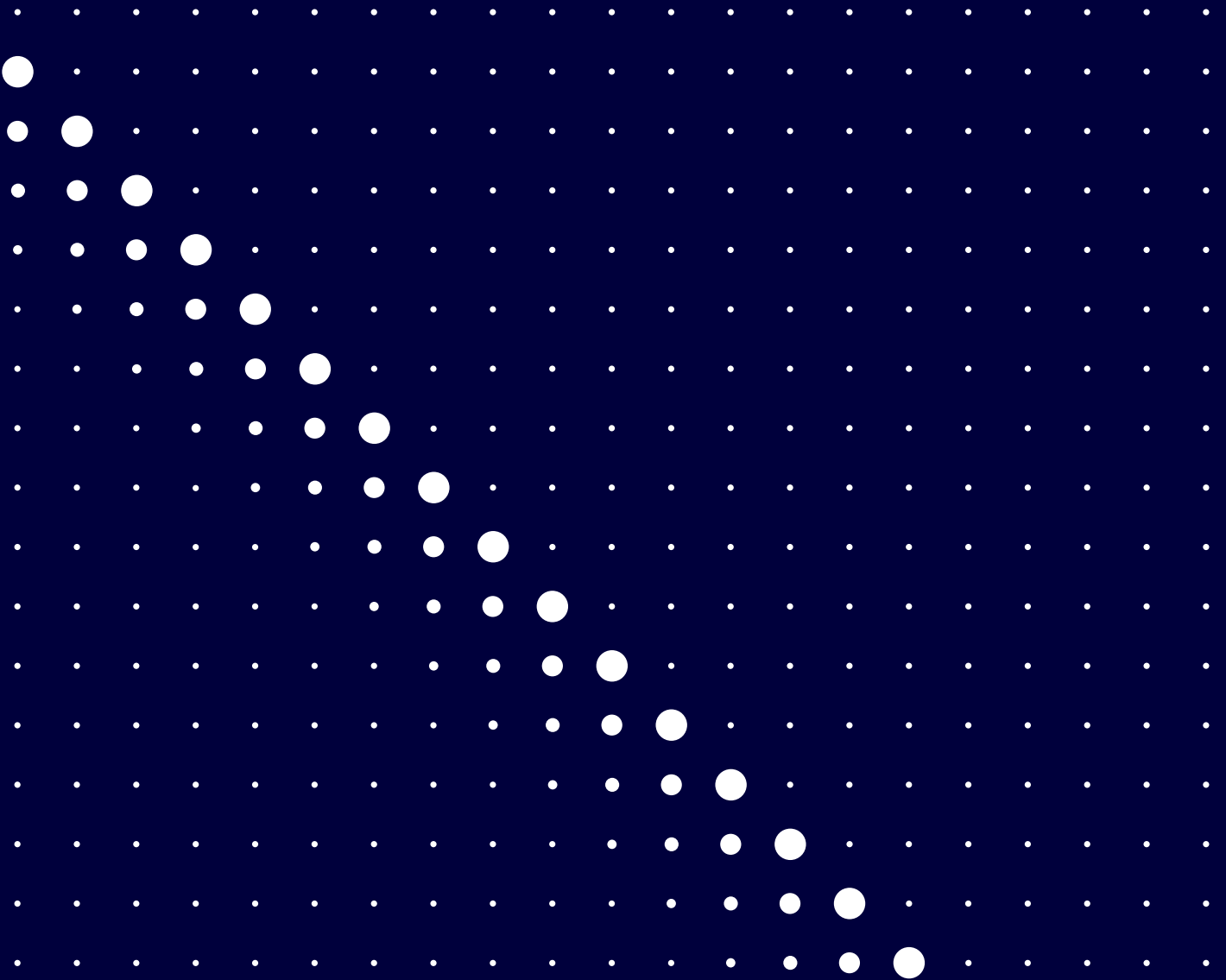


Advanced Production Scheduling in a Seagate Technology Wafer Fab

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The Challenge: Reducing cycle time in a highly utilised wafer fab.

