Questionnaire Survey on Dynamic Scheduling in Construction

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Abstract

Background: Dynamic Scheduling is a new topic in construction planning and scheduling research field. Understanding the planners’ day to day scheduling/rescheduling problems and studying the practicality of the problem’s characteristics are key issues in the development of any new dynamic scheduling system.

Objective: The purpose of this study was to collect the experienced opinion of field practitioners which will support an ongoing research in the development of a Dynamic Scheduling model for real-time scheduling for construction enterprises.

Design: A questionnaire survey consisting of 33 questions, mainly close ended.

Setting: The survey was published on the internet, and nearly 9,000 project management practitioners were invited for participation.

Participant: A total of 364 responses were received with an average response rate of 4.1%. The responses were received from 52 different nationalities with reasonable geographic distribution, and with various levels of experience and project management roles.

Analysis methods: A combination of frequency distribution and descriptive statistics were used for the analysis of survey responses.

Results: The responses analysis showed a clear interest from the project management population to the subject of dynamic scheduling, participants acknowledged the need for a new solution to manage the optimization tasks and they provided their various interests on how the proposed tool should work and how it should be integrated with current practices.

Conclusion: From the response rate, distribution of responses and the quality of replies to few test questions, the survey can be claimed to represent the project management community. The response results were analyzed presented in this study and converted into functional specifications of the proposed software tool which will be presented in future studies.

Keywords: Dynamic Scheduling; Schedule Optimization; Planning Software.

Introduction

Planning is the core of project management; so, its success contributes much to the success of projects. For the planning function to be successful, a complete and flexible resourced schedule
must be generated before the project’s commencement; and must be properly maintained during execution.

Real-time events extremely disrupt the integrity of project schedules. The presence and implementation of a predefined Dynamic Scheduling strategy to mitigate these disruptions is a must for the successful implementation of project planning.

An ongoing research in construction scheduling field is working on the development of a Dynamic Scheduling model for real-time scheduling for construction enterprises. The survey was designed to support this research by investigating the day to day scheduling/rescheduling problems facing field practitioners and to collect their experienced opinions of how a new dynamic scheduling system can be developed to assist them in a practical and efficient way.

The model under development will be the base for a new software tool for the optimization of construction schedules; this automated optimization solution will be integrated with the commonly used project management software packages. The results of this survey will define the default functionality of the proposed software tool.

The main function of the new software is to work in the background on the progressing/open front activities and try to establish alternative solutions in case one or more of these activities is somehow disrupted. So, for any disruption which might happen, the planner will find few readymade fully optimized (time/cost/resources) alternatives to choose from; these alternatives will be generated based on his previous settings of the mass of changes to the schedule expected with the optimization processes, and what kind of optimization he is searching for.

**Dynamic Scheduling Review**

The Dynamic Scheduling topic has gone through various researches and publications during the last two decades, especially within computer and manufacturing industries. However, it is still a quiet new topic in the application to construction industry; and there is a shortage in the literature of this topic in construction scheduling field.

Initially, a literature review was performed on static scheduling topic to outline the main features which govern static scheduling optimization process. This review was used to identify the questions of the Scheduling Section of the survey. Herroelen [1998] and Brucker [1999] collected and classified Resource Constrained Project Scheduling Problems (RCPSPs), which represent the core of static scheduling; they also proposed various optimization models for the problem’s analysis. Another detailed survey was lately presented by Hartmann [2010] for variants and extensions of the RCPSP.

Project Scheduling, especially in the construction field, is inherently complex and dynamic, involving multiple feedback processes and nonlinear relationships. While problems encountered during construction are fundamentally dynamic, most researchers have been treating the problems statically within a partial view of a project [Lyneis et al, 2001]. As a result, schedule delays and cost overruns are common in construction projects in spite of advances in construction equipment and management techniques. To overcome these chronic symptoms, enormous efforts have been devoted to the planning and control aspects of construction management [Lee et al, 2006].
Methods and techniques of Dynamic Scheduling as well as real-time events which cause disruptions to static scheduling were discussed and categorized differently in several surveys and researches ([Suresh, 1993]; [Stoop, 1996]; [Cowling, 2002]; [Vieira, 2003]; [Ouelhadj, 2009]). As a part of this study, another literature review was performed on the topics of dynamic scheduling; this review supported in building the academical side of the proposed dynamic scheduling system; however, this review showed that the literature lacked the practicality of implementation in construction. Features and polices of any dynamic scheduling system in construction will always be subjective to the project’s conditions and the project management strategy. So, the Dynamic Scheduling section of the survey was introduced to cover the gaps of the literature with respect to the practical implementation within construction industry.

