The construction and analysis of OR-problems are considered under the assumption that the problem structures depend essentially on logical constituents. The conventional approach to use binary ("0/1") variables suffers from models which are very complicated and intransparent. The nature of logical constituents is not "adequately" represented by complexes of binary variables. As an alternative the net-theoretic approach can be used to construct graphical problem descriptions. These descriptions base on the propositional or predicate logic and the theory of Petri nets. The resulting net models have the advantages of compactness and easy interpretation. Furthermore conventional arithmetic and logically based algorithms can be applied to the analysis of net models (for consistency checks e.g.). The efficiency of model construction and analysis is not considered. Instead of this the preceding aspect is explored which contributions to problem modelling result from combining logic, net theory, linear arithmetic and graphical problem description. An example demonstrates these results. It concerns the design of annual balance sheets of stock corporations with regard to corporate income tax.

1. Logically based problem descriptions for decision models

Decision models are often designed as arithmetic programs (OR-programs). The search for an intended - e.g. optimal - problem solution can be efficiently realized as far as the search space of possible problem solutions (problem space) is dense and convex. Therefore it is mostly tried to construct OR-programs in the domain of rational or real numbers. The density-assumption for the problem space can be regarded as adequate if the variables represent real entities to be measured on metric scales.

Such a real-valued representation of problem constituents looses adequacy if logical aspects must be modelled. This holds at least for the classical propositional and predicate logic which allow only two distinct truth values. Both these versions of logic are supposed in the following. (1) The logical aspects of a problem can be separated into

(*) This article is an abbreviated, revised version of the papers Zelewski (1986) and Zelewski (1988), available from the author.

(1) Real-valued logics that may be grounded on fuzzy set theory or theories of evidence are not considered.
two categories. The first category concerns subproblems of the yes/no-type that require decisions whether an action should be done ("yes") or not ("no"). The second category reflects logical dependencies between problem constituents, for example between partial decisions or between a decision and its real consequences.

Both categories or logical aspects are usually modelled in OR-programs with the help of binary logic variables $x_i$ with domains $D_i = \{0; 1\}$. They are called decision (indicator) variables if they represent subproblems of the yes/no-type (logical dependencies); see Williams (1985). The resulting problem descriptions are mixed integer programs which suffer from a great structural and computational complexity. The computational complexity grounds on the combinatorial explosion of possible problem solutions — with regard to an increasing number of problem describing binary logic variables — and the fact that techniques of differential calculus cannot be (directly) applied to mixed integer programs; see Gabriel (1982), Williams (1985).

The quantitative aspect of computational complexity does not play any role in the following, because the efficiency of problem solution is beyond the scope of this explorative study. Furthermore the analysis of net models which will be presented later is subject to the same difficulty of combinatorial explosion, at least in the case of analyzing net invariants.

The structural complexity describes a qualitative characteristic of decision models based on binary logic variables. Such models are generally very extensive and complicated problem descriptions because of great numbers and multiple interlockings of logic variables; see for example Gabriel (1982), Williams (1985), Johänntgen-Holthoff (1986) and Boos (1986). Especially the representation of logical dependencies between decisions and their consequences often leads to intransparent conglomerates of decision, indicator and "normal" variables. The inherent complexity of the resulting decision models impedes validating and using the models. For example it is hard to justify a recommended decision alternative when the underlying decision model is so complicated that nobody understands the model — except the model designer itself.

For that reason there is a need for model constructing techniques which allow more transparent representations of logical aspects in decision models. One possible approach (among others) to overcome the lack of transparency of conventional OR-programs is the construction of graphical problem descriptions. They are based on the experience that graphical models are more compact and easier to understand than the "variable-conglomerats" of OR-programs.

Graphical modelling techniques should fulfil two additional requirements. On the one hand they should make it possible to systematically derive the representation of logical problem aspects from a description of these aspects expressed in natural language (constructive requirement), because most real problems are firstly circumscribed with natural language statements. The derivation is designated as systematical if there exists a scheme which enables to derive representations for all logically expressable problem descriptions. On the other hand it is desirable that the graphical models can be analyzed