision Making. (2015, November 2). Retrieved from [http://GUILD OF PROJECT CONTROLS COMPENDIUM and REFERENCE \(CaR\) | Project Controls - planning, scheduling, cost management and forensic analysis \(Planning Planet\). \(n.d.\). Retrieved from http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective](http://GUILD OF PROJECT CONTROLS COMPENDIUM and REFERENCE (CaR) | Project Controls - planning, scheduling, cost management and forensic analysis (Planning Planet). (n.d.). Retrieved from http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective)

⁴ Format developed by Author

The above benefits were again input to the similar model to that used to determine the scoring type, applying a priority and a score to provide a weighted score result. Comparing the alternatives using the information from the benefits table provided the assessment of which method to be used. Please note that the lower two items (scoring flexibility / data manipulation potential) did not relate to A1 and scored zero (Refer to figure 2 below) but results of A2 were brought closer to A1 due to this.

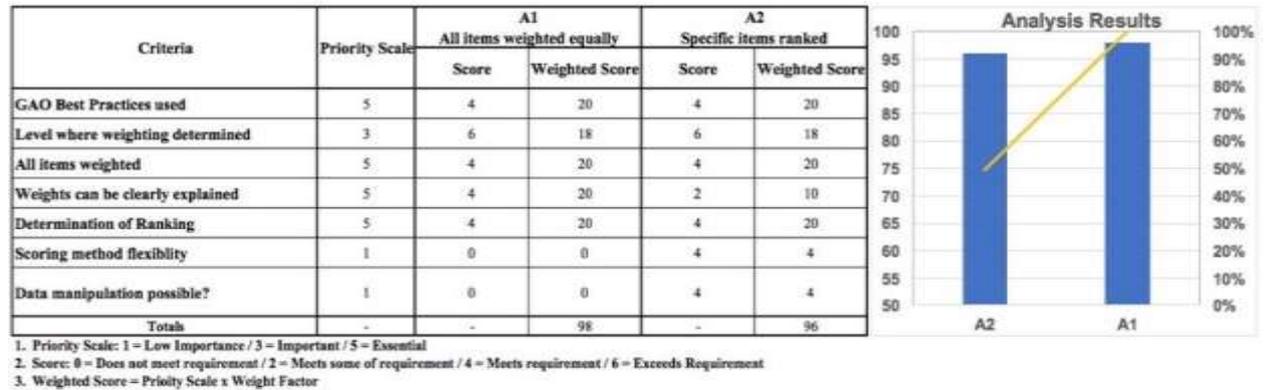


Figure 2 Vertical Scoring Analysis^{6 7}

A similar iterative process was adopted to evaluate choice of criteria to be used:

- i) Best Practices checklists,
- ii) Appendix II – An Auditor’s Key Questions and Documents,
- iii) Appendix VI – Standard Quantitative Measurements for Assessing Schedule Health

The result determined that in certain cases, the criteria was ambiguous, and as all items would be weighted equally with each data set having different check totals; i) 152 (0.658% for each point), ii) 87 (1.149% for each point) and iii) 74 (1.351% for each point), results solely depended on which criteria set used with weight variations significant across each (see table 3 below).

Equation 1: “GOA Data Set Weightings” Basis - $100\% / \text{Number of Data Set items}$ ($100\% / 152 = 0.658\% \mid 100\% / 87 = 1.149\% \mid 100\% / 74 = 1.351\%$)

⁵ By Author

⁶ Source: 10.3.3.7 Multi-Attribute Decision Making. (2015, November 2). Retrieved from [http://GUILD OF PROJECT CONTROLS COMPENDIUM and REFERENCE \(CaR\) | Project Controls - planning, scheduling, cost management and forensic analysis \(Planning Planet\). \(n.d.\). Retrieved from http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective](http://GUILD OF PROJECT CONTROLS COMPENDIUM and REFERENCE (CaR) | Project Controls - planning, scheduling, cost management and forensic analysis (Planning Planet). (n.d.). Retrieved from http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective)

⁷ Figure format developed by Author

Best Practices Checklist:	Weight Factor Based on Data Points		
	Best Practice Checklists	Appendix II	Appendix VI
1. Capturing All Activities	6.6%	12.6%	10.8%
2. Sequencing All Activities	9.2%	11.5%	24.3%
3. Assigning Resources to All Activities	11.2%	9.2%	8.1%
4. Establishing the Duration of All Activities	7.9%	9.2%	9.5%
5. Verifying That the Schedule Can Be Traced Horizontally and Vertically	5.9%	5.7%	1.4%
6. Confirming That the Critical Path Is Valid	7.9%	6.9%	8.1%
7. Ensuring Reasonable Total Float	5.9%	4.6%	6.8%
8. Conducting a Schedule Risk Analysis	11.2%	12.6%	4.1%
9. Updating the Schedule Using Actual Progress and Logic	13.2%	13.8%	8.1%
10. Maintaining a Baseline Schedule	21.1%	13.8%	18.9%

Table 3 Weighting Comparison using GAO's Data⁸

The development of a 'Hybrid' data set from the three GAO criteria sets is the proposed way to establish a concise listing that specifically addresses the quality of the schedule being presented for review.