Methods

Questionnaire Survey Design

The purpose of the questionnaire was not to represent the opinion of all planners worldwide about the scheduling problems, but to get a general practical opinion about the problem and the proposed solution’s outputs. In addition, the planning/scheduling process is now having some sort of common practice concepts due to the presence of commonly accepted knowledge guidelines and due to the use of common software packages which share the same concepts of modeling, inputs, analysis and outputs.

So, the sample chosen for the questionnaire was not intended to be very large in size or to be spread over large number of predefined different practices; it just needed to represent different types of directly involved users (contractors/consultants planners), different expertise levels (senior/junior planners and management) which will identify different levels of requirements, as well as planners with different nationalities & with different working locations in order to have a broad opinion about the expected features of the proposed solution.

The questions were carefully phrased, ordered and categorized under four sections: General Information, Scheduling Problem, Proposed Solution’s Features and Future Communications. Each section was designed to serve a certain purpose; whether to collect group of data, or to guide the survey elements in a specific direction required for the accomplishment of the survey’s objectives. The following points review the questionnaire’s sections detailed sub-objectives and how they were addressed with the survey questions (the full questionnaire is included in Appendix A):

General Information Section

The main objective of this section was to collect the survey participants’ information required for properly categorize their opinions based on their organization type, level of experience and their location. The followings were the objectives of the section:

- Categorize survey results by organization type: This objective was required to identify the organization types to which the proposed solution is applicable. Question 1 was added for this purpose.

- Categorize survey results by level of experience: Replies were expected to be different based on the participants’ level of experience, especially questions related to the method of solution integration or related to contractual matters. Questions 2 to 5 were introduced to collect information required for this purpose; each reply will have a certain weight, and the
total answers will be averaged into a 3 steps scale for experience (Small, Medium and High experience).

- Categorize survey results according to location: This was required for measuring the diversity of survey participation, in order to ensure that it was attended by several project management backgrounds and practices, and to help in classifying the level of suitability of the proposed solution to practices of different locations. Questions 6 & 7 were added for this purpose.

**Rescheduling Problem Section**

There were three objectives for this section:

- Refresh the memory of the surveyed planners with respect to the rescheduling problem, and to pull their attention that the study in the background of the survey is dealing with one of their main nightmares; which will hopefully motivate them to answer the questions with good care. The headings of questions 8-10 (schedule optimization) and 12-17 (real-time events) were carefully written to support this objective.

- Collect the participants’ experience/opinion on what they usually face in regard of schedule optimization and the rescheduling process; these opinions will be then added to the problem definition along with the same subject’s literature review. The answers alternatives given for questions 8-10 and 12-17 can be claimed to cover all possible replies required to collect the information needed for this objective.

- Check with the participants the need for a tool to support in the optimization of their schedules, and to test their willingness to trust a software tool for this purpose. Questions 11 & 18 were included to serve this objective; question 11 for the baseline / revised schedule optimization and question 18 for the updated schedule optimization.

**Proposed Solution’s Features**

This section was designed to let the planners answer to one main question: “What do you need from the proposed system?” The questions were designed to collect the field planners’ requirements with respect to inputs, expected outputs, and features of the final product; while responses alternatives were designed to include the two extremes of opinions and two intermediate choices. For this section, mainly, the collected responses must be weighed according to the elements’ experience in order to support the decision of what features are actually required (i.e. involves large time/effort for manual analysis. The sub-objectives of this section can be summarized as follows:

- Frequency & mass of analysis: Questions 19, 20 & 21 were added to collect the planners’ opinion about the required frequency for running the optimization analysis. Question no. 19 surveys how to measure the mass of changes of each alternative, while questions 20 & 21 checks the mass of changes which can be allowed in different scheduling phases.

- Practicality of optimization features & objectives: This objective is one of the main objectives of the survey. It aims for checking the practicality of different features of the proposed solution. Four questions were added for this purpose: Question no. 22 for checking the practicality of using activity modes, question no. 24 for enterprise resource
analysis, question no. 25 for few cost issues, and question no. 26 for criticality and flexibility indices.