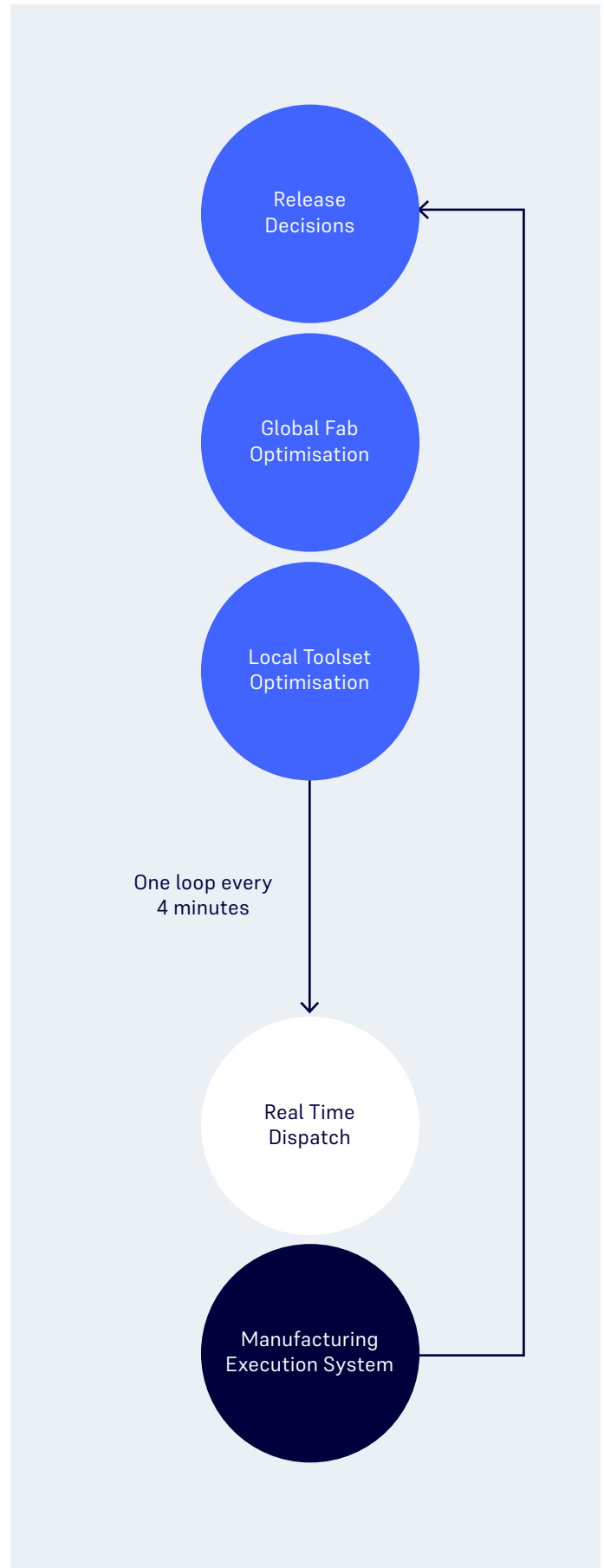
Seagate Technology is a data storage company with the goal of maximising humanity's potential through delivering world-class, precision engineered data solutions. Their Springtown facility in Derry, Northern Ireland produces wafers 8 inches in diameter - and they make up for approximately 25% of all read-write heads for hard drives globally.

The Seagate wafer fabrication process is exceedingly complex and with Springtown being a highly re-entrant facility, wafers often have to revisit the same toolset multiple times throughout the production process. Producing a single wafer can require around 1600 unique steps, which results in the manufacturing process taking a total of 6 to 9 months. Being an Integrated Device Manufacturer (IDM), Seagate has ownership over the complete supply chain and because of its complexity, the wafer fabrication process can account for around 65-80% of the total cycle time.

As time goes by, wafers are becoming more and more intricate, meaning that it's getting harder to meet cycle time targets. Seagate could combat this by expanding existing facilities, installing more tools or opening up new fabs. However, in the world of semiconductors, the cost of equipment can be extremely high and consumer demand can be unpredictable – making it a potentially high-risk investment. Therefore, to get the most out of their fab, Seagate's factory utilisation is constantly running near to 100%. As a result, small improvements in fab efficiency can help substantially increase capacity.

The Solution: Implementing hybrid-optimisation technology to solve scheduling problems.

Seagate understood that increasing the capacity of a highly utilised fab without acquiring new equipment would require an



improvement in production scheduling. They first started to work on a solution internally before evaluating the numerous different scheduling options on the market where they decided to partner with deep tech company Flexciton.

