Using DES for ROI calculations within semiconductor manufacturing

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Why using DES (Discrete Event Simulation)

DES is commonly used in many industries during planning and optimizing phases in the lifecycle of a plant. Production systems are comprehensively analyzed in terms of performance indicators. Often the resulting figures represent the starting point for investment assessments and decision making. The motivation to use DES in semiconductor manufacturing is to analyze the material flow within a production chain in terms of bottlenecks, throughput issues and production costs. It provides also a possibility for more specific route cost calculations and benefit investigations in the areas of (APC) advanced process control and (AEC) advanced equipment control. So far this approach is not integrated into profitability calculations. Therefore a system concept will be presented that integrates the results of APC/AEC relevant DES simulations in factory profitability calculations. This integration approach gains certain benefits for the semiconductor manufacturer.

Description of the DES approach

DES delivers more detailed input figures for the profitability calculations in comparison to the spread-sheet based calculations. These calculations are based on production figures like factory output rates, cycle times, utilization rates and personnel efforts. For any simulation, assumptions are necessary to define the boundary conditions and to fill the lack of required information. By using the presented DES approach these assumptions are based on equipment level whereas common spread-sheet assumptions are based on a work center level [cf. Wafer Cost Comparison Calculator (ISMI)]. This approach leads to a higher accuracy of the assumptions. Furthermore in contrast to spread-sheet based calculations DES takes into account the cyclic process chain and the resulting system dynamics. This enables a more detailed prediction of the equipment utilization, throughput and output rates.

Description of the DES system concept

The system concept of the developed software tool is split up into two core components. These components are the "Process Designer" and a 3rd party Discrete Event Simulation software (see figure 1). The "Process Designer" is developed with the multi-platform C++ QT toolkit which provides a Graphical User Interface. The "Process Designer" is able to process investment assessment relevant input data. On that basis it is possible to perform different profitability calculations.

The "Process Designer" provides two approaches to generate a factory model. The main approach is to generate automatically the factory model. This is achieved by using the import function of the "Process Designer". This function handles a spread-sheet based file format which contains product route, equipment and process relevant data. On this basis investigations regarding production performance parameters and cost factors are implemented. Furthermore it is possible to modify an existing factory model.

Using Software "Process Designer"

The "Process Designer" supports conducting simulation studies by providing data input functions and data preparation functions as well as data processing features. The "Process Designer" is able to communicate with the simulator. This interfacing is used to transfer data to the simulator in order to generate automatically a simulation model within the simulation software (see figure 1). After completing the model generation the simulation experiments are parameterized by the "Process Designer" and the simulations are done. The results are retransferred to the "Process Designer" which is able to integrate these results into the profitability calculations. Significant simulation results are the factory output rate in respect to equipment and product break downs, capacity gains, reduction of throughput times as well as reduction of transportation costs.