- Solution integration with current Project Management practices: Questions 27, 28 & 29 were added to investigate the preferences of the field practitioners on how the proposed solution should be integrated with existing practices, and which software packages should be considered in the integration process.

Future Communications

The objectives of this section were:

- Encourage the participants to complete and send their responses by asking them (question no. 30) for their willingness to receive a free copy of the developed software, which was claimed in the survey contents that will solve a considerable portion of their scheduling problems.

- Testing the survey’s success in collecting reliable information: This was planned to be checked by asking the participants (questions 31 & 32) if they would like to receive a copy of the survey results or future related research works. If their replies were oriented towards the willingness to receive future communications, then the survey succeeded to pull their attention to the topic (i.e. they have carefully responded to survey questions). On the other hand, the reverse replies might be an indication that the schedules optimization and dynamic scheduling issues does not represent a great concern to the planning community.

- Spread the survey within the participants’ contacts: Question 33 provided a platform for the participants to add few of their contacts which they believe might be interested in the topic.

Survey distribution and responses demographic analysis

A webpage was developed for the questionnaire survey and published on the internet to facilitate its spreading. Then invitations were sent to major construction companies and consultancy offices; in addition, other invitations were sent to the members of few popular planning forums. The total number of participants was 364, with a response rate of about 27% of sent invitations. Table 1 shows the summary statistics of the received responses.

The participants were fairly distributed among different organization categories as shown in Table 2.

Their distribution was also ideal with respect to seniority and experience levels (tables 3 & 4), where all roles/experience levels were required to participate, especially Senior Level and high/medium
experience planners because they will be the main target users for any proposed technical solution.

<table>
<thead>
<tr>
<th>Seniority Level</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Management</td>
<td>43</td>
<td>11.8%</td>
</tr>
<tr>
<td>Department Management</td>
<td>93</td>
<td>25.6%</td>
</tr>
<tr>
<td>Senior Level</td>
<td>204</td>
<td>56.0%</td>
</tr>
<tr>
<td>Junior Level</td>
<td>24</td>
<td>6.6%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>364</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

*Table 3: Responses distribution on Organizational Roles*

**Statistical methods used**

A combination of frequency distribution and descriptive statistics were used for the analysis of survey responses as will be shown later in the Discussion section.

**Results**

**Reliability and validity of responses**

With respect to geographical distribution, the following table shows that the participants were well distributed all over the world. The distribution was even close to the worldwide population distribution as per the UN population reports [UN Pop. Report 2011], except for Asia & Europe; this is reasonable because the higher the countries’ prosperity, the higher the need from project management and planning. So, in light of the above, the results can be claimed to represent the worldwide planning population.

<table>
<thead>
<tr>
<th>Location</th>
<th>No.</th>
<th>%</th>
<th>2010 Population</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>58</td>
<td>15.9%</td>
<td>1,033 (14.9%)</td>
<td>1.0%</td>
</tr>
<tr>
<td>Asia</td>
<td>124</td>
<td>34.1%</td>
<td>4,167 (60.3%)</td>
<td>-26.2%</td>
</tr>
<tr>
<td>Europe</td>
<td>114</td>
<td>32.1%</td>
<td>733 (10.6%)</td>
<td>21.5%</td>
</tr>
<tr>
<td>North America</td>
<td>33</td>
<td>9.1%</td>
<td>352 (5.1%)</td>
<td>4.0%</td>
</tr>
<tr>
<td>South America</td>
<td>11</td>
<td>3.0%</td>
<td>589 (8.5%)</td>
<td>-5.5%</td>
</tr>
<tr>
<td>Oceania</td>
<td>21</td>
<td>5.8%</td>
<td>36 (0.5%)</td>
<td>5.2%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>345</td>
<td>100.0%</td>
<td>6,910 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

*Table 5: Comparison of Responses distribution by Location and the world’s population distribution on 2010 (UN Pop. report 2011)*

With respect to validity of responses, the analysis of responses to certain questions having certain answers expected not to be selected regardless of the role and experience of the participant (for ex.: reply no. 4 to questions 12 & 13: ‘Disruption to schedules never happened’), shows that the frequency of selection to these answers was very low (less than 1%) which was considered as a sign of validity to the responses to other questions. In addition, 92-95% of the participants were interested in either the receipt of the final results of the survey, the receipt of a copy of the developed software tool, and the receipt of further updates for the same and/or similar works; this interest in the subject can be considered as another sign to the seriousness (i.e. validity) of the responses.
Responses statistical summary

The following tables summarize the statistical analysis of responses in a frequency distribution (number of responses to each answer and percentage distribution of responses) as well as descriptive statistics (mean and standard deviation for overall responses and categorized by experience levels and organization types).