Flexciton’s solution is an optimisation-based scheduler which has been designed specifically to solve wafer fab scheduling problems. It combines mixed integer linear programming (MILP) with heuristic search and smart decomposition to offer optimal results.

By utilising the power of parallel computing, Flexciton’s scheduler is able to calculate an optimised schedule extremely quickly, with an end to end time of 4 minutes.

The solution contains three different levels of scheduling aimed at optimising the entire fab. Level one is the local toolset optimiser. This solely looks at the WIP in front of or arriving at a toolset and optimizes the KPIs specific to that toolset. Level two is the global fab optimiser which is able to schedule the flow of WIP globally around the entire fab and ensures an optimised supply of WIP to individual toolsets. Finally, at level three is the release decisions optimiser which determines when to release WIP into a fab, to begin with. The solution has been

designed to work with a fab’s existing MES and dispatch system for easier integration.

The photolithography area sets the cadence of the Seagate facility and with the added complexity of reticle movement, it’s critical to have an optimised schedule. Flexciton’s scheduler is able to optimise a pod schedule with defined reticles based on current and upcoming WIP. Notifications are then sent to the operators on the factory floor via a user-friendly interface, so they know when to load and unload pods from each tool.

Today, Flexciton’s solution is fully integrated into the Springtown fab and early results are showing far superior performance than the heuristic-based scheduling algorithm previously employed by Seagate.

The Results: Substantially reducing overall cycle times.

Seagate has now tested Flexciton’s scheduler on 90% of its toolsets to ensure compatibility with tool uniqueness and is currently deployed and running on 40% of the tools in the fab 24/7. The amount of variability in the fab and the fact that no two 12-hour shifts are ever the same means

fig. 1 - CYCLE TIME IMPROVEMENT BY TOOLSET (ACTUAL OPERATION VS SIMULATION)

Toolset	Tool A	Tool B	Tool C	Tool D	Tool E	Tool F	Tool G	Tool H	Tool I	Tool J	Tool K	
Priority	1	-52%	4%	4%	32%	10%	59%	26%	4%	46%	46%	43%
	2	-26%	17%	11%	55%	32%	56%	10%	22%	35%	55%	40%
	3	-44%	5%	8%	45%	19%	0%	9%	10%	23%	23%	15%
	4	19%	8%	58%	18%	34%	65%	19%	72%	25%	35%	63%
Average	-26%	9%	20%	37%	24%	45%	16%	27%	32%	40%	40%	

that it can be difficult to get a baseline from which success can be measured. To combat this, Seagate uses a simulation model that they run before every shift that predicts how well the fab will perform.

Seagate's main objectives are to minimise queue and process time and the data so far have shown significant improvements in these areas. Certain tools have shown up to 45% improvement in cycle time on average over the simulation model when the solution is put into practice (see fig. 1).

"Moving from RTD to optimised scheduling, where operators lose some of the control, has been a big change for the Springtown facility. But with testing on all tools that have mixed or single recipes and process restrictions now complete, Seagate looks towards deploying global scheduling"

Tina O'Donnell, Wafer Systems
Engineering Manager at Seagate

Creating optimal schedules for reticles and reticles within pods for lithography tools has now been finalised and Seagate is currently in the process of testing these tools. In the near future, the fab aims to have the global scheduling approach fully implemented. This will include Flexciton identifying key bottlenecks and critical points in the line to automatically schedule WIP and get the most out of the fab.

Finally, an optimal WIP release strategy is currently being developed together with Seagate. This is to ensure the WIP is released into the line at the correct time and at the correct rate to assist in optimising the line. Once this is complete, Springtown will have a full fab implementation that schedules across the line – improving throughput and reducing cycle time throughout the entire facility.

About Flexciton

Flexciton is applying cutting-edge technology to optimise the world's most complex manufacturing process: semiconductor wafer fabrication. Utilising 10 years of academic research, their engineers have developed a hybrid-optimisation model that solves production scheduling problems that were previously unsolvable.

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About Seagate

Seagate Technologies has provided innovative, precision-engineered data solutions for over 40 years and is the leading provider of bytes globally – with over 3 zettabytes¹¹ of data shipped.

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