

Decision Systems: The Relation Between Problem Specification and Mathematical Analysis

Jaap Wessels

International Institute for Applied Systems Analysis

Laxenburg, Austria

Technical University Eindhoven

Eindhoven, The Netherlands

Abstract

In this paper it is demonstrated that automated support for decision making of a tactical or strategic nature requires a solver-independent medium for describing decision situations. Such a medium may be specific for one environment, but it is also possible to develop media for certain types of environments. By using such a medium one obtains a decoupling of problem formulation and method of analysis. This makes it possible to use (parts of) the problem formulation as input for different types of models. Such problem formulations may provide mathematical models themselves, although they might also contain some less formal features.

The decoupling makes it possible to choose problem formulations which are much closer to the original decision situation than would otherwise be possible with formulations in terms of a preselected solver. The argumentation is illustrated by treating a language for specifying goods flow problems in some detail. This language is based on timed colored Petri-nets.

1 Introduction

The present paper is based on two types of experiences. In the first place the experience that only in exceptional cases the step from the decision situation to a mathematical model is a simple and natural one. A case where the step is relatively natural is the problem of routing and loading of trucks for the distribution of baking flour from the mill to the bakeries. Although, even in such a case, quite relevant constraints do not fit in the mathematical language. However, in most decision making problems the step from problem to model is large and, usually, it is also one of the most essential steps in

the development of decision support systems. In the second place, we have experienced that only for operational decision making does one encounter the situation that a fixed sequence of steps leads from problem to model. Only in operational decision making one sees that essentially the same problem recurs, only with different data. In tactical and strategic decision making, however, one usually gets different types of problems subsequently, although they may use more or less the same data and other knowledge about the functioning of the system.

Example: a distribution structure

In order to keep a distribution structure in good shape in a changing world, one needs frequent adaptations. That means that not only operational decisions have to be made, but also tactical and strategic questions arise frequently and because of the complexity of these questions it would be good to have some tools for supporting this tactical and strategic decision making. However, the requirements for these tools are to be developed for a loosely described set of questions. Only later the real questions and how they are formulated appear. So, a main characteristic of pre-fabricated tools should be their flexibility and adaptability with respect to the types of questions they can be used for. Let us list some of these questions regarding a distribution structure in order to get some idea about their diversity:

- a. Do we still need a distribution structure with three levels in a united Europe with higher demands on speed and stronger price-competition?
 - b. Do we produce all our products in each factory or will the distribution structure still be able to satisfy the performance requirements if the less demanded products are only manufactured by one factory?
 - c. If the factories specialize, is it then still necessary that each central warehouse stores all products or is it sufficient to forward the products only to the closest central warehouse (possibly located on the same premises as the factory)?
 - d. Do we still need so many regional warehouses?
 - e. Are the regional warehouses located in the right areas?
 - f. From where does a warehouse get its products? Would it be better to keep fixed rules for this allocation or replace them by dynamic ones?
 - g. How is the transport organized (frequent combined shippings, less frequent direct shippings, or using an outside transport company)?
 - h. How do we fit a new line of products into the system?
 - i. How do we adapt the distribution structure after merging with a regional competitor who possesses his own distribution system?
- etc.