<table>
<thead>
<tr>
<th>Qs. No.</th>
<th>Answers</th>
<th>Overall Mean</th>
<th>S.D.</th>
<th>Categorized by Experience Level</th>
<th>Categorized by Organization Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mean   S.D. Mean   S.D. Mean   S.D.</td>
<td>Mean   S.D. Mean   S.D. Mean   S.D. Mean   S.D. Mean   S.D.</td>
</tr>
</tbody>
</table>

### Table 6: Summary of Statistical analysis for Survey’s Responses

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Questions 1 to 7 were used for categorizing results, so they were excluded from the analysis below. Also question 14 was excluded, because it was only used to refresh the participants’ memory about the real time events causing disruption to schedules so that they can answer the related questions effectively. And finally, question 27 was excluded because it was an open ended question for the participants to provide their suggestions.

Discussion

Rescheduling Problem section

This section was intended to collect the participants’ opinions about scheduling/rescheduling problems. With respect to resources analysis, 97.8% selected that it is required to be performed before baseline schedule submission, from which 87.5% acknowledged that the time was always not sufficient to review all resources distribution. For cash flow analysis, 91.4% selected that it is required, while 75.8% acknowledged that the time was always not sufficient to change the schedule accordingly. Similar response ratios were given to the same issues during schedule updates, but with less importance to cash flow analysis where 16.8% selected that it is not required during schedule updates.

Real time events were selected as the main cause of disruption to schedules, where less than 0.8% of the participants stated the real-time events does not impact schedule integrity, while more than 85% selected that this disruption usually/always happens.

Finally, 96.4% selected that the presence of optimization software might help during baseline scheduling, from which 70% selected that such software will definitely have an added value. A similar response ratio was given to the importance of this optimization software tool during schedule updates.

Proposed Solution’s Features section

The results for most of this section’s questions were fairly distributed among alternatives, where the most selected answer rarely crossed 60%. This is mainly due to the different practices and interest of participants; where some options were important to few participants, good to considered for others, and not practical for the balance. This leads us to the fact that all the mentioned features must be considered as optional within any proposed solution, and the decision to be left for the user for selection according to his opinion or project’s requirements.

For software packages to be integrated with, 77.5% accepted that the 3 mentioned packages are fairly enough, while the rest had few other packages which they suggested for integration with the new tool, but none of these packages exceeded 2.5% of the participants except for regular spreadsheet packages which were suggested by 4.4% of the responses.

Future Communications section

The results shown in table 6 shows the general interest of participants in the subject under study, where 94.2% were interested to receive a copy of the developed software tool, 92.4% of the participants were interested to receive the final results of the survey, and 95.8% were interested to receive further updates for the same subject or similar innovative works in planning/scheduling.
Conclusion

This questionnaire survey was designed and implemented as a part of an ongoing study on the applications of dynamic scheduling to construction industry. The results of the survey are to be used to identify the practical features of a new dynamic scheduling model for construction enterprises and an associated software tool for real-time scheduling in construction projects.

A total of 364 responses were received with an average response rate of 4.1%. The responses were received for participants from 52 different nationalities with reasonable geographic distribution, and with various levels of experience and project management roles. The statistical analysis of survey responses showed that most of the participants acknowledged the need for an optimization tool to support them during planning/scheduling their projects. The analysis also showed a clear interest of the project management population to the new subject. The responses were then further analyzed and converted into functional specifications of the proposed software tool which will be presented in future technical papers.