As with any scoring method, there needs to be questions specific to the schedule development as well as pass/fail metrics based on acceptance criteria (see table 4 below).

⁸ By Author

7. Best Practices : Ensuring Reasonable Total Float

Checklist	Appendix II	Appendix VI	Hybrid
11 The total float values calculated by the scheduling software are reasonable and accurately reflect a schedule's flexibility.	a Are the total float values that the scheduling software calculates reasonable and do they accurately reflect true schedule flexibility?	a Remaining detail activities and milestones with dissimilar total float time units	a Total Number of 'Not Started' & 'Active' Tasks with TF > 10% of Project Duration (as a % of Total)
11 The program really has the amount of schedule flexibility indicated by the levels of float.	b Are excessive values of total float being driven by activities that are missing logic?	b Remaining detail activities and milestones with relatively high total float	b Total number of 'Not Started' & 'Active' Tasks with TF >= 42days (as a % of Total)
11 Remaining activities in the schedule are sorted by total float and assessed for reasonableness. Any activities that appear to have a great deal of float are examined for missing or incomplete logic.	c Is total float monitored? Does management have a plan to mitigate negative total float?	c Remaining detail activities with negative total float	c Total Number of 'Not Started' & 'Active' Tasks with TF < 0 (as a % of Total)
11 Total float values that appear to be excessive are documented to show that the program management team has performed an assessment and agreed that the logic and float are consistent with the plan.	d Does management rely on free float to level resources or reassign resources to assist critical activities?	d Average total float value of remaining detail activities and milestones	d Average of TF for All Tasks & Milestones. (too little means schedule too tight / too much is schedule is not properly built).
11 Total float is calculated to the main deliveries and milestones as well as to the program's completion.		e Median total float value of remaining detail activities and milestones	
11 Total and free float inform management as to which activities can be reassigned resources in order to mitigate slips in other activities.			
11 Management balances the use of float with the fact that total float is shared along a path of activities.			
11 Periodic reports routinely show the amount of float consumed in a period and remaining on the critical and near-critical paths.			
11 Date constraints causing negative float have been justified. If delay is significant, plans to recover the implied schedule slip have been evaluated and implemented.			

Table 4 Typical Determination of Criteria^{9 10}

Development of the 'Hybrid' criteria provided 82 scoring items, plus 33 key information items, in which to assess the development and quality of the schedule. A summary table of the check items against each Best Practice along with weighting factor is shown below.

Equation 2: "Hybrid Data Set Weightings" Basis - 100% / Number of Data Set items (100% / 82 = 1.219%)

⁹ Table developed by Author

¹⁰ United States. (2015). Best Practice Checklists, Appendix II and Appendix VI. In *GAO schedule assessment guide: Best practices for project schedules* (pp. 25/26, 46/47, 61/62, 68/69, 73/74, 89, 96/97, 119/120, 132/133, 146/147, 151/165, 183/188). U.S. Government Accountability Office.

<u>Ten Best Practices</u>	Check Items	Weight
	Total	
1. Capturing all activities.	13	15.9%
2. Sequencing all activities.	14	17.1%
3. Assigning resources to all activities.	10	12.2%
4. Establishing the duration of all activities.	10	12.2%
5. Verifying that the schedule can be traced horizontally and vertically.	2	2.4%
6. Confirming that the critical path is valid.	7	8.5%
7. Ensuring reasonable total float.	4	4.9%
8. Conducting a schedule risk analysis.	6	7.3%
9. Updating the schedule using actual progress and logic.	7	8.5%
10. Maintaining a baseline schedule.	9	11.0%

Table 5 Best Practice Summary using Hybrid Criteria¹¹

The final step in the process and applying the Best Practice information from table 5 against the GAO's Table 7 Best Practices Entailed in the Four characteristics of a Reliable Schedule, the results are shown in figure 3.