Performing profitability calculations

The results of the DES are used as input for different Excel-based methods of profitability calculations. In order to provide an adequate graphical representation of the calculation results the Excel-spread sheet information are enriched by the DES results. The graphical presentation is done by using the provided presentation capabilities of Microsoft Excel. Thereby typical charts for costs and/or benefits breakdowns over different periods or break-even point analysis are available in the profitability calculation figures visualization using the example of VM integration in figure 3.
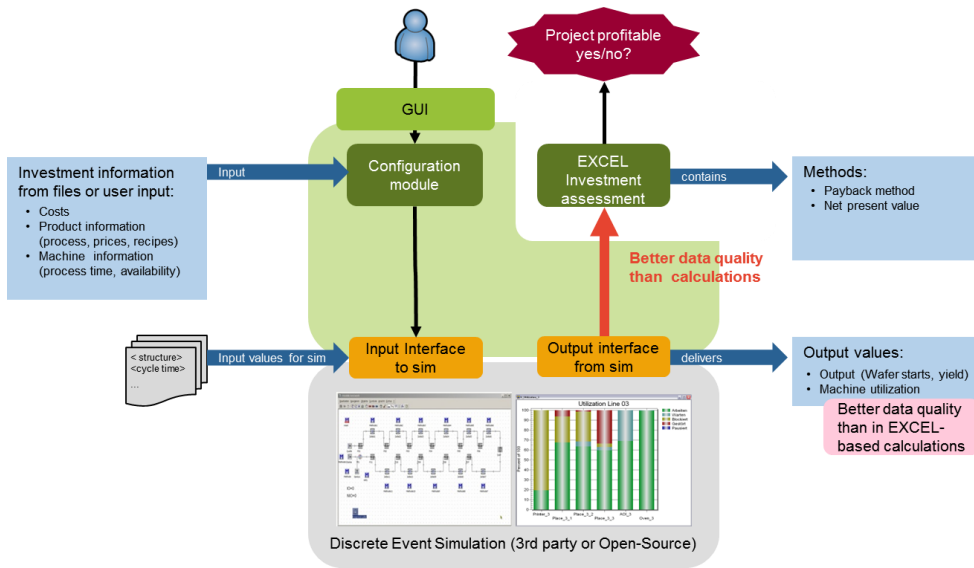
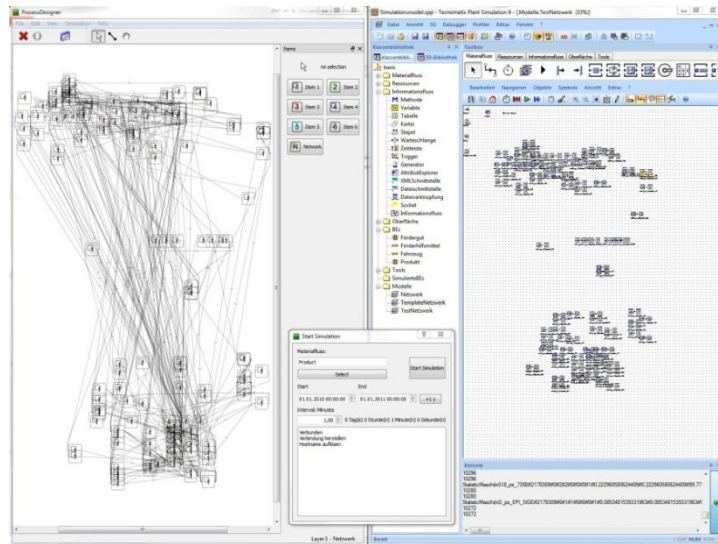Figure 1: Schematic overview of the system concept

Figure 2: The self-developed "Process Designer" (left) coupled with the
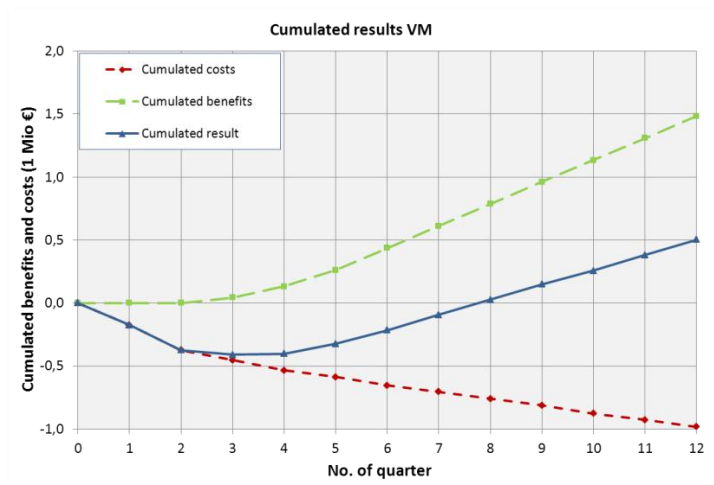DES simulator "Plant Simulation" (right)

Figure 3: Output of Excel-based calculations for virtual metrololgy integration