The problem of scheduling in the presence of real-time events is of great importance for the successful implementation of scheduling systems in construction projects. Various researches should be generated in construction scheduling field to investigate the issue of how to handle the occurrence of real-time events during the execution of a given schedule, in regard of how and when to run the repair or the optimization algorithms to the current static schedule to bring it back to the optimal or near-optimal state.
Appendix A: Dynamic Scheduling Questionnaire

Planning is the core of project management; so, its success contributes much to the success of projects. For the planning function to be successful, a complete and flexible resourced schedule must be generated before the commencement of the project, and must be properly maintained during the execution.

Real-time events extremely disrupt the integrity of project schedules. The presence and implementation of a predefined Dynamic Scheduling strategy to mitigate these disruptions is a must for the successful implementation of project planning.

The purpose of this survey is to collect the experienced opinion of field practitioners which will support an undergoing research working on the development of a Dynamic Scheduling model for real-time scheduling for construction enterprises. The developed model will be the base for a new software tool for the optimization of construction schedules; this automated optimization solution will be fully integrated with the commonly used project management software packages.

The main function of the new software is to work in the background on the progressing/open front activities and try to establish alternative solutions in case one or more of these activities is somehow disrupted. So, for any disruption which might happen, the planner will find few readymade fully optimized (time/cost/resources) alternatives to choose from; these alternatives will be generated based on his previous settings of the mass of changes to the schedule expected with the optimization processes, and what kind of optimization he is searching for.

Your inputs within this survey will be an important factor in shaping the proposed solution; so, please answer the questions carefully. And thank you in advance for participating.

General Information:

This section is intended to collect some information about your work experience which will help us during the analysis of the survey results.

Name: ..............................................................

E-Mail address: .....................................................

Current Organization: ..............................................

1. What is the category of your current organization?
   - [ ] Project Management Consultants
   - [ ] General Engineering Consultants
   - [ ] General Contractors
   - [ ] Specialized Contractor (please state specialty field) ..............

2. What is the level of your current occupation?
   - [ ] Top management
   - [ ] Department management
   - [ ] Senior level
   - [ ] Junior level
3. What are your total years of experience within Project Management different fields?
   - More than 15 years
   - From 10 to 15 years
   - From 5 to 10 years
   - Less than 5 years

4. What are your total years of experience within Planning/Scheduling field?
   - More than 15 years
   - From 10 to 15 years
   - From 5 to 10 years
   - Less than 5 years

5. What is the scale of your current/previous projects? (More than one choice can be selected)
   - Mega projects (equal or greater than 1 billion US dollars)
   - Large scaled projects (between 100 million to 1 billion USD)
   - Medium scaled projects (between 10 to 100 million USD)
   - Small scaled projects (less than 10 million USD)

6. What is your nationality? (The question is required only to check that the survey was attended by various PM backgrounds, in order to ensure that the questionnaire’s results represents the planning population)

7. Please list the countries where you have worked before (starting from your current location):
   1. ………………….  2. ………………….  3. ………………….
   4. ………………….  5. ………………….  6. ………………….

Scheduling/Rescheduling Problems:
This section is intended to understand the mass of problems you experienced in regard of rescheduling the works of your projects.

8. In how many cases during the baseline schedule / revised schedule preparation you had the time to properly check the resources distribution and tried to level/smooth the resource histograms, and avoid gaps on the time frame between different assignments?
   - Always had the time to optimize all resource assignments
   - Usually had the time to optimize assignments of scarce/critical resources
   - Never had the time for it
   - I don’t think it is required

9. In how many cases during the baseline schedule / revised schedule preparation you had the time to check the project’s cash flow and may be go back and change certain sequence to match a certain cash flow requirement or to reduce negative troughs?
   - Always had the time for it
   - Usually had the time to view it, but not to change the schedule accordingly
10. **In how many cases during the baseline schedule / revised schedule preparation you had the time to check the critical/near critical paths for their flexibility (note: a flexible path is the one having most of its activities with normal un-crashed durations. This path gives the ability to apply some crashing measures upon its delay/disruption events)?**

- Never had the time for it
- I don’t think it is required during baseline preparation
- Always had the time for it
- Usually had the time only for the main critical path
- Never had the time for it
- I don’t think it is required during baseline preparation

11. **So, in general, do you think it will be a good solution to prepare your baseline / revised schedule, and then pass it to an optimization software to give some suggestions on how to optimize it?**

- Yes, it will save a lot of time and produce more professional output
- Yes, in all cases it will have some added value
- It's always good to try
- I think this will add more time to the schedule preparation period without having an added value