Schedule characteristic & Best Practice	Total	Weight	BP Weight
Comprehensive, reflecting 1. Capturing all activities 3. Assigning resources to all activities 4. Establishing the durations of all activities	33	40.2%	1. 39.4% 3. 30.3% 4. 30.3%
Well constructed, with 2. Sequencing all activities 6. Confirming that the critical path is valid 7. Ensuring reasonable total float	25	30.5%	2. 56.0% 6. 28.0% 7. 16.0%
Credible, reflecting 5. Verifying that the schedule can be traced horizontally and vertically 8. Conducting a schedule risk analysis	8	9.8%	5. 25.0% 8. 75.0%
Controlled, being 9. Updating the schedule using actual progress and logic 10. Maintaining a baseline schedule	16	19.5%	9. 50.0% 10. 50.0%

Source: GAO | GAO-18-89G. | Table 7: Best Practices Entailed in the Four Characteristics of a Reliable Schedule

Figure 3 GAO's Four Characteristics Weightings^{12 13}

¹¹ By Author

¹² United States. (2015). Best Practices Entailed in the Four characteristics of a Reliable Schedule. In *GAO schedule assessment guide: Best practices for project schedules* (pp. 149). U.S. Government Accountability Office.

¹³ Figure developed by Author

With all the components available; MADM Method, Vertical and Horizontal Scoring, and Hybrid data set, the final step is to generate the scoring template to be used to determine the result. The template will include each of the GAO's Ten Best Practices along with the Schedule Development and Acceptance questions, showing columns for a pass/fail and a percentage earned for each question passed. To the far right a column which provides a guide with regards the acceptable 'Pass criteria'.

Figure 4 shows an extract of a 'typical' scoring template, in this case for Best Practice 1 – Capturing All Activities. The full template covering all Ten Best Practices can be viewed in Appendix V of this paper.

GAO BEST PRACTICE	Project: _____					
	Schedule Development	Acceptance	Final Score			Pass Criteria
			Pass	Fail	%	
1. Capturing All Activities						
Count of 'All' Tasks & Milestones (Not Started, Active & Completed)			N/A	N/A	N/A	For Information
Count of 'All' Milestones (Not Started, Active & Completed)			N/A	N/A	N/A	For Information
Count of 'All' Tasks (Not Started, Active & Completed)			N/A	N/A	N/A	For Information
a) WBS - Does the WBS meet Client requirements?			1		1.2	Yes
b) Activity IDs - Are these easy to understand, or has 'intelligent' coding been used to develop the Act ID as opposed to the activity coding structure?			1		1.2	Yes
c) Are Activity Names clear as to the scope of work included. If it is not clear, please go to item '??'			1		1.2	Yes / Partial
d) Does the Activity Name description use 'Action Verbs' to describe the work? (if Partial, go to item '??')			1		1.2	Yes / Partial
e) Are there any duplicate activity names?			1		1.2	No
f) Does the schedule include 'ALL' interface activities with other Contractors, 3rd Party suppliers, Client?			1		1.2	Yes
g) Has Schedule being set-up correctly to cater for modularised units and their independent critical paths, as well as the overall critical path? At times, there is a need to identify the critical construction path through individual modules (i.e. subprojects) as well as overall project path. Using soft constraints is not an option.			1		1.2	Yes
h) Have soft constraints been used to place, Client / 3rd Party Deliverables? (These should be placed using FS Lags from Project start)			1		1.2	No
i) Have Milestones being used as a substitute for Tasks?			1		1.2	No
j) Count of 'All' activities with no WBS (as a % of Total)			1		1.2	0%
k) Count of 'All' activities with unclear Activity Names (as a % of Total) [refer to item 'c' above]			1		1.2	Less than 10%
l) Count of 'All' activities not using 'Action Verbs' in the Activity Names (as a % of Total) [refer to item 'd' above]			1		1.2	Less than 25%
m) Ratio of Milestones/Tasks = Count of 'All' Milestones / Count of 'All' Activities (Where 'All' = Not Started, Active & Completed)			1		1.2	Less than 20%
2. Sequencing All Activities						
3. Assigning Resources to All Activities						
4. Establishing the Duration of All Activities						
5. Verifying That the Schedule Can Be Traced Horizontally and Vertically						
6. Confirming That the Critical Path Is Valid						
7. Ensuring Reasonable Total Float						
8. Conducting a Schedule Risk Analysis						
9. Updating the Schedule Using Actual Progress and Logic						
10. Maintaining a Baseline Schedule						
					100.0	

Figure 4 Typical Best Practice Scoring Template¹⁴

¹⁴ By Author

To complete the Scorecard data-input the scorer needs pull together information from several areas;

- Schedule Log from Primavera
- XER file from Primavera (Using an XER Reader)

It is necessary to obtain the information from the individual XER files (P6 File) in a Microsoft Excel format, the use of a XER Reading macro based spreadsheet “XER-READER_0.75.3.xlsm” or similar is necessary. It also allows the user to easily and quickly obtain the data required for analysis.

