Petri-net modelling of an assembly process system

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Abstract: Petri nets represent a powerful graphical and mathematical modelling tool that is applicable to many systems [3]. Using Petri nets it is possible to study information-processing systems that are characterized as being concurrent and asynchronous. It is also possible to model non-determinism and conflict resolutions. Many different extensions of classical Petri nets exist, and these are able to model a variety of real systems. In particular, timed Petri nets can be used to model and analyse a wide range of concurrent discrete-event systems [1]. There is a lot of literature on the applicability of PNs in the modelling, analysis, synthesis and implementation of systems in the manufacturing-applications domain. A survey of the research area and a comprehensive bibliography can be found in [5]. Aalst [6] discusses the use of Petri nets in the context of workflow management.

Petri nets are a family of tools that provide a framework or working paradigm which can be used for many of the problems that appear during the life-cycle of a production system [4]. If used in all stages an additional benefit of improving the communication between these stages is achieved.

In [2] a method for modelling production systems using timed Petri nets based on data from production-management systems is presented. To make a product, a set of operations has to be performed. With timed Petri nets production operations can be modelled and when all combined the model of a production system is achieved. The analysis of complex models generally based on simulation. With a simulation of a Petri net model the evolution of the marking through time can be observed. Different heuristic rules can be introduced and in this way different evolutions of the Petri net are usually possible. When the marking of the places that represent resources is being considered, the schedule of process operations can be observed, i.e., when, and using which resource, a job has to be processed. Usually, different rules are needed to improve different predefined production objectives (makespan, throughput, production rates, and other temporal quantities).

In our work we are dealing with a typical assembly process system. The production system is divided into a number of departments. The existing information-technology systems include a management system, which is used to plan the production and supervisory system, which is used to supervise the production process. To implement a detailed schedule, how the work should be done, an additional scheduling system should be implemented. The scheduling can be performed using timed Petri nets. The data needed to produce a Petri-net model can be retrieved from the existing IT systems.

Each product that can be produced in the assembly system is composed of one or more sub-assembly items. The structure of all products is described with the bill of material (BOM). To build a particular item from the BOM list, some process steps are needed. These steps are described with routing data. Using these data timed Petri net model is build.

Afterwards different heuristic rules are used to schedule the work needed to produce all the products. Additionally comparison with another approach was made using commercial scheduling tool.

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