Abstract Submission Template APC Conference 2016

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Information Sheet

Abstract/Presentation Title: **Production Gain Potentials based on Continuous Analysis of Dynamic Bottlenecks in Real-Time**

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Abstract for Oral Session or Poster Session (select one):

Suggested Topic (e.g. etch, run-to-run, standards, etc.): Continuous Manufacturing Optimization, Real-time data collection and management, data quality, time synchronization

Abstracts must include a description of the **Motivation** for the work, a description of the **Approach** used, and a description of the **Results**. Only MS Word and PDF formats are accepted. Abstracts will be included in the conference proceedings, in PDF format. Accepted authors may also submit an extended abstract along with their PowerPoint presentation for inclusion in the proceedings. Abstracts must not contain confidential information. Send your abstract file as an attachment to Info@apcconference.com. Abstracts are due on July 15, 2016. Abstract Submission Template APC Conference 2016.doc

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Motivation

Strong production capacity growth is a reality, especially for 200 mm fabs. This trend leads to dramatically increased requirements for production information systems. Such systems, which are capable to report and visualize the fab performance in real-time are still a vision for most existing fabs. Within this domain, state-of-the-art applications ("Business Intelligence" / Data Warehouses) are typically fed via extracts out of operational systems (MES etc.). Such extracts are aggregated by ETL batch jobs (ETL: Extract, Transform, Load the data). It is a big challenge to enable robust and performant ETL data aggregation. Another major draw-back is, that such applications do not integrate the fab operational, engineering, and strategic layer. This reflects the need for a conceptually new approach, which

a) is capable of continuously processing information (continuous creation of information out of any fab event) and therefore eliminates the need for complicated and error-prone ETL processes;
b) is capable to handle a deep-structured information model, which enables and guarantees best informational granularity for real-time analysis (operational data), as well as for detailed root cause analysis (engineering and strategic data); and which enables from a mathematical perspective optimal algorithmic efficiency throughout those data layers;
c) is capable to support standard hw and sw infrastructure (i.e. standard db-system, messaging system, analysis services).

Approach

To overcome this strategic gap, and based on own research activities, SYSTEMA, XFAB and other partners are executing a research project. The goal is to enable the factories to continuously process real-time data for each production step, and thereby enriching the engineering and strategic data level at the same time. That is, to immediately transform these data into *information components*, and continuously aggregate those information components to more valuable information. The underlying deep-structured information model enables this new approach and therefore eliminates the need for complicated data aggregation (ETL) processes. As another effect, the load on IT systems is reduced, and the overall solution approaches a "security by design concept". This enables a qualitative step forward with regard to state-of-the-art. Following three informational levels are covered:

a) Operational level: all atomic fab events are stored (many years of data)
b) Engineering level: the data model covers newly structured information, which enables in a most advantageous manner ad-hoc and multi-variant analytics; root-cause analysis and knowledge discovery
c) Strategic level: enabling of interoperability between different engineering domains, such as MES, Simulation and Operating Curve Management (OCM)

Results

The performance of a complex manufacturing system such as semiconductor fab is determined by its bottleneck (according to the theory of constraints). As a first outcome of this research project, we present a) a real-time analysis of dynamic production bottlenecks (operational level), and b) a detailed engineering analysis of production gain potentials as caused by dynamic bottlenecks (engineering level). This analysis will show unplanned vacancies of downstream equipment, as caused by moving dynamic production bottlenecks. In a third step we will demonstrate the interoperability of the new approach with a fab simulation tool (strategic level). Our new data model offers very interesting advantages for integration of fab simulation, because the data/information structures are compatible with each other. This offers new perspectives in online simulation, as well as for fab planning and knowledge discovery. SYSTEMA is developing this solution as based on its "Xation" Technology. The goal is that Fab engineers on all information levels (operational, engineering, and strategic) may directly interact with the system.