Once the analysis has been performed, what overall percentage is going to determine how good the schedule is... 75%, 80%95%, 100%? Obviously the higher the figure the better, but projects need to move ahead and the quality of the schedule process is key to their success. Management need to actively reinforce what their acceptance limits are and include in the Tender documents, and Final contract, that should a schedule quality review be below a given % that the schedule will be rejected as being in non-compliance of the agreement.

Case Study using the Scoring Template for Project ‘X’

An old O&G Project, Project ‘X’, had a baseline of 3,999 activities with the provision of rolling wave scheduling for the completion activities finally reached 4,816 activities. It was for the fabrication and minor completions of 10,500 tonnes of modules (12) destined for the Middle East. The schedule was resource loaded with direct workhours but did not contain costs as this was part of the EPC Managements team lump sum the breakdown of which was not made known to the Client.

Project ‘X’ XER was uploaded in the macro-based XER-READER Excel spreadsheet and along with the Primavera Schedule Log file, populated all the cells requiring input to provide an overall assessment figure. Figure 5 below shows a summary of the results using the score card showing that the schedule quality has scored 59.8%.

Project 'X' - Checksheet Summary Score	
<u>Ten Best Practices</u>	Score
1. Capturing all activities.	7.3
2. Sequencing all activities.	11.0
3. Assigning resources to all activities.	9.8
4. Establishing the duration of all activities.	7.3
5. Verifying that the schedule can be traced horizontally and vertically.	2.4
6. Confirming that the critical path is valid.	7.3
7. Ensuring reasonable total float.	4.9
8. Conducting a schedule risk analysis.	2.4
9. Updating the schedule using actual progress and logic.	3.7
10. Maintaining a baseline schedule.	3.7
Total :	59.8

Figure 5 Scorecard Results Summary¹⁵

What does 59.8% mean? It would indicate that the schedule while functional needs work done to it to improve the overall quality. As a seasoned Senior Project Controls practitioner, I would recommend that 80% be the best starting point for an acceptable score. In this case, the schedule as presented falls short of that mark, so my recommendation would be for the schedule to be accepted with the proviso that the contractor addresses the areas that need improvement and resubmit, but in the meantime let the work continue as it should not be administrative tasks to delays completion of the project.

The scoring criteria of 80% was chosen as it is consistent with several legal and common socio-economic definitions:

- 1) It meets the “reasonable person” test, is “a fair pass mark based on numerous years’ of knowledge and experience in the industry as a senior project controls specialist, reviewing and accepting contractor’s schedules. The pass mark is based on the key elements of the schedule being present (activities captured, logic sequencing complete, simple IDs, detailed descriptions, resource loaded, and correct critical path identified, etc..) providing the quality basis for the product.”¹⁶
- 2) It meets the “Clear and Compelling Evidence” test, which means that there is “between 75% to 80% chance” that what has been presented as a pass mark is highly and substantially more probable to be correct than incorrect, and has met the burden of proof obligations¹⁷.

¹⁵ By Author

¹⁶ Negligence legal definition of negligence. (n.d.). Retrieved from <http://legal-dictionary.thefreedictionary.com/Negligence>

¹⁷ Clear and convincing evidence standard | LegalMatch Law Library. (n.d.). Retrieved from <http://www.legalmatch.com/law-library/article/clear-and-convincing-evidence-standard.html>

- 3) 80% is consistent with Pareto's "80/20" rule.¹⁸
- 4) 80% (Letter grade of B-) is consistent with the minimum acceptable grade for most graduate school¹⁹

If the GAO Assessment Guide is used as a basis, developed schedules should be hitting close, if not, better than the recommended 80% figure.

With that in mind, we need to address one of the purposes of this paper, "incorporation into the contractual documents". Within the 'Schedule Development' section of the contractual documents includes contractual/legal words to the effect "CONTRACTOR shall develop, submit and maintain a Project Execution Schedule in line with the coordination procedures. The initial submittal which when accepted will be termed the 'Project Baseline' must achieve a minimum score of 80% using the 'self-assessment scorecard' which shall be submitted along with the schedule for review and acceptance by COMPANY. As a reference CONTRACTOR shall be familiar with the GAO document, GAO-16-89G, Schedule Assessment Guide."

Benchmarking

As a check, two commercially available schedule analysis software packages; 1. Deltek Acumen²⁰ and 2. XER Schedule Toolkit²¹ were reviewed to determine if the developed scoring model was 'in the ballpark' so to speak. Both packages mentioned are available on the open market, and provide comprehensive analysis of how good the schedule quality is. The choice to select these two packages; Acumen Fuse (now called Deltek Acumen) has long being regarded as a leader in performing this type of analysis, mainly using the DCMA's 14-point check²², but can be adapted to view the GAO schedule check also – This package is a significant outlay of funds to purchase with high cost yearly maintenance fees.

