

Robust Configuration and Monitoring of Semiconductor Supply Chain

Task Leader

Dr. Argon Chen

Principal Investigator

Dr. Argon Chen

Dr. David Chiang

Dr. Ruey-Shan Guo

ITRS Grand Challenge

Responding to rapidly changing complex business requirements [Factory Integration]

Primary Anticipated Result (50 words max)

This task will develop a robust configuration methodology accompanied with monitoring and control mechanisms for semiconductor supply chains. The aim of the robust configuration is not only to attain the best performance, but also to minimize the performance variability given the dynamic engineering and business changes. The performance of every supply-chain node will be then monitored statistically and adjustments will be made, if necessary, to ensure good performance of the entire supply chain.

Task Background (200 words max)

Semiconductor fabrication is itself a very complicated manufacturing process. Its global, cross-company supply chain operations are even more complicated and dynamic than usual planning and scheduling solutions have become impossible to employ. Many semiconductor companies have tried and failed to implement the most sophisticated advanced planning and scheduling (APS) solutions provided by notable supply chain planning (SCP) vendors. Some companies even observe that many deliberate interventions by planners have caused additional operation variability. Supply-chain variability is a critical factor with great impacts on the work-in-process (WIP) level, cycle time, and throughput. Given the high capital investment in capacity, manufacturing planners usually pursue a higher throughput that in turn results in an exponential rise of cycle time. However, it is not impossible to achieve a higher throughput while keeping or even shortening the cycle time. The solution is to keep the operation variability low. Techniques of reducing variability have been intensively discussed and investigated in the fields of stochastic control and quality engineering but rarely applied and integrated to operations planning because of nature differences between a supply-chain system and a manufacturing process. The mission of this task is therefore to develop novel methodologies that will integrate the quality engineering and control techniques with operations programming and optimization to achieve the robust supply chain performance.

Research Description (300 words max)

Chen et al. (2000) have proposed and applied both statistical optimization and control techniques to semiconductor manufacturing systems. However, many important issues of supply-chain operations, such as scalability and controllability of supply chain performance, differentiability of quality of service (QoS), and stability against process varieties, engineering changes and operation exceptions, have not been addressed in the literature. In addition, the

advance of modern sensor and information technologies, such as RFID, has made available more real-time information. Conventional modeling techniques of supply chain operations are no longer effective for supply chain configuration, performance diagnoses and improvement. This research task is to develop empirical supply chain behavior models to describe how supply chain configurations affect supply chain performances and their variability. With such models, a robust supply chain configuration can be first designed and then monitored with diagnoses and adjustments for further supply chain performance improvement.

This task consists of three subtasks. The first subtask is to provide an empirical behavior model with novel performance metrics by effective experimental designs of simulations. Given the behavior model, the second subtask configures a robust supply chain system by optimizing the performance metrics and minimizing their variability simultaneously. The third subtask then develops monitoring and control methodologies to ensure the supply chain stability and to compensate for any performance excursions. The subtasks are summarized as follows:

1. Construction of an empirical behavior model:
 - a. to determine the performance metrics with scalable, controllable and service-differentiable properties,
 - b. to characterize and simulate the process varieties, engineering changes, and operation exceptions, and
 - c. to describe the impact of supply chain configuration on the chosen performance metrics.
2. Robust supply chain configuration
 - a. to formulate a polynomial-goal programming problem, and
 - b. to solve the polynomial-goal programming problem.
3. Supply chain monitoring and control
 - a. to translate the system performance metrics into node controllable metrics,
 - b. to monitor the node controllable metrics, and
 - c. to make adjustments to the node for a given out-of-control signal

Task Deliverables for transfer to industry (30 words each max)

Semiconductor supply chain performance metrics (Model, Report) (MAY-05)

Supply chain simulation model, metrics decomposition, and goal programming formulation (Model, Report) (MAY-06)

Supply chain configuration model, polynomial goal programming, monitoring and control methodologies (Model, Methodology, Report) (MAY-07)

Graduate Students (if known)

TBD (2 M.S. students)