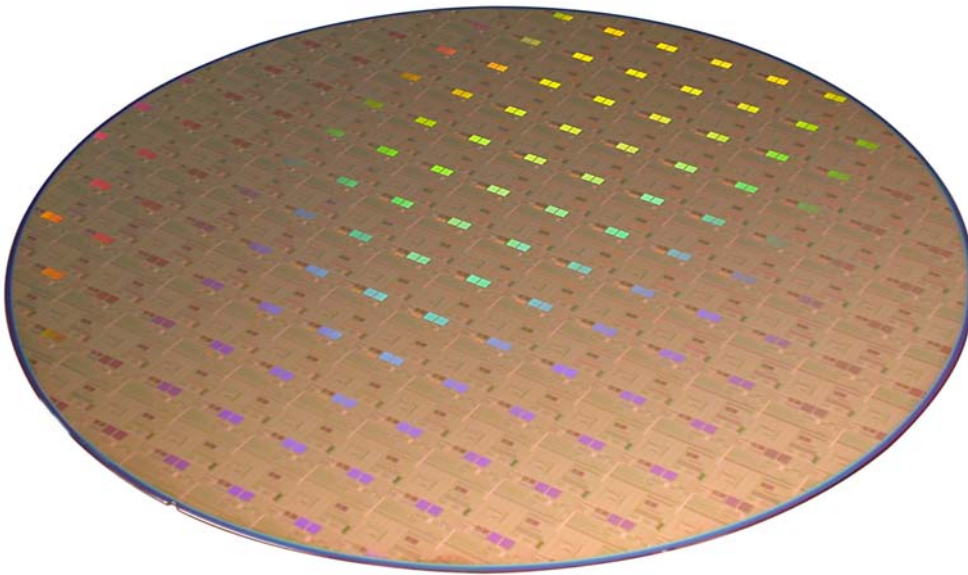


ILOG Fab PowerOps

Detailed production scheduling for semiconductor fabs



Challenges to staying competitive and profitable

To remain competitive and profitable, semiconductor fabs must reduce cycle time, increase tool utilization and respond quickly to dynamic business events. However, achieving these manufacturing objectives with traditional production scheduling software is especially challenging due to complex process flows, high product mix and often unpredictable events that interrupt planned operations.

Today's solutions lack precision

Generic scheduling modules within enterprise resource planning (ERP) and supply chain management (SCM) packages are insufficient for fabs because they lack information on semiconductor tools and process details. Moreover, these planning applications do not continuously and automatically respond to factory level events. On the other hand, common rule-based dispatching systems may sort lot lists for single process steps, but they do not assign and balance work in process (WIP) across all the tools in a process area.

What fabs need to improve KPIs

Fundamentally, fab scheduling is too complex to be managed by rules and lot priority schemes. Fabs need real-time detailed production scheduling software to shorten production lead times, reduce capital equipment costs and accelerate new product introductions. They need ILOG Fab PowerOps.

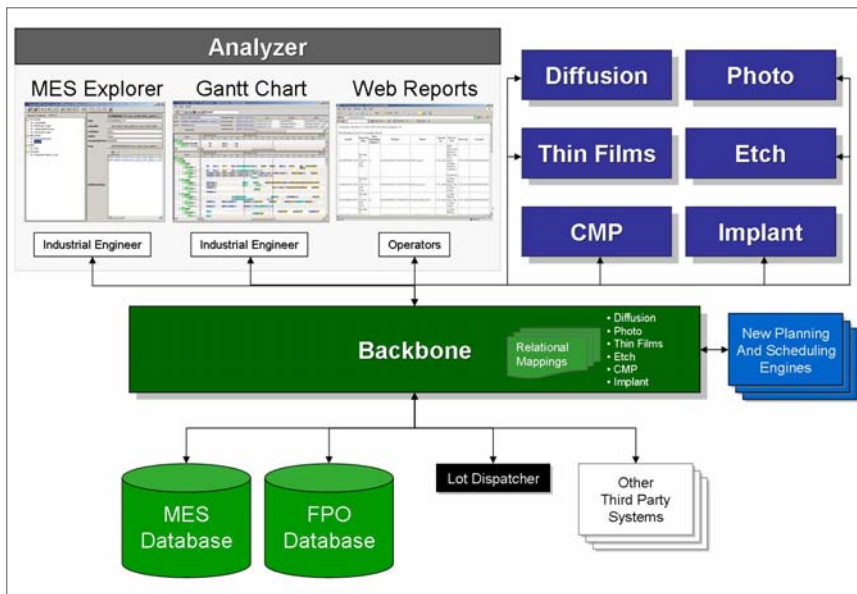
- Minimize cycle time
- Balance WIP
- Maximize tool utilization
- Process hot lots faster