12. **In how many cases, after the baseline schedule / revised schedule preparation, an unexpected event occurs disturbing your schedule and causing portion of it to be incorrect and awaiting a future revision?**

- Always happens
- Usually happens
- Rarely happens
- Never happened

13. **In how many cases, after the baseline schedule / revised schedule preparation, an unexpected request from the client or company top management occurs disturbing your schedule and causing portion of it to be incorrect and awaiting a future revision?**

- Always happens
- Usually happens
- Rarely happens
- Never happened

14. **Which one of the following real-time events usually occur causing portion of your schedule to have incorrect logic and needs quick revision? (More than one choice can be selected)**

- Delayed engineering inputs
Delayed material delivery
Equipment breakdowns
Elongated construction activities
Other reasons ..............................................................

15. How many times the previously mentioned real-time events occur during the updates, and you didn’t have the time to check the integrity of your resource distribution before officially issuing the schedule update?

- Always had the time to check it
- Usually had the time only for scarce resources
- Never had the time to check it
- I don’t think these checks are required with each update

16. In how many cases during the schedule update you had the time to check the project’s cash flow and may be go back and change certain sequence to match a certain cash flow requirement or to reduce negative troughs?

- Always had the time for it
- Usually had the time to view it, but not to change the schedule accordingly
- Never had the time for it
- I don’t think it is required during schedule update

17. In how many cases during the schedule update you had the time to check the critical/near critical paths for their flexibility (note: a flexible path is the one having most of its activities with normal un-crashed durations. This path gives the ability to apply some crashing measures upon its delay/disruption events)?

- Always had the time for it
- Usually had the time only for the main critical path
- Never had the time for it
- I don’t think it is required during schedule update

18. So, in general, do you think it will be a good solution to prepare your schedule update, and then pass it also to an optimization software to give some suggestions on how to optimize it?

- Yes, it will save a lot of time and produce more professional output
- Yes, in all cases it’s good to try, it might produce good solutions
- It’s a good idea, but in many cases, logic changes might not be acceptable from contractual point of view
- No, I think this will add more time to the update process without having an added
Proposed Solution’s Features:

This part of the questionnaire might be the best section for some of the participants; the questions of this section are designed to survey your experienced opinion about what features the new software should contain in order to support in the day-to-day rescheduling works.

19. As explained in the Introduction of the survey, the proposed software will be running in the background attempting to optimize the project schedule and searching for alternative solutions in case of problems. So, how often do you think these alternatives needs to be proposed?

- Along with each periodical schedule update
- In case of resource requirements crossing predefined thresholds
- In case of delays to one of predefined milestones
- Only when requested by the planner

20. Sometimes the optimum solution will involve large amount of changes to the schedule, how often do you think large mass of changes to be allowed for the sake of optimization of the project’s resources/time/cost?

- Depends on the benefits associated with the optimized solution
- Large changes can be accepted on a predefined periods (during schedule updates).
- Large changes can only be accepted as What-If schedules for separate contractual approvals.
- Large changes can only be accepted when a schedule revision is under preparation (i.e. upon the planner’s request)

21. The optimization process takes large processing time, and if you knew that increasing the number of activities to be optimized will dramatically increase the hardware requirements where the software operates; in your opinion, which portion of the schedule should take the concentration of the background optimization calculations?

- Only critical activities affecting the project completion
- Critical/near critical activities affecting one or more of the project predefined milestones
- Critical, near critical and activities with start date close to the data date
- All activities. A completely optimized schedule worth the costs of additional hardware

22. “Activity modes” is the option where you can define different arrangement of resources for each activity, so that the optimization software can choose from while arranging the project’s resource distribution. Do you feel it is practical to use Activity Modes as an option during the optimization process, bearing in mind that each mode must be separately defined by the planner?
Activity modes will add to the optimization software another level of flexibility in reaching the optimum solutions, so it must be used along with each optimization process.

- Can be used for critical/scarce resources.
- It is only needed when a major rescheduling process is required.
- Activity modes are not practical in real life, once a certain mode is set for an activity, it will cause confusions to change it.

