Surveying, Planning and Scheduling for a Hill Road Work at Kalrayan Hills by Adopting ISS Method

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Abstract— To date, few construction methods have helped the project managers make a decision on the near-optimum distributions of men, material, Space and tools according to their job objectives and job limitations. This thesis presents an intelligent scheduling system (ISS) that can assist the project managers to find the near-optimum agenda plan according to their job objectives and job limitations. Intelligent scheduling system (ISS) uses model techniques to share out resources and allocate dissimilar levels of priorities to different tricks in each model cycle to find the near-optimum solution. ISS considers and combines most of the important construction factors (agenda of task, expenses, manpower, breathing space, utensils and material) at the same time in a incorporated environment, which makes the resulting agenda that will be nearer to optimum. Moreover, ISS allows for what-if analysis of probable scenarios, and schedule adjustments based on unexpected conditions (modified orders, delayed material delivery, etc.). As a final point, two model applications and one real-world construction job are utilized to illustrate and evaluate the success of ISS with two commonly used software packages, Primavera Project Planner and Microsoft Project.

Key words: Primavera Project Planner, intelligent scheduling system, Microsoft Project

I. Introduction

Construction projects are becoming gradually superior and more composite in terms of physical size and cost, hence the risks and potential for losses require better control. Project management has evolved mainly because of the need to direct costs and schedule. The Intelligent Scheduling Systems have been implemented to produce answers to the Questions which becomes difficult to the Project Managers.

- What is the near-optimum resource (i.e., manpower, material and equipment) distribution for each activity for different combinations of project objectives (e.g., bare minimum project cost and bare minimum job duration) and project constraints (e.g., project due date and daily resource constraints)?
- What is the near-optimum space distribution that can satisfy the requirements of resources with the minimum prohibition for the project objectives?
- What is the probability to reach the project objectives? Thus, the contractors can decide if they should buy the insurances for their projects and how much that they should buy accordingly. More importantly, is there a more reliable way to do risk analyses?
- What are the impacts if schedule adjustments are required based on unforeseen conditions (e.g., change orders and late material delivery)?

ISS was developed from combining computer simulation with analytical techniques. This approach can use the advantages and avoid the disadvantages of both simulation and mathematical modeling techniques. ISS considers and Integrates most of the important construction factors (schedule, cost, manpower, equipment, and material) simultaneously during the process of finding the near-optimum schedule, which makes the resulting schedule closer to optimal.

II. Objective of Study

The Main Objectives to Implement ISS method is:

- To produce efficient schedules, and Handle complex, mission-critical scheduling problems using ISS Method

The Major Objectives of ISS Method is:

1) Applies evolutionary techniques to decide the near-optimum distributions of manpower, equipment, material and space according to project objectives and project constraints.
2) Considers and integrates most of the important construction factors (schedule, cost, manpower, equipment, material and space) simultaneously in a unified environment, which makes the resulting schedule that will be close to optimal
3) Improves risk analyses on project duration, project cost, project revenue, and net present

III. Other Tools and Concepts Utilized

1) Captures Quantity Takeoffs from a 3D CAD model automatically
   a) ISS allows project managers to capture quantity takeoffs from a 3D CAD model automatically through database linkage system (built by the author andwill be introduced in a companion paper) and Dynamic Data Exchange (DDE) technique, or assign them manually
2) Develops Production Rate of Driving Resources
   a) The production rate of the driving resource determines the duration of the activity. ISS affords a manual interface to allow project managers to assign a possible maximum production rate for each resource in each activity. Production rates of driving resources in each activity will be identified and posted after running the simulation process
3) Develops the Utilization rate of each Resource/Space Allocation
   a) The purpose of developing utilization rates for each resource (manpower, equipment, material, space) allotted to a whole project in ISS is to afford project mangers the necessary databases to adjust the required resource amounts and space distributions.
4) What-if Analysis of possible scenario

a) ISS allows project managers to set up project constraints for any variable, project goals, maximum available resources for the whole projects. Once any of the settings is changed, ISS will reallocate the resource distribution for every activity. Thus activity duration, Project Schedule, Net Present Value will change accordingly.
5) Schedule Adjustments based on unforeseen conditions
a) ISS allows the project managers to do the schedule adjustments based on their requirements and practical situations.

IV. STRUCTURE OF ISS

A. Iss Flow Chart

The Flow Chart Consists of
1) Activity Network Building
2) Simulation Execution
3) Risk Analysis

B. Activity Network Building:

1) Step 1

The available manpower/equipment/material/space types in the whole project are identified. Then, the activity network is built and the resource types required in each activity are identified.