The other package XER Schedule Toolkit is an excellent piece of software that every planner and scheduler reviewing schedules should have in his toolkit. The software is very reasonably priced and very reasonable maintenance plans. For those interested, there are an excellent number of training videos for both packages online. These packages produce a schedule quality dashboard which is backed up with individual key metrics.

As mentioned above, Deltek Acumen have metrics for "Industry Standards" both DCMA and GAO are listed alongside NASA²³. For the GAO, they have 82 checks over 12 sections as it appears Best Practice 8 and 10 have been split into two sections. A cursory review of their acceptance criteria suggests that the developed scoring model is within range, but Deltek has a middle ground on some items whereas the scoring model is a straight pass or fail.

¹⁸ Understanding the pareto principle (the 80/20 rule) – BetterExplained. (n.d.). Retrieved from <https://betterexplained.com/articles/understanding-the-pareto-principle-the-8020-rule/>

¹⁹ Test grade percentage calculator. (n.d.). Retrieved from http://www.csghnetwork.com/test_grade_percentage_calculator.html

²⁰ DELTEK ACUMEN 8.0 [Computer software]. (2016)

²¹ XER SCHEDULE TOOLKIT version 132-0-0-19 [Computer software]. (2016)

²² DCMA (Defense Contract Management Agency), Date unknown, *Generally Accepted Scheduling Practices (GASP)*.

²³ *Schedule Management Handbook*, NASA/SP-2010-3403, March 2011.

XER Schedule Toolkit uses the DCMA as its basis and has 21 checks listed, as with Deltek Acumen there is some middle ground.

Using the Project 'X' XER file the following results were returned with regards the quality of the schedule.

Deltek Acumen

The suite of reports that Deltek Acumen can produce are extensive so I've run the Schedule Quality Executive Summary along with the associated Ribbon and Phase Analysis. There are total of 5 figures providing the Schedule Quality information. Amongst the analysis Deltek Acumen advises that the schedule is rated as having an 18.5% of success.

Trend Analysis

The following section details how the characteristics of the workbook vary over time. This provides useful insight by showing improving/worsening trends. The analysis was conducted using years as time intervals:

- **Missing Logic:** decreases over time with the best period being 2013 (1) and the worst period being 2015 (536).
- **Logic Density:** increases over time with the highest period being 2017 (6.15) and the lowest period being 2013 (2.00).
- **Critical:** increases over time with the highest period being 2017 (385) and the lowest period being 2013 (0).
- **Hard Constraints:** increases over time with the best period being 2013 (0) and the worst period being 2016 (17).
- **Negative Float:** increases over time with the best period being 2013 (0) and the worst period being 2017 (372).
- **Insufficient Detail:** remains constant over time.
- **Number of Lags:** increases over time with the best period being 2013 (0) and the worst period being 2016 (1526).
- **Number of Leads:** increases over time with the best period being 2013 (0) and the worst period being 2016 (18).
- **Merge Hotspot:** increases over time with the best period being 2013 (0) and the worst period being 2016 (1,130).

Figure 6 Deltek Acumen Executive Summary – Trend Analysis²⁴

²⁴ DELTEK ACUMEN 8.0 [Computer software]. (2016) Trend Analysis Report

Ribbon Analysis

A ribbon analysis shows how the results from the selected metrics vary across the selected groupings of activities. This is a useful means of comparing between such groupings. In addition, the scorecard value for each ribbon provides an overarching summary of each ribbon.

The workbook has been grouped by **by projects**. The analysis contains 1 ribbon: "O&G P1B".

Ribbon Analyzer

Ribbons \ Phases	Missing Logic	Logic Density™	Critical	Hard Constraints	Negative Float	Insufficient Detail™	Number of Lags	Number of Leads	Merge Hotspot	Scorecard Value
O&G P1B	702	4.50	431	17	406	0	2638	18	1,705	18.5%

The overall score for this ribbon is 18.5%.

O&G_P1B Ribbon Analysis

The O&G P1B ribbon contains 3900 normal activities, 916 milestones, 0 summaries and 0 LOEs spanning from Wednesday, 16 October, 2013 to Thursday, 23 February, 2017.

90.5% of the activities in this ribbon are complete; 7.6% are planned and 1.9% are in progress.

The ribbon is 1226 days long and has a remaining cost of \$42.8K.

The ribbon was analyzed using 9 metrics, as detailed below:

- 702 activities (15%) have Missing Logic. Less than 25% exceptions. Some improvements may be required.
- This ribbon has a Logic Density of 4.50. There are more than 4 links per activity.
- 431 activities (94%) are Critical.
- 17 activities (0%) have Hard Constraints. Less than 5% hard constraints. Some improvements may be required.
- 406 activities (89%) have Negative Float. More than 25% of schedule has negative float
- 0 activities (0%) have Insufficient Detail.
- This ribbon has a Number of Lags of 2638 (55%). More than 50% of activities have lags- failed tripwire.
- 18 activities (0%) have Number of Leads. Less than 5% of activities have negative lags.
- 1,705 activities (35%) are Merge Hotspot. More than 25% of activities have more than two predecessors.