Changing the rules of business™

ILOG Fab PowerOps

Improve Overall Factory Efficiency (OFE)



ILOG FPO service-oriented architecture

Solution requirements

ILOG Fab PowerOps (FPO) is real-time, detailed production scheduling software for semiconductor manufacturing. It creates and updates optimal forward-looking production schedules for all the tools in each fab process area. Combining detailed fab operational models with optimization-based operations research techniques and continuous event monitoring, ILOG FPO shortens cycle time, increases tool utilization and enables fabs to respond more effectively to tool interruptions, recipe qualifications and hot lots.

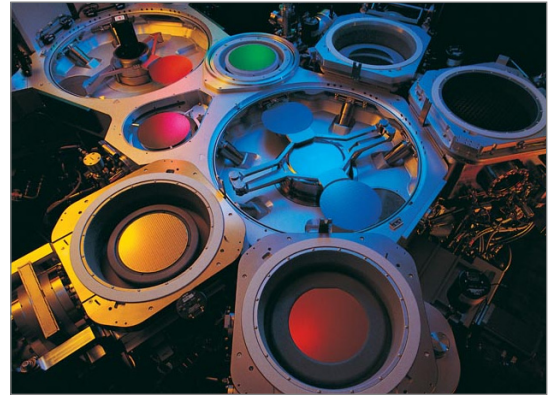
ILOG Fab PowerOps advantage

ILOG FPO's architecture provides the following three major areas of functionality for integrating with the existing factory systems, generating optimal schedules and monitoring production performance.

- **Scheduling Engines** – integrate predefined operational models for each process area with optimization techniques to produce optimal schedules every few minutes
- **ILOG FPO Analyzer** – provides graphical user interfaces (GUIs) for displaying and comparing schedules as Gantt charts, displaying performance metrics graphs and tuning scheduling engine parameters
- **ILOG FPO Backbone** – connects ILOG FPO modules with the manufacturing execution system (MES), ERP and other factory system data sources; filters and transforms data; stores custom data and parameters; archives schedules; and publishes schedules to GUIs, equipment interfaces and dispatching systems

Precise operational models

Since all fabs use very similar processes and tools, the operating models for each process area have been predefined within ILOG FPO's scheduling engines. These models for diffusion, photolithography, thin films, etch, implant and chemical mechanical polishing (CMP) areas are based on the operating scenarios and process tool types used by top-tier fabs throughout the world. These models enable scheduling algorithms to consider reentrant process routes, physical tool configurations, batching requirements, internal buffer sizes, multichamber tool configurations, process setup times, run times, interprocess timing constraints, critical ratios and other unique operating requirements in determining the optimal lot distribution and sequencing across all the tools within each process area.



Predefined process area operational models

Scheduling engine	Model inputs and objectives
Diffusion	Models wet-sink batching, single and dual tube furnace batching, interprocess timing constraints, lot staging, recipe run times, tool capabilities, monitor wafers, new recipe qualification and hot lots. Provides fully automated asynchronous batching for wet sinks and furnaces, and minimizes queue, setup and transport times.
Photo	Models linked track-stepper tool setup requirements, send-ahead wafers, reticle location and transport time, critical layer recipe tool matching, soft-and hard-bake setup times, and split- and hot-lot processing. Minimizes reticle movement, hot-plate heat/cool times and send-ahead wafers.
Etch	Models virtual tools on multichamber cluster tools, parallel and sequential chamber modes, precleans, critical timing and tool matching from photolithography, recipe setup times and split-lot experiments. It minimizes recipe setups, intrabay moves and lot queue time.
Thin Films	Models virtual tools on multichambered cluster tools, parallel and sequential chamber modes, separation of copper and aluminum processes, recipe setup times and split-lot experiments. It minimizes recipe setups, intrabay moves and lot queue time.
CMP*	Models polishing tools, measurement tools, send-a-head wafers and split-lot experiments. Minimizes recipe setups, intrabay moves and lot queue time.
Implant*	Models implantation, annealing and split lot experiments. Minimizes recipe setups, intra-bay moves and lot queue time.

