14.1 Formal Theories vs. Factual Theories vs. Decision Technologies

The terms model, theory, and law have been used with a variety of meanings, for a number of purposes, and in many different areas of our life. It is therefore necessary to define more accurately what we mean by models, theories, and laws to describe their interrelationships and to indicate their use before we can specify the requirements they have to satisfy and the purposes for which they can be used. To facilitate our task we shall distinguish between definitions given and used in the scientific area and definitions and interpretations as they can be found in more application-oriented areas, which we will call “technologies” by contrast to “scientific disciplines.” By technologies we mean areas such as operations research, decision analysis, and information processing, even though these areas call themselves sometimes theories (i.e., decision theory) or science (i.e., computer science, management science, etc.). This is by no means a value statement. We only want to indicate that the main goals of these areas are different. While the main purpose of a scientific discipline is to generate knowledge and to come closer to truth without making any value statements, technologies normally try to generate tools for solving problems better and very often by either accepting or basing on given value schemes.
Let us first turn to the area of scientific inquiry and consider the following quotation concerning the definition of the term model: “A possible realization in which all valid sentences of a theory T are satisfied is called a model of T.”

Harré [1967, p. 86] calls: “A model, a, of a thing, A, is in one of many possible ways a replica or an analogue of A.” And a few years later, “In certain formal sciences such as logic and mathematics a model for or of a theory is a set of sentences, which can be matched with the sentences in which the theory is expressed, according to some matching rule. . . . The other meaning of ‘model’ is that of some real or imagined thing or process, which behave similarly to some other thing or process, or in some other way than in its behavior is similar to it” [Harré, 1972, p. 173]. He sees two major purposes of models in science: (1) logical: to enable certain inferences, which would not otherwise be possible to be made; and (2) epistemological: that is, to express and enable us to extend our knowledge of the world. Models according to Harré are either used as a heuristic to simplify a phenomenon or to make it more readily handable and explanatorily where a model is a model of the real causal mechanism.

Leo Apostel [1961, p. 4] provides us with a very good example for various definitions of models as tuples of a number of components when defining: “Let then \( R (S, P, M, T) \) indicate the main variables of the modelling relationship. The subject \( S \) takes, in view of the purpose \( P \), the entity \( M \) as a model of the prototype \( T \).” For the four components of the definition he gives a number of examples which are quite informative concerning the use of models in science and which can be summarized as follows:

**Subjects (S) and purposes (P):**

1. For a certain domain of facts let no theory be known. If we replace our study of this domain by the study of another set of facts for which a theory is well known, and that has certain important characteristics in common with the field under investigation then we use a model to develop our knowledge from a zero (or near zero) starting point.

2. For a domain \( D \) of facts, we do have a full-fledged theory but one too difficult mathematically to yield solutions, given our present techniques. We then interpret the fundamental notions of the theory in a model, in such a way that simplifying assumptions can express this assignment.

3. If two theories are without contact with each other we can try to use the one as model for the other or introduce a common model interpreting both and thus relating both languages to each other.