2) Step 2

The work quantity takeoffs for manpower/equipment/material are imported from 3D CAD model or assigned manually in each activity. And, the maximum available resource/space quantity and mean unit cost in the whole project are identified. In this simulation model all of the resources, except material resources which are assumed without daily resource constraints, are assigned integer variables with uniform distribution from one to their maximum available resource amount in each activity. The mean resource productivity and resource relationship constraints (e.g. one truck needs one driver) in each activity are assigned. The project objectives (e.g., minimum project duration, minimum project cost, or minimum project cost without exceeding assigned project due date) and project constraints (e.g., project due date and daily resource constraints) are defined.

C. Simulation Execution

3) Step 3

The Number of simulation Iterations is set

4) Step 4

In each activity, activity priority (the right to take precedence in obtaining required resources) is an assigned integer variable with a uniform distribution from one to the total activity quantity in the whole project.

5) Step 5

Manpower /Equipment/Space is distributed accordingly to the activity priority assigned in step 4.

6) Step 6

Activity duration, activity schedule and project duration are calculated according to the resources distributed in step 5.

7) Step 7

After the resources are assigned to each activity and the activity schedule is calculated, the resources used in every hour/day are summarized. If a resource is assigned a certain value that violates the assigned resources' relationship constraints, or the total resource amount used in any hour/day exceeds the hourly/daily resource limit, this resource will be re-assigned another value so that the above constraints are satisfied.

8) Step 8

Material Quantity required for each activity is calculated.

9) Step 9

Activity Cost and Project Cost are calculated.

10) Step 10

The simulation model produces outputs on a number of parameters that can be used towards optimization of the project. Such project parameters are: activity and project durations, activity and project costs, project net present value, project revenue, material quantity and optimum crew in each activity, actual resource productivity in each activity, risk analysis of project duration, project cost, and project net present value at the project's start date. The output data is saved in each simulation iteration.

11) Step 11

At the end of every run, the simulation model will compare the outputs produced in step 10 with the optimum computer outputs in memory (from the previous simulation run). If the new outputs are better than the previous optimum ones, the model will replace the old optimum outputs with the new outputs and update the underlying databases (e.g., the assigned resources and space for each activity). Alternatively, if the simulation produces successively worse results, the simulation model will maintain the optimum results in memory. Successive simulation alterations (to specified number of simulation runs) will therefore produce optimal results. Optimality is dependent on the project objectives defined in step 2.

12) Step 12

The algorithm repeats step 4 to 12, until the total number of simulation runs reaches the number of simulation iterations set in step 3.

D. Risk Analysis:

13) Step 13

The number of extra simulations iterations for risk analysis is set.

14) Step 14

The resource productivity and resource unit cost are set as probability density function.

15) Step 15

The resource quantity is assigned as constant as the optimum result obtained from simulation execution stage.

16) Step 16

The probability distribution/cumulative distribution of project duration/project cost/project revenue/project net present value are produced.

V. ISS ALGORITHM

Activities are the basic elements that ISS directly deals with during a simulation experiment. The dynamic behaviour of a construction process is portrayed by detailing the changes in the state of activities. The major simulation algorithm of ISS involves two stages: (1) calculate production rate of driving resource, activity duration, activity cost, activity revenue, and space requirements of an activity; and (2) select activity for construction

A. *Stage 1:*

Calculate Production rate of driving resource, activity duration, activity cost, activity revenue, and space requirements of activity.

Before ISS can begin the resource/space allocation, the activity duration, activity cost, activity revenue, and the space requirements of each activity must be calculated first.

B. *Stage 2:*

All activities are equally checked against their logical, resource and space requirements. If an activity meets all conditions for start, it is selected into the feasibility activity set, and the early start time of an activity is equal to the maximum of the earliest available time of required resources, required spaces, and dependent activities. The activity with the minimum early start time is then selected for construction.

VI. CONCLUSIONS

ISS uses simulation techniques to assign different levels of priorities to different activities in every simulation cycle to find near-optimum distributions of manpower, material, equipment and space according to their project objectives and project constraints. This helps ISS to avoid the resulting schedule to be trapped in local optima and get rid of application limits.

The major contributions of this model are listed as follows:

1) Applies evolutionary techniques to decide the near-optimum distributions of manpower, equipment, material and space according to project objectives and project constraints
2) Considers and integrates most of the important construction factors (schedule, cost, manpower, equipment, material and space) simultaneously in a unified environment, which makes the resulting schedule that will be close to optimal
3) Improves risk analyses on project duration, project cost, project revenue, and net present.

And, the other tools and concepts utilized in this model are listed as follows:

1) Captures quantity take offs from a 3D CAD model automatically
2) Develops production rates of driving resources
3) Develops the utilization rate of each resource/space allocation
4) What-if analyses of possible scenarios
5) Schedule adjustments based on unforeseen conditions

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