*Available 2006

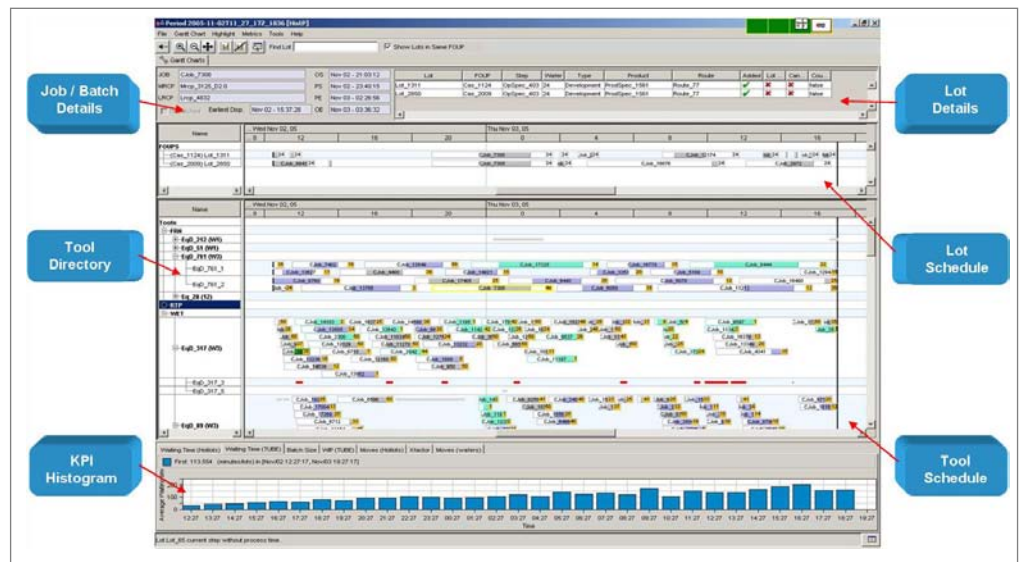
Optimized schedules

ILOG's leadership in optimization is based on excellence in two technologies: mixed integer linear programming (MIP) and constraint programming (CP). For almost 20 years, ILOG and its customers have been using these two technologies to solve the largest, most complex scheduling problems in airline operations, transportation, logistics, process manufacturing and build-to-order manufacturing. By combining our engines and experience with detailed fab operational models, ILOG is able to deliver optimized schedules based on the evaluation of all the WIP, tool, step and process-timing constraints in multiple alternative schedules before recommending the optimal schedule for a process area. ILOG FPO generates schedules that anticipate the future by accounting for the impact of WIP-to-tool assignments on near-term scheduling decisions.

Interactive scheduling tools and what-if analysis

ILOG FPO Analyzer provides GUIs for viewing, comparing and analyzing the schedules in a Gantt format, reviewing the performance of production metrics, and tuning scheduling algorithms. GUIs for operators and supervisors are accessible through Web browsers so that quick decisions can be made from anywhere inside the fab or a remote location. These operational GUIs contain a subset of the analysis features that simplify and tailor the functions needed by operators and supervisor in a real-time operating environment.

ILOG FPO Analyzer's Engineer GUI is a workstation application that provides scheduling experts, such as industrial engineers, and fab performance managers with sophisticated scheduling analytics. Different schedules can be compared side by side or with actual historical schedules, enabling fab managers to perform what-if analysis and measure the effects of tuning ILOG FPO to alternative business strategies. Using the ILOG FPO Analyzer's KPI histograms, fab managers can continuously monitor total cycle time, X-factor, queue time, process time, tool process time, idle time and other metrics by tool, tool type or process area.