Figure 7 Deltek Acumen Executive Summary – Ribbon Analysis²⁵

²⁵ DELTEK ACUMEN 8.0 [Computer software]. (2016) Ribbon Analysis Report

		Time Line			Ribbon Analyzer									
		2015	2016	2017	Missing Logic	Logic Density™	Critical	Hard Constraints	Negative Float	Insufficient Detail™	Number of Lags	Number of Leads	Merge Hotspot	Score
Ribbon	O&G_P1B	[Progress Bar]			702 15%	4.5	431 94%	17 0%	406 89%	0 0%	2638 55%	18 0%	1,705 35%	19
Phase Analyzer	Missing Logic	536 28%	157 5%	8 2%										
	Logic Density™	3.75	4.92	6.15										
	Critical	0 0%	110 92%	385 95%										
	Hard Constraints	0 0%	17 1%	0 0%										
	Negative Float	0 0%	34 63%	372 92%										
	Insufficient Detail™	0 0%	0 0%	0 0%										
	Number of Lags	1023 52%	1526 60%	89 26%										
	Number of Leads	0 0%	18 1%	0 0%										
	Merge Hotspot	367 19%	1,130 45%	208 61%										
Score	16	21	2											

Figure 8 Deltek Acumen Schedule Quality Analysis²⁶

		Ribbon Analysis									
		Primary Formula Analysis									
		Ribbon Analyzer									
		Missing Logic	Logic Density™	Critical	Hard Constraints	Negative Float	Insufficient Detail™	Number of Lags	Number of Leads	Merge Hotspot	Score
Ribbons	O&G_P1B	702	4.5	431	17	406	0	2638	18	1,705	19

		Secondary Formula Analysis									
		Ribbon Analyzer									
		Missing Logic	Logic Density™	Critical	Hard Constraints	Negative Float	Insufficient Detail™	Number of Lags	Number of Leads	Merge Hotspot	Score
Ribbons	O&G_P1B	15%		94%	0%	89%	0%	55%	0%	35%	

Figure 9 Deltek Acumen Ribbon Analysis²⁷

²⁶ DELTEK ACUMEN 8.0 [Computer software]. (2016) Schedule Quality Analysis Report

²⁷ DELTEK ACUMEN 8.0 [Computer software]. (2016) Schedule Quality Ribbon Analysis Report

Phase Analysis

Primary Formula Analysis				
		Time Line		
		2015	2016	2017
Phase Analyzer	Missing Logic	536	157	8
	Logic Density™	3.75	4.92	6.15
	Critical	0	110	385
	Hard Constraints	0	17	0
	Negative Float	0	34	372
	Insufficient Detail™	0	0	0
	Number of Lags	1023	1526	89
	Number of Leads	0	18	0
	Merge Hotspot	367	1,130	208
	Score	16	21	2

Secondary Formula Analysis				
		Time Line		
		2015	2016	2017
Phase Analyzer	Missing Logic	28%	5%	2%
	Logic Density™			
	Critical	0%	92%	95%
	Hard Constraints	0%	1%	0%
	Negative Float	0%	63%	92%
	Insufficient Detail™	0%	0%	0%
	Number of Lags	52%	60%	26%
	Number of Leads	0%	1%	0%
	Merge Hotspot	19%	45%	61%
	Score			

Figure 10 Deltek Acumen Phase Analysis²⁸

Another aspect that Deltek Acumen provides is checking of the schedule metrics against their online database of Project Schedules contained in their database returning an Index value and percentile ranking for both Schedule and Logic Indexes.

²⁸ DELTEK ACUMEN 8.0 [Computer software]. (2016) Schedule Quality Phased Analysis Report



