

based models tend to become too large even for a modest-size system. In applying Petri nets, it is often necessary to add special modifications or restrictions suited to the particular application. Two successful application areas are performance evaluation [28-50] and communication protocols [51-62]. Promising areas of applications include modeling and analysis of distributed-software systems [63-71], distributed database systems [72-75], concurrent and parallel programs [76-92], flexible manufacturing/industrial, control systems [93-100], discrete-event systems [101-103], multiprocessor memory systems [30, 104-105], dataflow computing systems [106-108], fault-tolerant systems [109-114], programmable logic and VLSI arrays [115-120], asynchronous circuits and structures [121-129], compilers and operating systems [130-131], office-information systems [132-135], formal languages [136-142], and logic programs [143-150]. Other interesting applications considered in the literature are local area networks [151-153], legal systems [154], human-machine communication [155, 156], neural networks [157-158], digital filters [159-161], decision models [162] and electronic funds transfer in banks [321].

The use of computer-aided tools is a necessity for practical applications of Petri nets. Most Petri net research groups have their own software packages and tools to assist the drawing, analysis and/or simulation of various applications. A recent article [163] provides a good overview of typical Petri net tools existing as of 1986. Some of these tools and their applications are discussed in details in references [164-170].

### 1.3 Transition Enabling and Firing

A *Petri net* is a particular kind of directed graph, together with an initial state called the *initial marking*,  $M_0$ . The underlying graph  $N$  of a Petri net is a directed, weighted, bipartite graph consisting of two kinds of nodes, called *places* and *transitions*, where arcs are either from a place to a transition or from a transition to a place. In graphical representation, places are drawn as circles, transitions as bars or boxes. Arcs are labeled