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SIMULATION-ASSISTED DECISION MAKING FOR SUPPLY CHAIN DISRUPTIONS IN PRODUCTION CONTROL

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ABSTRACT

Supply chain disruptions with an unpredictable occurrence such as significant differences between forecasts and actual customer demands are challenging for semiconductor manufacturers. Normally, these events are responded to with a time-consuming mostly manual procedure. This work describes an approach for an automated framework to react faster and with less effort on these unpredictable events. Within this framework simulation is necessary for the evaluation of automated decisions. Therefore, a discrete event simulation and a simulation based on a system dynamics approach have been combined. As a result of this framework's approach, safety stocks can be reduced due to a more accurate cycle time prediction and a reduced number of false alarms regarding supply chain disruptions.

1 INTRODUCTION

Current production planning systems are not designed to adapt to disruptions in supply chain networks, like unexpected change in customer's demand, automatically and in real-time. Semiconductor manufacturers are forced to react on those events with non-automated procedures, large inventories and long lead times. Therefore, decisions are unnecessarily delayed and corrective measures in semiconductor wafer processing, often called front-end, may take place too late. Thereupon, we identified the need for a technical solution to automate and accelerate decision making in complex production environments, considering multiple aspects like product mix, time-coupling and on time delivery.

2 CONCEPT

We develop an automated framework in an event-driven system architecture to enable semiconductor manufacturers to react faster on unpredictable changes in customer demands. The so-called Advanced Dispatch Control (ADC) will influence production lines based on events happened in encapsulated sections of the supply chain. ADC will connect those different domains of a company to push relevant information from supply chain to production line. To do so, ADC transfers the concept of closed control loops from run-to-run control in manufacturing processes to the interface between supply chain and production line. The selected approach consists of the following four major steps (cf. Figure 1): (1) Receive an event from a supply chain observer component (e.g. customer request for early delivery). (2) Analyze the received event and retrieve additional information (e.g. context to identify affected lots) from existing data sources (e.g. Manufacturing Execution System). (3) Decide for corrective measures that can be applied to an existing dispatcher component (e.g. speed up several lots and slow down others) and evaluate them as well as their consequences (e.g. work in progress level, cycle time, etc.) by simulation. (4) Apply correction plan to production by influencing lots via the existing dispatcher component and thereby adapt dispatch sequence on manufacturing equipment in production line.

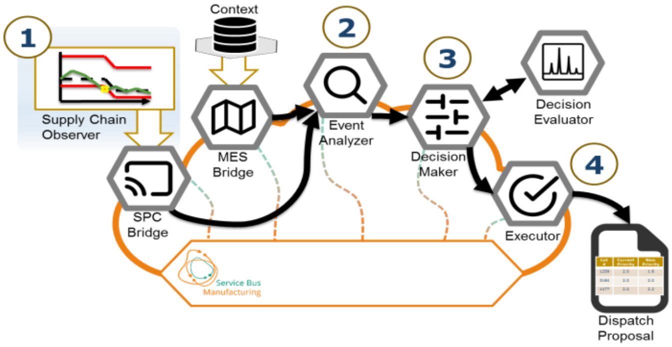

Figure 1: Information flow of Advanced Dispatch Control.

3 DECISION MAKING

The aim of the decision making process (cf. step 3 in Figure 1) is to decide for corrective measures induced by supply chain disruptions. First, similar situations in the historical data stock must be identified by a classification to get an overview of already applied corrective measures. Subsequently, to speed up or slow down lots their target priority is calculated by a regression. The performance of algorithms for this problem of classification as well as regression is being evaluated at the moment. Before executed, the corrective measures need to be evaluated. Therefore, a two-step simulation approach has been chosen. First, consequences for production lines such as changing delivery dates or job queues are determined by a discrete event simulation using the existing Measurement and Improvement of Manufacturing Capacity (MIMAC) model which is well known in the semiconductor community. Second, interdependencies and effects for relevant key performance indicators such as work in progress are deduced from a simulation based on a system dynamics model, a causal loop diagram which has been developed for this application in production control. An exemplary excerpt of this model is depicted in Figure 2, showing the relations between cycle time, Fab-throughput and work in progress. The complete model consists of 25 influencing factors for production control and represents causal relations between them. In total, a number of three balancing loops and four reinforcing loops could be identified.

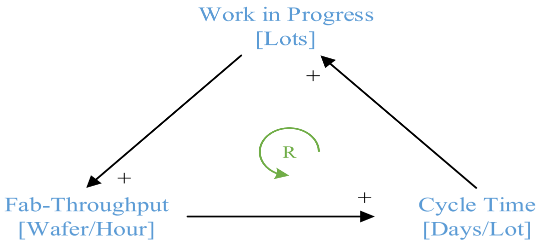

Figure 2: Exemplary excerpt from Causal Loop Diagram.

4 CONCLUSION AND OUTLOOK

Both simulation approaches cover important aspects to evaluate corrective measures in production control before applying them to the real production line. While simulation of production lines is well known in academia and industry, causal loop diagrams for production control in particular have received little attention so far. Nevertheless, this approach allows for the evaluation of a wide range of key performance indicators. The promising interim results show an improved cycle time prediction leading to a reduced cycle time spread by up to 66 percent. A leading semiconductor manufacturer with whom these results have been discussed expects a resulting safety stock reduction by up to 15 percent. Further work will be the evaluation of algorithms as described in decision making section as well as the evaluation with real production data.