Summary

Today, in order to gain competitive advantage, manufacturers around the world make a combined use of innovative production technologies and production processes and methods. Technologies like optimization and discrete-event simulation are used to test the effects of alternative policies, which help to organize manufacturing operations. However, an integrated platform for simulation and optimization algorithms within which the user could generate and control the effects of the alternative policies is missing. Alternative control policies become even more relevant today as there is a need to keep complex manufacturing systems stable on the occurrence of execution exceptions and at the same time meeting optimization goals.

The work discussed in this report complements the work in the areas of combination of simulation and optimization technologies. The system developed is a predictive-reactive system which combines both the technologies. The predictive part determines the feasible schedule to be used for a parallel machines flow shop (PMFS) – a flexible manufacturing system, in a predictive way and serves as a starting point for the analysis carried out later. It considers a mix of fixed and flexible part flows, delivery constraints, buffer constraints, part flow constraints, and optimization constraints during its computations. This schedule is generated using a combination of rule-based simulation and optimization: using first the optimization algorithm to compute a rough plan, followed by using a rule based simulation system to locally fine tune the plan, and obtain the final schedule. The schedule generated by this predictive system, when implemented in the real world system is adapted by the reactive part of the system by generating alternative policies on the occurrence of system exceptions. These new alternative policies constitute the significant processes in the real world for a corresponding exception. In the reactive phase, alternative policies too are generated using a combination of simulation and optimization. The optimization algorithm brings the deviation from the predictive schedule back to its original trajectory as much as possible. In other words, it tries to change as less as possible. It does this while considering and solving adaptation synchrony problems (the problem that computations and changes in the real-world take time, while the real-world continues to evolve leading to differing states being used at different times) that may occur on the shop floor due to the change (or the new schedule). The simulation based system also predicts if there will be problems

in the near future due to the rescheduling action and tries to generate solutions based on rules, which make sure that the future execution of the schedule in the real-world will be problem free. The final rescheduling solution is evaluated by the simulation system and then implemented in the real-world.

The overall approach suggested in this report is based on the integration of technologies like optimization and discrete-event simulation, thus making it unique in the application of today's industrial problems.