ILOG FPO Analyzer's scheduling dashboard

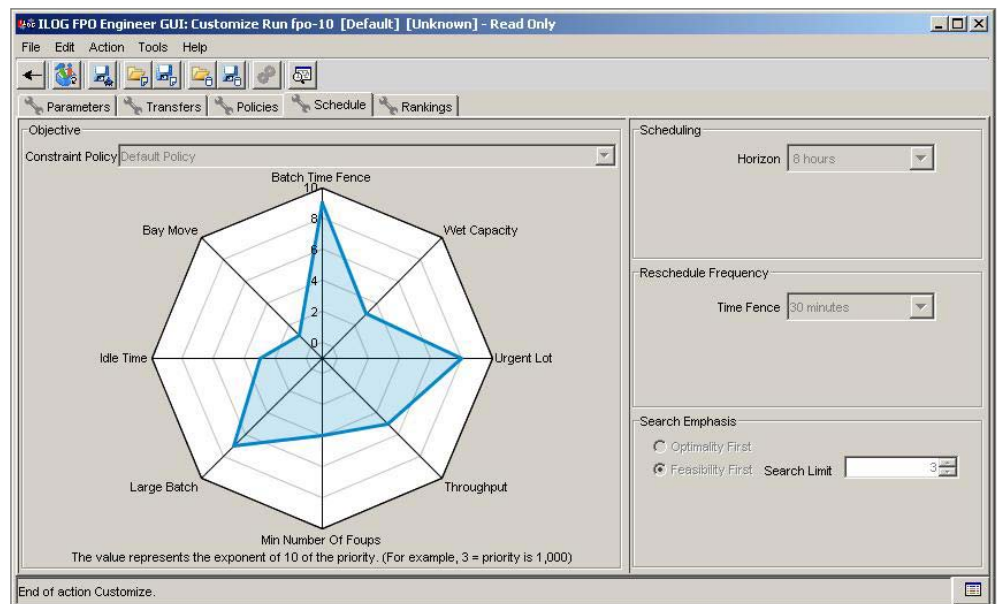
Low-risk integration with existing systems

The predefined MES data models in ILOG FPO Backbone include lot status, lot history, equipment status, equipment history, route and step. They help support low-risk integration and deployment with existing factory systems. Since fabs do not have the same systems or operating procedures, integration requirements vary. ILOG Fab PowerOps provides an integration toolkit to make this work as manageable as possible. And ILOG's experienced Professional Services team combines years of experience solving the toughest detailed scheduling problems in the world, with recent exposure to state-of-the-art 300mm fab processes. ILOG tools and services guarantee your success. After system connectors have been installed, ILOG FPO Backbone centrally manages all data transfers and communication between the factory systems and ILOG FPO's scheduling and analysis modules. It continuously extracts MES and other factory system data, filters and transforms it for the scheduling engine's database and initiates commands to the engine to generate schedules. When new schedules are ready, ILOG FPO Backbone publishes them to ILOG FPO Analyzer GUIs and other factory-system components (e.g. dispatching, equipment interfaces and AMHS).

Adaptable to unique and changing business requirements

While basic semiconductor processes are common across all fabs, each fab has unique business drivers and operational differences. ILOG FPO's scheduling algorithms are easily tuned to support a fab's production stages (e.g. startup, ramp, fully ramped), production class (e.g. memory, logic, foundry, R&D), process technology, level of automation and other individual fab requirements. Fab managers can adjust the weighting of manufacturing objectives and enable or disable constraints to prioritize new product introduction, process development, clear older products through the line or increase volumes of products in response to seasonal consumer demand. When fab managers need to experiment with different tuning alternatives, ILOG FPO Backbone automatically archives MES data so that scheduling scenarios and tuning decisions can be analyzed offline before they are implemented in production.

ILOG FPO can even support highly custom operating scenarios with entirely new constraints simply added to the scheduling algorithms. ILOG's Professional Services team can help you quickly adapt ILOG FPO to your fab's needs, and train your managers on how to tune the application in response to changing business requirements.



ILOG FPO Analyzer's scheduling engine tuning interface

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Business benefits

- Reduced production cycle time in each process area
- Significantly increased tool utilization
- Shortened new product introduction time by scheduling hot lots and recipe qualification more efficiently
- Improved product yield by eliminating unnecessary recipe setups, reducing reticle movement and efficiently scheduling production within critical process time windows
- Reduced WIP bottlenecks through forward-looking schedule analysis
- Real-time responsiveness to production changes and tool interruptions
- Quick adaptation to unique operational requirements and changing business drivers
- Reduced system deployment and support risks with provided predefined operational models, proven commercial scheduling algorithms, connectors for leading factory system components and installation on leading commercial computing platforms
- Reduced or eliminated complex dispatching rule development and maintenance
- Detailed fab performance visibility through state of the art Gantt charts and KPI display

Precise KPI analysis

- Lot cycle time
- Hot lot cycle time
- Process step cycle time
- Xfactor (actual cycle time / theoretical cycle time)
- Lot waiting time
- WIP moves
- Tool utilization
- Many others

ABOUT ILOG

ILOG delivers software and services that empower customers to make better decisions faster and manage change and complexity. Over 2,000 global corporations and more than 400 leading software vendors rely on ILOG's market-leading business rule management system (BRMS), optimization and visualization software components, to achieve dramatic returns on investment, create market-defining products and services, and sharpen their competitive edge. The BRMS market share leader, ILOG was founded in 1987 and employs more than 600 people worldwide.

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