Figure 11 Deltek Acumen Schedule Index²⁹

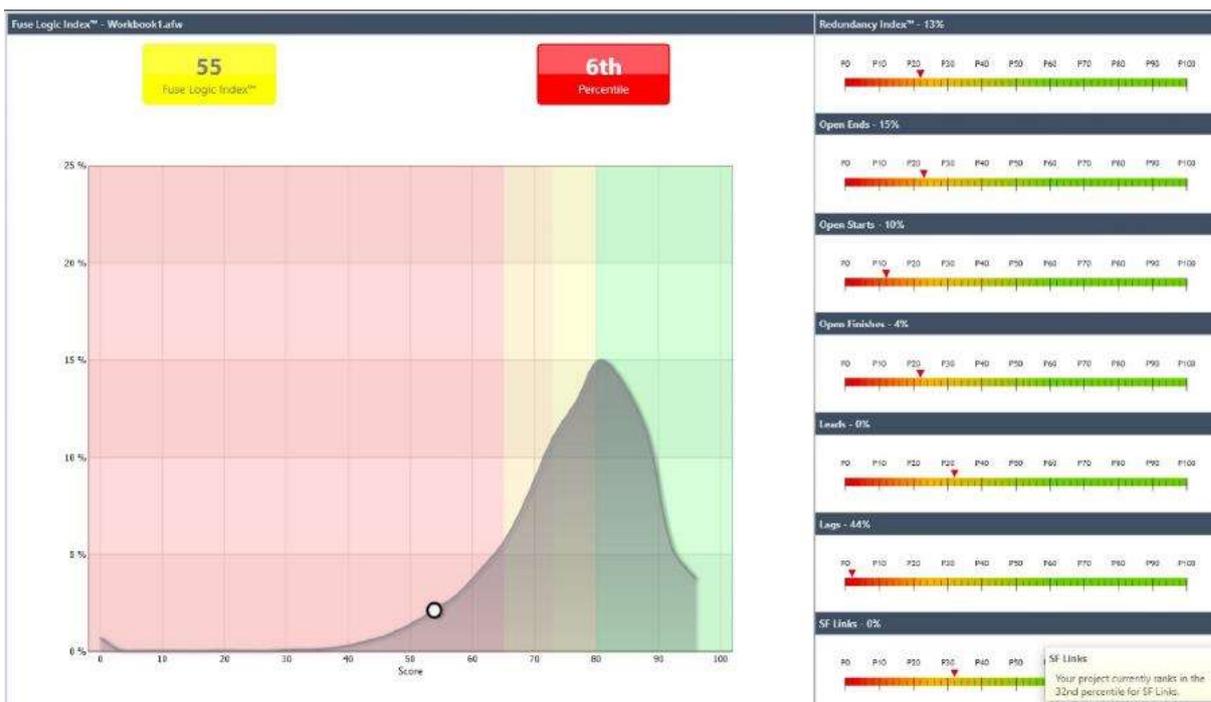


Figure 12 Deltek Acumen Logic Index³⁰

²⁹ DELTEK ACUMEN 8.0 [Computer software]. (2016) Schedule Index Ranking

³⁰ DELTEK ACUMEN 8.0 [Computer software]. (2016) Logic Index Ranking

XER Schedule Toolkit

The twenty-one checks performed by XER Schedule Toolkit provide various ways to view the results. The two figures below '12' and '13' show the typical output after analyzing the imported XER file. The schedule, as checked, shows 10 Green, 1 Orange, and 10 Red results there is no overall score, but indications are that the schedule quality is not great, potentially around the 50% mark.

Schedule Toolkit - Schedule Compliance Summary Report		Threshold limits			
Missing Predecessors (676 of 4,816 – 14.0%)	0	2	5	Percent	
Missing Successors (28 of 4,816 – 0.6%)	0	2	5	Percent	
Open Finish Tasks (201 of 4,816 – 4.2%)	0	2	5	Percent	
Open Start Tasks (478 of 4,816 – 9.9%)	0	2	5	Percent	
Relationship Leads (20 of 10,825 – 0.2%)	0	1	1	Percent	
Relationship Lags (4,788 of 10,825 – 44.2%)	0	1	5	Percent	
Relationship Ratio (4,699 of 10,825 – 43.4%)	0	5	10	Percent	
Constraints (64 of 4,816 – 1.3%)	0	2	5	Percent	
High Float (0 of 4,816 – 0.0%)	0	2	5	Percent	
Negative Float (406 of 4,816 – 8.4%)	0	1	1	Percent	
High Duration (9 of 3,900 – 0.2%)	0	2	5	Percent	
High Costs (0 of 4,816 – 0.0%)	0	15	40	Percent	
Invalid Dates (0 of 4,816 – 0.0%)	0	1	1	Percent	
In Progress Errors (1 of 4,816 – 0.0%)	0	2	5	Percent	
Unresourced Tasks (764 of 3,900 – 19.6%)	0	2	5	Percent	
Assignment Dates (8 of 3,137 – 0.3%)	0	2	5	Percent	
Late Tasks Starting (2,634 of 4,816 – 54.7%)	0	2	5	Percent	
Late Tasks Finishing (2,906 of 4,816 – 60.3%)	0	2	5	Percent	
Missing Baseline Tasks (893 of 4,816 – 18.5%)	0	5	10	Number	
Redundant Logic (1,339 of 10,825 – 12.4%)	0	5	10	Number	
Logical Loops(0)	0	0	0	Number	

Figure 13 XER Schedule Toolkit Compliance Results³¹

³¹ XER SCHEDULE TOOLKIT version 132-0-0-19 [Computer software]. (2016) Schedule Quality Compliance report





Figure 14 XER Schedule Toolkit Quality Dials³²

Reviewing the Schedule update against the Original Baseline only checks the valid Tasks that appear in both XER files. The activity count is 3,923 while the update has 4,816 due to rolling wave development of system completion activities.

