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A model for manpower relocation considering the impact derived from weather forecasts

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Preface from the editor

It is only a few years ago, the computational tools and abilities still did not allow to assist in the organisation of complex construction sites, although the theoretical ideas had been quite advanced. Now Hong Ha Le has taken up on the issue of site organisation with a special focus on the weather-dependent resource allocation**.**

First of all a thorough resource allocation requires a detailed description of work processes. Then, on the basis of the considered parameters such as performance ratios**,** material and space requirements, different simulation and sensitivity analyses can be performed.

In this dissertation the author has focused on the dependencies of construction process on the weather conditions. Medium-range weather forecasts nowadays can be sufficiently precise and reliable. So it is possible to adjust the on-site work concept for an upcoming week in order to avoid unnecessary disruptions due to bad weather.

This concept is especially interesting for specialized construction companies which work with small and flexible work crews, for example for the outer lining of industrial facilities such as gasoil tanks. Companies in this field usually manage several construction projects, which are at far distance to each other and largely depend on the weather conditions.

The weather conditions concerning wind, humidity, temperature and rainfall can be very different from site to site. In order to optimize the performance, a company can allocate a more or less number of crews to each site depending on the forecasted weather in that region. Thus it can avoid idle time of crew members, but still keep a minimum of work force for auxiliary and off-site work.

The author has developed an innovative method to incorporate weather forecast information into a discrete event simulation model. In the first step, the impact of weather on the intended schedule is calculated. Then, in the second step, different allocation alternatives are offered, so that crew can be shifted from site to site.

Although this concept could also be operated on a day-to-day basis, in reality, it proves to be most attractive when operated on a weekly basis. At 75 %, the 7-day-forecast is already reliable enough to be used for crew disposition. And the company managers can now decide at the end of a week (Friday or Saturday), where to send which number of crew for the whole or for parts of the next week.

The dissertation shows that improvements and considerable innovation can be developed by combining the latest advancements in different disciplines, here in construction simulation and weather forecast algorithms.

Weimar, April 2014

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Hong Ha Le

Weimar, April 2014

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Abbreviations

Abbreviations	Explanation
CPM	Critical Path Method
CSP	Constraint Satisfaction Problem
DWD	German Meteorological Service
e.g.	for example
EIFS	Exterior Insulation and Finishing Systems
FSG	Flensburger Schiffbau Gesellschaft mbH & Co. KG (Flensburg Shipyard Company mbH & Co. KG)
i.e.	that is
ID	Identification number
K	Kelvin
LoB	Line-of-Balance
MAM	Manpower Allocation Module
NECA	National Electrical Contractors' Association
PERT	Program Evaluation and Review Technique
PF	Productivity factor
PF^c	Cumulative productivity factor
PLM	Product Lifecycle Management
PR	Performance ratio
RMSE	Root Mean Squared Error
RV	Reduction of error variance
SimCoMar	Simulation Cooperation in Maritime Industries
SIMoFIT	Simulation of Outfitting Processes in Shipbuilding and Civil Engineering
STS	Simulation Toolkit for Shipbuilding
WCM	Weather Construction Module
WCT	Wind Chill Temperature index
WS	Work step

1 Introduction

1.1 General introduction

Construction planning is complicated and time-consuming work because of the dynamic and complex nature of a construction process. Contractors usually face problems of project delays and cost overruns. Hence, the issues of estimating and meeting the construction time frame are often emphasised in every contract. In fact, it is difficult to estimate the exact duration of the construction process in the planning phase because there are many unforeseeable or unexpected factors that can affect the execution process. The deviation between the actual schedule and the planned schedule happens due to many reasons such as weather effects, incorrect planning, technical problems, poor procurement decisions, etc. That is to say, construction processes normally face many uncertainties that need to be handled during the execution phase in order to complete the project on time. Therefore, making a construction project schedule prior to construction is actually not the end of the planning process. Control and further steering of the project are indeed necessary.

Detecting the deviations of the actual schedule from the planned schedule and solving the problems arising therefrom are necessary in a project control procedure. However, knowing about deviations and solving them after they have occurred seems to be a responsive action. The ability to be aware of problems, forecast their consequences before they happen and perform control actions on time is indeed quite important from the perspective of a contractor. As a result, the demand of management tools that are able to support contractors in predicting the impact of influencing factors on execution process has emerged.

Since its first development, simulation has been implemented in many research fields such as engineering, physics, social science etc. Over time, it has proved to be a powerful technique that is highly recommended for use in the field of construction management thanks to the abilities to solve many problems in construction processes. A simulation model allows users to abstract the real construction process along with its influencing factors. Furthermore, by performing simulation experiments, users can also determine appropriate solutions for problems caused by those factors.

1.2 Motivation

Weather conditions are among the many and most common causes of disruptions in the execution progress. Three sources of variability in task completion time are: the task itself, the workers performing the task, and the environment where the task is performed [1, p. 625]. Construction activities are normally executed in an outdoor environment; hence,