Chapter 2
Different Approaches for Studying Interruptible Industrial Processes:
Application of Two Different Simulation Techniques

Lorenzo Damiani
University of Genoa, Italy

Guido Guizzi
University of Naples Federico II, Italy

Pietro Giribone
University of Genoa, Italy

Roberto Revetria
University of Genoa, Italy

Elpidio Romano
UTIU - International Telematic University Uninettuno, Italy

ABSTRACT

Simulation is the best tool used to predict the behavior of real world systems. For the analysis of complex systems, simulation is often used prior to the operation of the system as a mediator for a dynamic situation. This chapter presents the issue of complex systems simulation through Discrete Event Simulation (DES) and System Dynamics (SD) techniques. The Authors original approach stands in the combined employ of the two SD and DES simulation techniques to solve real logistic problems. In the course of the chapter, examples of real world issues regarding logistics are explained. In particular, the following case studies are provided: a production environment, a waste collection scheme, a hub base, a harbor including container terminal, bulk terminal and navigation channel.

INTRODUCTION

This chapter presents a new simulation methodology of complex dynamic systems, particularly useful in the field of logistics. As known, the two main methods for dealing with complex systems are the DES (Discrete Event Simulation) and the SD (System Dynamics) approaches.

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The DES approach consists in the representation of a system through the employ of discrete state variables. The state variables, which describe in each instant the state of the system, in this case vary with discontinuities in time.

The DES approach is very useful to study problems connected to queue situations. For queue is intended a situation in which a series of entities remains waiting for an operation, whose carrying out is demanded to other entities. The DES simulation allows to represent the behavior of the queue and all the correlated times of waiting and operation. In particular, often the time of operation is represented by a Gaussian stochastic variable, being negligible with respect to the time of waiting.

Today, many logistic problems are faced through a simulative approach of the DES type. However, in logistics it is common to find situations in which the operation time is comparable or also longer than the waiting time. In these situations, the DES approach loses its efficacy because, adopting discrete state variables in the time domain, it is not possible to go into detail of certain operations, such as those of loading or downloading, typical of logistic systems.

Many of the operations which are common in logistics, can be in fact interrupted. In particular, two typologies of operations exist: those that if interrupted must re-start from the beginning (e.g. the safety controls) and those that, if interrupted, restart from the point in which they had stopped (e.g. the operations of loading and downloading).

In order to appreciate the details of the various operations, it is useful to rely on continuous variables in time instead of discrete variables, with an SD approach (Sterman, 2000) through which it is possible to simulate in detail the operation, allowing to evaluate its development and evolution in time. The only SD analysis is however not sufficient to solve the problem, as it does not allow to simulate with a sufficient computational speed a complex system such as a logistic system, characterized by multiple variables. The employ of the SD technique would allow to study the system in great detail, but would make the equation system very complex.

To solve this issue, the authors propose a simulative approach combining SD and DES. The approach is based on the chain of events. An entity passes from a position to the next of the chain of events no more on the basis of stochastic variables, but on the basis of what is effectively happening inside the operation. The detailed development of the operation is simulated with a SD approach, the most indicated for processes of loading and downloading which presuppose the existence of a material storage.

This kind of hybrid approach is considered effective because it joins the advantages of both the simulation methodologies: the DES speed of execution and the SD deterministic features. For this reason, the authors believe that the proposed methodology represents an advancement in the state of the art of logistic systems simulation.

In this chapter is demonstrated the effectiveness of the new simulative approach through the presentation of four applicative examples:

1) A production model
2) A model for studying the collection of garbage bins by trucks
3) An offshore supply base
4) A harbor model, finalized to study the dry bulk terminal, the container terminal and the navigation in the harbor inlet channel.

These examples were chosen since they are representative of the authors professional experience, and present typical issues of the simulation of production and logistic world. All the examples presented