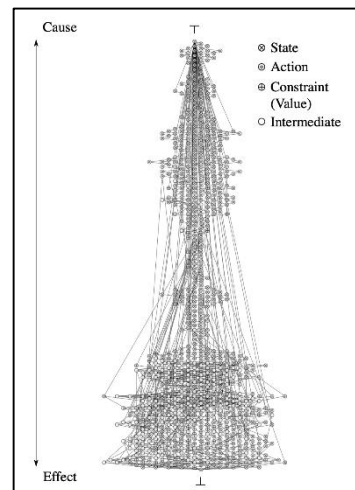


# Modeling of Manufacturing Systems for Expert Knowledge Description

In recent years, many production systems, such as automatic assembly lines using robots, have become more complex due to their automation. In such systems, the workers on the shop floor often check the state of the production system and modify it to solve problems such as quality degradation and production inefficiency, as well as to improve equipment to cope with changes in plans based on their own experience. As systems become more complex as described above, how to efficiently perform such tasks with limited human resources will become important in the start-up and operation of manufacturing systems. In order to achieve this, it is necessary to have a mechanism to accumulate the experience and knowledge of expert workers and to be able to refer to the accumulated knowledge as necessary as the way that expert workers are doing in the shop floor today.

This study proposes a method of describing a model of a manufacturing system in terms of its elements and the order relationships among them. It is difficult to separate the knowledge of problem solving and improvements in manufacturing systems from the structure of the manufacturing system. Although various models of production systems have been proposed, it is desirable to use a model that can easily refer to the structure of the manufacturing system in relation to the knowledge in order to describe and refer to the knowledge of the manufacturing system. Furthermore, the knowledge of a person about a manufacturing system depends on how the person perceives the manufacturing system, and the knowledge of the manufacturing system abstracted in the mind requires a model that matches the level of the abstraction. The model of a manufacturing system proposed in this study describes the relationships among elements as simple ordered relationships, and we propose a mechanism to build this model based on the established system modeling language SysML. This description enables the construction of a model hierarchized by the aforementioned level of abstraction while maintaining the structure (ordered relations) of the described system, making it easy to trace the knowledge possessed by experts on the model of the system. We call this description "system lattice" and verify the proposed method by describing the process of an expert's identification of a problem occurring on an actual mock manufacturing line on the model of the system described by its system lattice. draw the target letter on the curved shape only with three joints.



**Figure 1.** Target mock manufacturing line. **Figure 2.** System lattice of the system.

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