SIMULATION VERSUS CONSTRAINT-BASED GRAPHICAL MODELING OF CONSTRUCTION PROCESSES

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ABSTRACT
The paper introduces a new constraint-based graphical approach to modeling construction processes, Foresight, designed to combine the versatility of discrete-event simulation, the ease-of-use of the Critical Path Method, and the visual insight of linear scheduling. The usability of Foresight is compared with Stroboscope (a construction-specific simulation system) in a case study of the classic earthmoving problem. The Foresight model is shown, first, to be visually more insightful than its Stroboscope equivalent, and second, to require a fraction of the number of modeling terms and modeling concepts in its definition.

1 INTRODUCTION
Simulation is the most versatile tool currently available for the planning and control of construction projects. Despite this and the fact that there are simulation systems designed specifically for modeling construction processes (such as Stroboscope (Martinez 1996)) simulation is rarely adopted by construction planners. This is due to the high degree of expertise required in its use (Flood 2010). The Critical Path Method (CPM) has become the standard analytical tool for construction planning and control since it is easy to use and applicable to a relatively broad range of construction processes. CPM is, however, a compromise solution; it is not very effective at modeling repetitive tasks, and it is time-centric treating all other limiting factors (such as resource demand and space buffers) as secondary constraints. A third approach to modeling construction processes that has gained popularity in recent years is linear scheduling (LS) (Flood 2010). The popularity of LS is due largely to the strong visual (graphical) insight it provides into the relative progress of individual tasks. However, LS can only be used to model construction work that is repetitive, and even then it is limited by the types of constraint it can consider.

This paper introduces a new graphical constraint-based method of modeling construction processes, Foresight, that has the goal of combining the modeling versatility of simulation, the simplicity-in-use of CPM, and the visual insight of LP. The performance of Foresight is compared with Stroboscope (a popular discrete-event construction simulation system) in a case study of the classic earthmoving problem.

Foresight is a constraint-based graphical approach to modeling processes described in detail by Flood (2010). Foresight models comprise a hierarchically structured set of nested boxes termed work units, each representing a discrete unit of work, such as excavate trench or erect steel frame. The work units exist in an n-dimensional attribute space, example attributes being time, money, distance, work to be completed, and productive resources (anything that is key to defining and measuring progress). The section of attribute space occupied by a work unit is defined by constraints between the work units. A work unit at any level (including its constraints) can be repeated within a model as often as required.

2 FORESIGHT VS. STROBOSCOPE: EARTHMOVING SYSTEM CASE STUDY
Figure 1 shows a Stroboscope model of an earthmoving system (Martinez 1996) in which an excavator is used to load a fleet of dump-trucks that haul excavated material to a spoil heap and then return. Figure 2