Using computer simulations to plan construction projects accurately

Alison Smith[1], Rana Ead[1], Simaan Abourizk[1]

[1]Department of Civil Engineering, University of Alberta

Page 69 / WISEST Special Issue / Volume 2 / DOI: 10.29173/aar70

Abstract

The three main objectives in construction projects are completing the project on time, within budget, and with good quality. Each construction project is unique and unpredictable making it beneficial to model the project before executing it. There are many ways to model a construction project; however, computer models are ideal. It is very costly and time consuming to experiment with the actual system. Therefore, by using a computer simulation, accurate data can be collected from the project without the time and cost drawbacks. The specific construction project researched is based on a real project from Fort Mcmurray Alberta, Canada. The construction project involved the delivery and erection of three different types of steel in a construction site. Once the steel has been delivered, it needs to be stored and then carried by forklift to one of two cranes to be erected. A schedule was provided for which days each type of material was expected to be delivered and erected, however this schedule did not account for the 20% chance that any delivery could be delayed by one day or the 10% chance that deliveries could be delayed by two days. A model project was created on Simphony.NET with the assumptions that work could commence the entire day (24 hours), the site has unlimited storage, and a delay in one delivery does not delay all the deliveries after it. The schedule for the project was then modified to reflect the results of the simulation. The modified schedule showed that several deliveries of materials were delayed. However, due to the model's assumptions and the time for erection being relatively short, the planned schedule for the erection of the materials was not delayed. By using the data collected from the computer simulation it was possible to more accurately plan the schedule for this construction project.

Key words:

construction, construction project, computer simulation, simulation, construction simulation, Fort McMurray

Cite as: : Smith A., Coleman P., Ead R. Abourizk S. 2019. Using computer simulations to plan construction projects accurately. Alberta Academic Review, Vol 2 (2) 69-70, WISEST Special Issue (non peer-reviewed), DOI 10.29173/aar70.

ISSN 2561-5327 (print)
ISSN 2561-5335 (online)

CC BY

Using Computer Simulation to Plan Construction Projects Accurately

Student Researcher: Alison Smith
Supervisor: Rana Ead
Principal Investigator: Dr. Simaan AbouRizk

Department of Civil Engineering, University of Alberta

Supported By:

Canada

Introduction

- The three main objectives in construction projects are completing the project on time, within budget, and with good quality
- Construction projects are unpredictable and unique, so it is better to model the project before executing it
- Computer simulation models help to visualize construction projects without the cost and time drawbacks that come with experimenting with the actual system

Problem Statement

- The problem is a steel erection project inspired from a real project in Fort McMurray, Alberta, Canada
- The process involves the delivery of three types of steel materials to the site, moving them by forklift to a crane and erecting them with the crane
- 2 cranes and 2 forklifts are used
- Material 1 uses crane 1, material 2 uses crane 2 and material 3 uses both cranes
- There is a 20% chance deliveries will be delayed one day and a 10% chance they will be delayed two days

Tasks	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Delivery of Material 1 (10 ton/day)										
Erection of Material 1 (10 ton/day)				1	2	3	4	5	6	7
Delivery of Material 2 (12 ton/day)										
Erection of Material 2 (10 ton/day)					2	3	4	5	6	
Delivery of Material 3 (15 ton/day)										
Erection of Material 3 (20 ton/day)						3	4	5	6	

Figure 1: Schedule showing the planned delivery and erection of materials 1, 2, and 3

Model

- The model is a computer simulation created on Simphony.NET
- Materials 1, 2, and 3 are created as entities that travel through different tasks such as "loading onto forklift," in the model to represent the construction process
- At the end of the model a counter records useful information such as the amount of time it took for the project to be completed

Abbreviation	Meaning
M1	Material 1
M2	Material 2
M3	Material 3
C1	Crane 1
C2	Crane 2

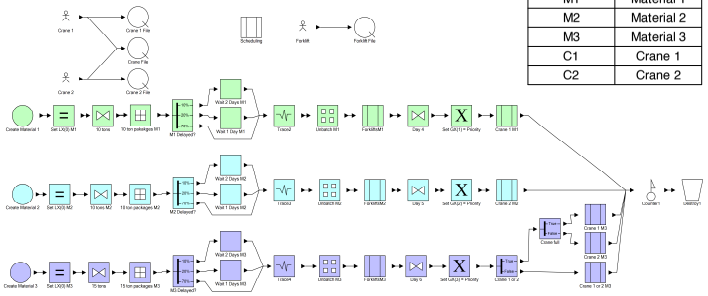

Figure 2: An image of the simulation created on simphony.NET. This model simulates the problem assuming work can commence the entire day (24hrs), that the erection site has unlimited storage, and delaying one delivery will not delay all the deliveries after it.

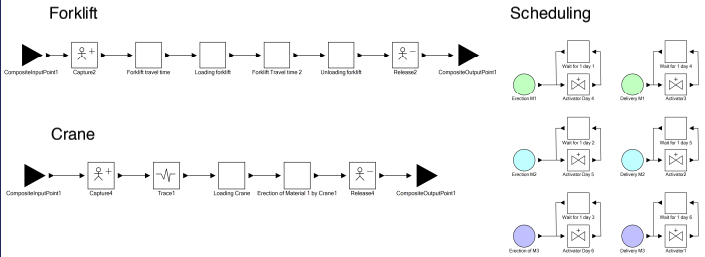

Figure 3: An image of the forklift, crane, and scheduling sub-models in the model. The forklift and crane sub-models are the expanded view of what tasks the materials go through when passing through the tasks ForkliftsM1 and Crane 1 M1 in the model. The scheduling sub-model runs at the same time as the model and makes sure tasks don't get ahead of schedule

Results

- With the results collected from running the simulation, a second schedule was produced
- This schedule shows on which days materials were delivered and blank spaces where nothing was delivered
- Although several deliveries got delayed, none of the erection schedules were delayed because the erection process is fast and due the assumption that unlimited storage is available

Tasks	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Delivery of Material 1 (10 ton/day)			*			*				
Erection of Material 1 (10 ton/day)				1	2	3	4	5	6	7
Delivery of Material 2 (12 ton/day)				*						
Erection of Material 2 (10 ton/day)					2	3	4	5	6	
Delivery of Material 3 (15 ton/day)										
Erection of Material 3 (20 ton/day)						3	4	5	6	

Figure 4: Schedule showing the delivery and erection of materials 1, 2, and 3 according to the simulation. The * shows when two deliveries arrived on the same day

Conclusion

- Computer simulation allows us to better visualize the construction process.
- Uncertainty is easily accounted for in the simulation.
- Results of the simulation can be used for improved planning.

Acknowledgements

I would like to thank Rana Ead for helping me with the research project and poster and acknowledge Edmonton Chapter of Beta Sigma Phi and Canada Summer Jobs for sponsoring this project.

Literature Cited

RazaviAlavi, SeyedReza and S. AbouRizk (2017). "Site Layout and Construction Plan Optimization Using an Integrated Genetic Algorithm Simulation Framework" *Journal of Computing in Civil Engineering*. 31(4): 04017011

albertaacademicreview.com