23. Beside activity modes, there are various other tactics that the optimization algorithm can utilize for attempting to reach the optimum solution. Which one of the following directions do you think is more reasonable in order to have minimum disruption to the original schedule logic? (More than one choice can be selected)

- Adjusting activities resource levels
- Rearranging the sequence of similar activities
- Manipulating lags between activities to adjust their location within the time frame
- Depends on the main objectives of the rescheduling process

24. The key issue of optimizing the project schedule is the proper utilization of resources; so, one of the key strategies a construction company can take is to properly utilize its resources between the running projects. Do you think the resources allocation between predefined projects can be a practical optimization tactic?

- Yes, as long as there is a benefit in the background of the allocation.
- Yes, but the mobilization/demobilization time and cost must be taken into consideration.
- Yes for tools/manpower resources, but not for large equipment.
- Resource allocation between running projects can show a theoretical savings, but practically it is not a good approach.

25. The cost and cash flow are very important issues in the project management field, an improper distribution of resources or large usage of hired resources can have large impact on the project budget. Which of the following measures do you think is important to be investigated while searching for optimum solutions? (More than one choice can be selected)

- Monitoring costs on the cost codes level along with each optimization trial is the hardest but the best solution for keeping the project within budget.
- The total cost of the project including internal equipment rental values in order to measure the mass of resource idleness.
- Project cash flow is important to monitor, in order to avoid unplanned large negatives which might require additional funding.
- Loading costs on schedules will complicate the analysis/decision making processes, so it should be checked separately.
26. An optimum/near optimum solution does not only mean a properly resources schedule meeting the target date/budget, there are also few other measures which can be used to weight the solutions resulting from the analysis. Which one of the followings you feel can be practically taken into consideration while choosing the alternative solutions? (More than one choice can be selected)

- **Criticality Index:** The less the number of critical activities in the project, the better the solution is.
- **Float Index:** The larger the float of predefined (or all) activities/resources, the better the solution becomes.
- **Activities Flexibility Index:** Each activity can have three duration values which vary according to its level of resources: minimum, maximum and preferred. Then, the closer the duration value from the preferred value, the more flexible (i.e. better) the solution is.
- **Resources Flexibility Index:** Each resource can have three defined values within the project: minimum (the amount of resources fully available for the project and must be utilized), maximum (including rented/hired) and preferred (the best utilization of the company’s resources. Then, the closer the value of assigned resources to the preferred value, the flexible (i.e. better) the solution is.

27. Please list any other practical features/factors which you feel should be included in the optimization process:

1. ........................................................................
2. ........................................................................
3. ........................................................................

28. How do you feel the new software should be integrated with current project management practices?

- Completely dependent software. No need for integration with existing software packages (i.e. current software packages will not be used in parallel).
- Dependent software which contains inputs, analysis and outputs. But projects can be converted to the formats of the commonly used software packages.
- Dependent software which communicates with common software packages in the form of their file formats. Data inputs and updates are done in the existing software packages then passed to the new software tool for optimization analysis; then returned back to the original software for presentation of outputs.
- An integrated solution with common software packages, where the tool can read from the existing packages’ databases to produce schedule alternatives, and have the ability to write back to the same databases if changes were accepted for implementation, or to store the alternatives as What-If schedules.

29. Which software packages do you think the new solution should be compatible and/or integrated with?

- **Primavera Project Management**
  - Must be compatible with
  - Strongly recommended
It’s good to be considered    Compatibility not required

- **Microsoft Project**
  - Must be compatible with
  - It’s good to be considered

- **Asta Power Project**
  - Must be compatible with
  - It’s good to be considered

- Please list any other software which you feel that it is **strongly recommended** to have the new solution integrated with

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**Future Communications:**

30. Would you like to receive a FREE copy of the Dynamic Scheduling software after the completion of its development?
- Yes
- No

31. After the analysis completion of this survey’s responses, would you like to receive a summary of the survey’s results?
- Yes, I need it for other research topic in the same/similar field
- Yes, it’s good to know the common opinions
- No, not interested

32. Would you like to receive any updates in future for researches with similar topics? (More than one choice can be selected)
- Yes, for any innovative works in the planning/scheduling field
- Yes, for research topics related to Schedules Optimization
- Yes, for research topics related to Dynamic Scheduling
- Not interested

33. Please list few names who worked/currently working in the field of Planning/Scheduling/Project Controls, and whom you feel we should contact to participate in the survey (please note that their contacts will be used **only** for this survey’s communications): ………………………………………………………………………
References