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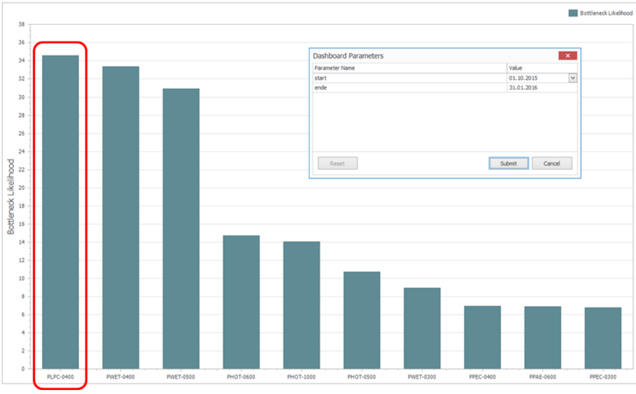

Fig. 1: Analysis of dynamic production bottlenecks; (operational level; calc. of “bottleneck likelihood”)

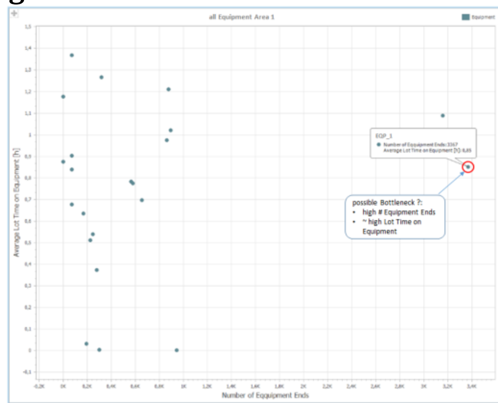

Fig. 2: Multivariate analysis of equipment throughput (red circle: bottleneck equip / Fig.1)

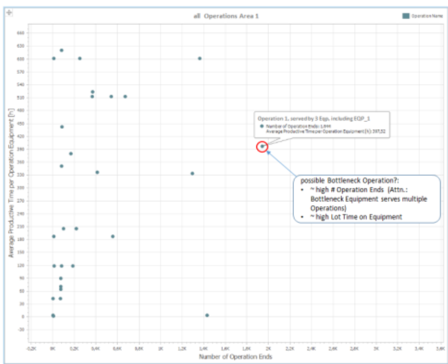

Fig. 3: Multivariate analysis of production-operation throughput (red circle: operations covered by production bottleneck equipment)

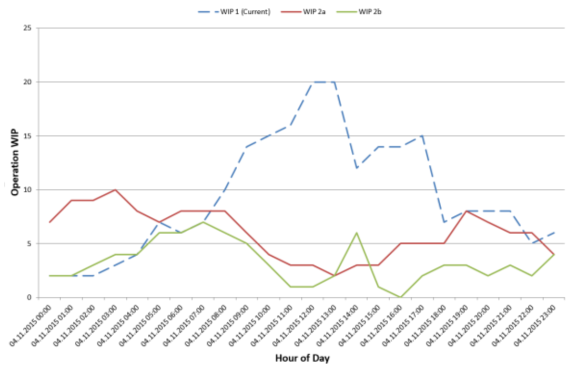

Fig. 4: Development of “bottleneck operation” of Fig. 3, and building a “WIP mountain” (blue dotted line); the diagram also shows the succeeding operations of the “bottleneck operation” and the corresponding WIP development (green, red line)

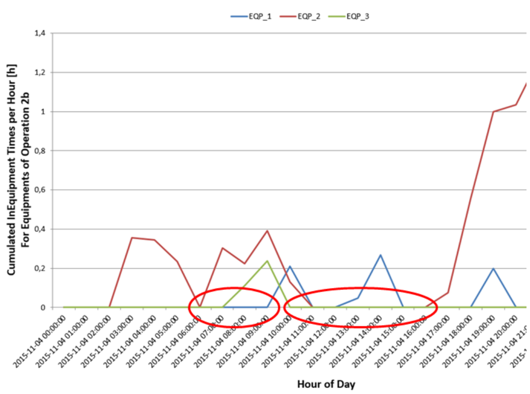

Fig. 5: Development of equipment utilization of an operation which follows the “bottleneck operation”; caused by the “WIP mountain”, equipment did run out of material, and production capacity was lost (red circles)

Fig. 6: Methodology of dynamic production fore-casting, as based on statistical throughput forecast in combination with other context information; this methodology will be further evaluated with regard to further improving the productivity of fabs. The diagram shows a condensed production route (vertical axis) in correspondence to the development of the WIP per operation and per hour (horizontal axis); the system continuously forecasts 8 hours.