Proceedings of the 2019 Winter Simulation Conference
N. Mustafee, K.-H.G. Bae, S. Lazarova-Molnar, M. Rabe, C. Szabo, P. Haas, and Y.-J. Son, eds.

PROJECT TYPE MANUFACTURING PROCESS SIMULATION: A CASE STUDY ON SHIPYARD HOISTING PROCESS

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ABSTRACT

Hoisting process is becoming the most challenging area to improve efficiency in the shipyard due to its project type nature that hinders hoisting process from employing existing modeling & simulation methods achieved by other types of manufacturing process. In order to solve this problem, a new dedicated modeling and simulation method is proposed, it applies four views with task centric idea to reflect particularity of project type hoisting process, focusing on work flow perspective instead of material flow, allowing integrated simulation of both information activity and working activity by introducing information task to the task view. Through this method the shop manager can not only predict on-site performance like common simulation scenarios, but also make it possible to evaluate communication scenario, which is very important to project type manufacturing process.

1 INTRODUCTION

Shipyard hoisting process accounts for about half of the entire shipbuilding lead time. Specially, it is a project type manufacturing process for each hoisting is planned, organized and executed exclusively. Actually a shipyard simultaneously handles hundreds of hoisting process with limited space, tight time and bottleneck resources, so the on-site execution entails more complicated interactive elements, any error may strongly affect the objective of delivery time, cost and safety. It is very urgent to apply modeling & simulation technology to validate hoisting process plan in advance.

Many researches and experiences have been made in area of discrete manufacturing system simulation. The representative commercial software Delmia Quest, Plant Simulation, Arena, AnyLogic achieved considerable success in a lot of industries, however, they are not quite suitable for shipbuilding industry because shipbuilding is engineering to order (ETO) industry, which means low repetitive production, plan-driven and reconfigurable resource. Hence Lee et al. (2014) initiated a process-centric modeling methodology and develop a prototype system. While it is still inadequate when it comes to project type manufacturing process simulation like shipyard hoisting process. In this study a task-centric method for project type manufacturing process modeling and simulation is proposed.

2 SHIPYARD HOISTING PROCESS MODELING METHOD

The shipyard hoisting process model has four views: task, resource, product, and schedule. The task view describes work scope of a hoisting with multi-layer, multi-stage and multi-type structure. Considering the intense information flow contained in a project, the task view possesses information task in addition to working task. Information task controls, coordinates working task's status across management hierarchies and horizontal work teams, the management persons within the hoisting process organization are in charge of it. The resource view describes facility and organization factors required by hoisting process, each bottom

working task corresponds to a work team and a group of facilities, each information task corresponds to several management roles. The product view is a hoisting-oriented BOM describes all the items that to be hoisted. The schedule view describes timetable of working tasks by defining milestones with time attributes, the milestones connect each other with one of four kinds of constraints: “finish-start, finish-finish, start-finish, start-start”. Through combining schedule view and task view, a hoisting task network is acquired which can express more abundant meaning than PERT diagram.

3 SHIPYARD HOISTING PROCESS SIMULATION METHOD

Based on above model, the simulation method applies task centric idea to construct simulation framework. Foremost, unlike flow-shop or job-shop convention, the task object replaces product object as WIP (work in process) instance because work flow is the most prominent behavior instead of material flow, also the task object is equipped with functions to transform input to output. By comparison, the product and resource are passive factors whose status can only be manipulated by task object. The milestones of schedule view store time and sequence constraint attributes to activate related tasks. Only when the milestone happens and status of resource satisfies requirements shall the task execute its function. After the task goes through a predefined period to finish its work, it will produce an output signal to the system environment, meanwhile change its status to complete, release occupied resource and product.

The characteristic of task view also allows integrated information flow simulation. In this case the information task bridges milestones and working tasks, when the start time arrives, the milestone activates information task rather than working task, then the information task performs job authorizing or job arranging function to activate working task, during this process the management persons stay busy until the information task finishes. The subsequent process is same with pure working task simulation, except that in the end of each working task, an information task is connected to check and confirm the working task finish. The simulation clock is propelled by recording each task’s lifecycle status transition.

4 RESULT AND CONCLUSION

The simulation framework is realized by object-oriented programming language, a simulation database is created to provide basic data of task, resource and product. The shipyard hoisting tasks instance and hoisting plan are gathered as input data. With the goal of predicting hoisting plan, the simulation generates output of cycle time, resource utilization rate, throughput, work in process level, these output enable planners have deep insight into the plan and support them making right decision.

In conclusion, this study proposes a task centric method for project type manufacturing process modeling & simulation, making up deficiency of current methods and enlarging simulation application scope. Another significance lies in that the method reflects integration between information flow and material flow so as to support simultaneously simulating them, which enables planners to conduct more comprehensive analysis avoiding ignorance of communication details, this is especially important to project type manufacturing process like shipyard hoisting process.

ACKNOWLEGEMENT

This research is funded by the International Exchange Program of Harbin Engineering University for Innovation-oriented Talents Cultivation. The author also would like to express his gratitude to Computer-Aided Systems and Production Engineering Research Lab. for discussion and assistance.

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