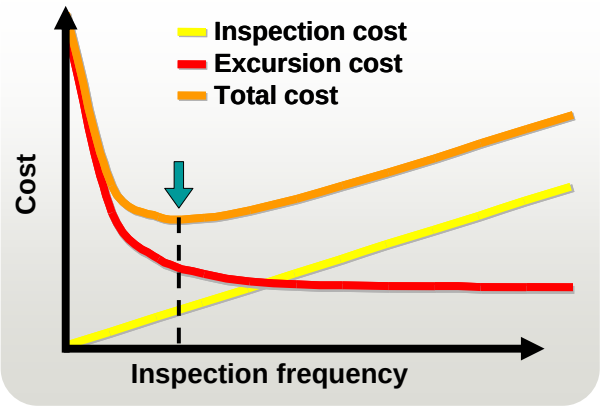
Inspection planning based on excursion risk management

IP1.0 is the first inspection planning software offered to the semiconductor industry. Using process, defect, and economic data, IP1.0 allows fabs to identify the defect inspection capacity that minimizes excursion risk and maximizes fab profitability.

Importance

Fab spending on process control is approaching 20% of capex. This is one more reason fabs need to plan inspection spending as carefully as process and AMHS spending.

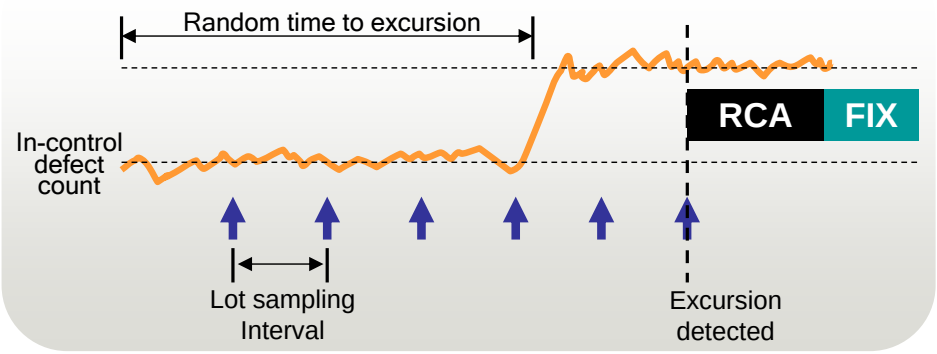
Analysis with fab data estimated up to 2% fab yield increase due to sample plan optimization*. There was no increase in tool cost, utilization, false alarm risk, or cycle-time.



The key to identifying the optimal inspection capacity is to balance competing inspection and excursion costs. IP1.0 captures inspection costs with a cost-of-ownership model. The excursion costs are assessed by calculating excursion detection delays.

The excursion detection model

Process tools are modeled to experience out-of-control (OOC) states at random points in time. In the OOC state, a defect count of some type has increased. These excursion events need to be detected quickly to minimize yield impact.



An in-&-out-of-control cycle for a single process tool.

Variables affecting the time to detection

The time to excursion detection is a function of cycle-times & detection probabilities. IP1.0 takes a vast number of inputs into account to calculate these values, e.g. 1) tool throughput, 2) tool MTBF/MTTR, 3) cycle-time to inspection and/or review station, 4) sampling (% of lots, % of wafers, % of wafer area inspected), 5) lot-to-lot and wafer-to-wafer variance of defect counts, 6) capture rates for individual defect types, 7) review sample size, and 8) classification accuracy & purity for individual defect types.

The complexity addressed by IP1.0

The in-&-out-of-control diagram shown is for a single process tool & excursion. A high dimensional probability problem arises when multiple process tools with multiple excursion types are considered simultaneously. Recent algorithm advances allow IP1.0 to model this problem fast and accurately.

IP1.0 is also a process tool capacity model that captures the impact that excursions (and their detection) have on process tool availability. Therefore, IP1.0s dynamic queueing model captures the full fab throughput and cycle-time impacts associated with sampling plans. These are cost impacts that current fab capacity models omit.

IP1.0 takes many factors into account. Please visit our website to learn more about the many intricacies of Inspection Planning and to download technical papers.

*For references visit www.sensoranalytics.com or send an email to info@sensoranalytics.com

Technical features of algorithms in IP1.0

Multi step & product with step dependence	All process and inspection steps can be modeled for multiple products. An inspection tool can sample multiple steps/products. Multiple inspection tools can also sample the same process step. Dependent process steps are not treated independently.
Multiple defect & excursion types	Each tool cluster and/or process step can have multiple defect types. Each one with its own excursion characteristics. Excursions can impact one or multiple steps/products.
Simultaneous excursions	A process tool cluster can have more than one excursion taking place simultaneously.
Defect capture rates	Inspection tools have defect specific capture rates (also known as defect detection probabilities).
Wafer sampling	Wafer sampling can be specified as % of lots, % of wafers, and % of wafer area to inspect.
Review sampling & classification	Excursion detection impact of review percentage and classification accuracy & purity is taken into account.
Excursion signal to noise & yield impact.	Excursion types have their own signal to noise ratio and yield impact inputs. The data analysis module can provide these inputs.
Lot-to-lot & wafer-to-wafer variance	These variances impact all sampling variables and in particular the number of wafers required per lot.
Material handling model	Model has inputs for the travel time lots experience on the material handling system.

Process tool model	If desired, all process tools are modeled explicitly. This makes IP1.0 a regular fab capacity model as well. All tool downtimes are part of queueing calculations.
Preventive maintenance (PM) impact	PMs have an impact on tool availability, queueing/cycle-time, and excursion yield losses.
MTBF/MTTR impact	Non-excursions related MTBF/MTTR of all tools is factored into queueing calculations.
Fab cycle time impact	A dynamic queueing model captures the cycle-time impact of capacity and sampling plans.
Fab throughput	Fab throughput is a function of capacity and sampling plans.
Excursion signal propagation	Excursion signals are seen at probe and can propagate to downstream inspection steps.
False alarm response, root cause analysis, & excursion fix	These events & their durations impact fab costs, yield, and process tool availability.
Simulation verification	Analytic approximations used are verified with simulation models for accuracy.
Optimization capability	A custom genetic algorithm is used to optimize capacity and sampling plans.