Figure ‘X’ provides an indication of the how the contractor performed against its baseline.



Figure 15 XER Schedule Toolkit Adherence Report³³

Results from both Deltek Acumen and XER Schedule Toolkit support that the schedule submitted is not of a great quality, Deltek Acumen suggests it has a 18.5% chance of achievement, while XER Schedule Toolkit although it does not cite a figure, indicates that 10+ points out of 21 are not meeting the criteria.

³² XER SCHEDULE TOOLKIT version 132-0-0-19 [Computer software]. (2016) Schedule Quality Report

³³ XER SCHEDULE TOOLKIT version 132-0-0-19 [Computer software]. (2016) Baseline Adherence Report

Argument in support of thesis

The author's research goal was to provide a scorecard that would reside in the Schedule section of the Contractual documents which supported the GAO's Best Practices to determine whether the schedule as submitted meets the acceptable 80%. The paper demonstrates the available options used to select a suitable scoring method, and scoring criteria, before finally developing the scorecard. The scorecard was then tested in a case study using an old O&G project providing a result of 59.8% indicating that the schedule quality needed improvement. The O&G Project was analyzed using two professional software packages Deltek and XER Schedule Toolkit. Both packages scored the schedule as being low quality and in need of refinement, Deltek Acumen (18.5% chance of succeeding) and XER Schedule Toolkit (circa 50%+). It should be noted that although both packages indicated the quality % was lower than the developed scorecard, they supported the fact that the schedule quality needed improvement.

Conclusion

The original purpose of this paper was to:

1. Incorporate into Contracting documents;
2. Quickly assess the quality of a contractor's schedule being presented for review; and
3. Provide the relevant contractors with a score card that can be used to enhance any subsequent submission(s).

Point 1 was established by proposing that clear direction be provided that the Contractor is familiar with the GAO Schedule Assessment Guide, and develops a schedule in accordance with its guidance. In addition, there is a need to perform a self-assessment on the schedule which must score a minimum of 80%, and be submitted with the schedule for acceptance. Projects are dynamic and there may be the need to accept a lower figure 'subject to' the contractor making improvements to reach the minimum % within a stipulated timeframe, as there is a need to keep the project moving ahead and not being delayed due to what could be termed as administrative noise.

Point 2 was developed as shown in Figure 4, with the full version contained in Appendix V. The Scorecard as developed adopts a scoring method that the author who is a senior project controls professional considers acceptable to meet the requirements of a quality schedule. The scorecard when completed against a previous project provided a score of 59.8% suggesting that it was lower than the required 80%. This was supported by the benchmarking exercise using the commercially available software packages, Deltek Acumen (which provided an 18.5% of success for the schedule) and XER Schedule Toolkit (approx. 50%). This paper provides a 'free' score card for fellow professionals to use, or develop further, without having to purchase software.

Point 3 can be seen in Appendix V, and covers the Ten Best Practices as outlined by the GAO. Recognizing that both Deltek Acumen and XER Schedule Toolkit are leaders in schedule quality analysis, there is a need to gain alignment between software products. There needs to be a standardized approach to scoring of the quality of a schedule, resulting in better alignment between scoring methods, be it the developed scorecard for this paper, Deltek Acumen, XER Schedule Toolkit, or any other schedule quality analysis software.

With all three points addressed, the author urges fellow professionals to adopt the ‘Scorecard’ as an alternate, manual schedule analysis method to the commercial software packages to determine schedule quality of their current and future schedules.

To conclude, the author recommends that the following wording be included in the ‘Schedule’ section of the contract documents to require that the contractors schedule meet or exceed the GAO’s requirement “CONTRACTOR shall develop, submit and maintain a Project Execution Schedule in line with the coordination procedures. The initial submittal which when accepted will be termed the ‘Project Baseline’ must achieve a minimum score of 80% using the ‘self-assessment scorecard’ which shall be submitted along with the schedule for review and acceptance by COMPANY. As a reference CONTRACTOR shall be familiar with the GAO document, GAO-16-89G, Schedule Assessment Guide.” and that to minimize delays to the project by not having a schedule that meets the requirements, that the schedules be accepted “subject to” making the corrections/improvements on/before the next required submittal date.

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