Amer Mohey El-Din Fahmy, MSc

Egypt

Amer Mohey El-Din Fahmy is a Planning Manager, at CCC/TAV JV, Development of Muscat International Airport project. He holds a BSc (Hons.) in Construction & Building Eng. from AASTMT, Egypt; MSc (Hons.) in Construction Management from AASTMT; and is currently a PhD student at Loughborough University, Construction Project Management (expected completion 2014). With 14 years of experience, he held several project management related positions within major construction industry enterprises (such as CCC & Siemens), for large and mega projects related to aviation, power networks, marine works, infrastructure, and industrial facilities; with contractor and consultancy experience in few middle east countries (Egypt, Jordan, Saudi Arabia, UAE, Bahrain, Qatar & Oman). His main specialty is focused on project controls systems establishment, procedural to implementation; especially with respect to integrated controls solutions, either with well-known software packages or with development of in-house oriented IT solutions. Amer’s experience is complemented with an academic background, including research activities within construction automation context, and with teaching experience within the Construction Management track, in the Construction & Building Engineering department, AASTMT, Egypt. Email: amer.fahmy@dynamicscheduling.net

Prof. Tarek Hassan, PhD

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Dr Tarek Hassan is Professor of Construction Informatics in Loughborough University (UK) and Director of the European Union Research Group (EURG). Tarek’s first degree is in Civil Engineering, also an MSc in Civil Engineering and another MSc in Construction Management from Loughborough University with distinction. He was awarded his PhD from Loughborough in 1996. His academic experience is complemented by 10 years of industrial experience with several international construction companies as a site engineer, site manager and project manager. His areas of expertise include advanced construction information technology, ICT (Information and Communication Technologies) for energy efficiency, smart buildings, industrialised construction, collaborative engineering,
Information Modelling, simulation, virtual enterprise business relationships, e-Business and legal aspects of ICT.

Tarek has been involved in over 17 EU funded projects as Coordinator or partner under the ICT and NMP (Nano technologies, materials and production) programmes of FP4, FP5, FP6 and FP7. He’s got a wide network of European and International partners including Universities, ICT companies, construction organisations, research institutes, consultants, municipalities, etc. He raised research funding of 7 Million Euros and participated in projects of total value of 40 Million Euros. Tarek is engaged in several activities with the EC (European Commission) as an expert evaluator of proposals, expert reviewer of running projects and advising the EC on projects’ performance and strategic research agendas for future calls. He is a member of the ECTP (European Construction Technology Platform), with focus area on processes and ICT. He serves on various international panels for evaluation of proposals including the Academy of Finland and the National Research Foundation of Singapore, funding agents of Poland and Russia. He has been an invited key note speaker to several international conferences and sits on the editorial board of international journals.

Tarek’s research breadth focused mainly advanced ICT to improve energy efficiency in buildings, and with considerable influence on the EC research agenda in identifying research priorities; in addition to researching into dynamic scheduling in construction, engineering higher education and gender aspects within engineering. Tarek’s research output has been reported in high quality journals, conferences and books chapters with a total of over 150 publications. Website: [http://www.lboro.ac.uk/departments/civil-building/staff/hassantarek](http://www.lboro.ac.uk/departments/civil-building/staff/hassantarek), e-mail: T.Hassan@lboro.ac.uk.

**Hesham A. Bassioni, PhD**

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Hesham A. Bassioni: PhD (U. Loughborough, UK), MIBA (ESLSCA, Fr), ME (U. Florida, USA), BSc (U. Alexandria, Eg), PMP. He is Dean of College of Continuing Education, Arab Academy for Science, Technology & Maritime Transport. He has a varied practical and academic experience for over 22 years. His consultancy and practical experience has been in the areas of: Project and program management; contract administration and claims management; FIDIC & Bespoke Contracts; project scheduling and control: cost estimating and control; feasibility studies, business cases and business plans; and project risk management. Organizational business management and restructuring; business process re-engineering; quality control and assurance; business excellence; business performance management (Balanced Scorecard); strategic management; risk management; and Disaster Risk Management (DRM). He has published over 30 research papers in various construction management leading journals and conferences. Prof. Bassioni has refereed papers to leading construction management journals and conferences. Email: hbassioni@yahoo.co.uk; hbassioni@aast.edu