Smart Subfab Transformation using Context-Based Control – Dr. Holland M. Smith III

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The idea of a "smart" subfab is one that supports all of the traditional needs of process tools – vacuum, heating, chilling, abatement, etc. – in the most efficient way possible. There are many efficiency improvements that can be made in subfab operations that save electricity, reduce resource consumption, or lower greenhouse gas emissions (to name just a few examples) without compromising on the needs of the upstairs tools. In order to automate many of these improvements however, a factory needs to implement a technological layer capable of achieving context-based control of subfab equipment.

One of the principles characterizing the evolution of factories towards smart manufacturing is the unification of previously disparate data sources and systems into new forms that provide additional value and functionality beyond that delivered by the underlying components. In front-end wafer manufacturing, this trend is exemplified by the relationship between subfab and fab-level data and control. Historically, subfab data has been collected by separate SCADA systems with simple timestamps that lack the context of what the process tools are doing. Tool-level data has been collected by SECS/GEM-based or similarly-enabled applications independent of any subfab element context. This has been sufficient to provide basic subfab element monitoring in parallel with tool- and process-level applications like station controllers and FDC. However, as processes have gotten more complex, it has become apparent that value can be gained by merging tool- and process-level context information with subfab data. Achieving such a merger improves quality and yield by making it easier to monitor subfab system health from within the same framework that engineers use to achieve process control (as an example: SPC charts for process pump exhaust pressure). It also enables making correlations between process and subfab-element parameters, which can be important for yield improvement.

Beyond analytical benefits however, the merging of tool-level and factory-level context information with subfab systems unlocks an entirely new smart manufacturing layer when the element of control is added. There are many intelligent decisions in subfab operations management that can be automated if the right data is provided to the right type of system. As an example, many modern abatement and pump platforms provide energy savings modes that can be activated during times when the process tool does not require full usage. There are also energy/resource-intensive processes that may make sense to run at different times due to varying costs such as daytime or nighttime electricity rates. A factory can conceivably exploit these optimizations, but in order to do so automatically there must be a system in place that has the ability to analyze factory- and tool-level condition data and automatically control the relevant subfab elements based on the results of the analysis.

In this paper, we describe the implementation of such a platform and show results that can be achieved. The system, which now has more than 3500 installations in major IDMs, can:

1. Collect data from a diversity of subfab systems - pumps, abatement units, TMS, chillers, etc (independent of vendor) - from within the tool/process-level context

2. Integrate with tool- and factory-level Digital Twins

3. Control the same subfab elements - pumps, abatement units, TMS, etc.

4. Execute control decisions based on automatic analysis provided by tool- and factory-level systems, such as a factory scheduler.

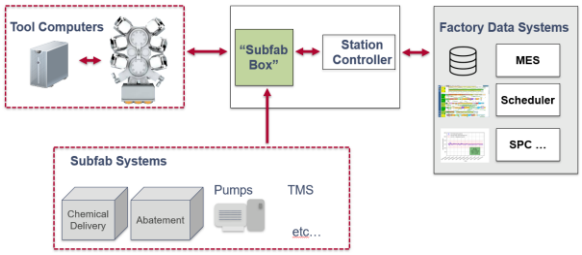

Fig 1. Schematic of Context-Based Subfab Controller

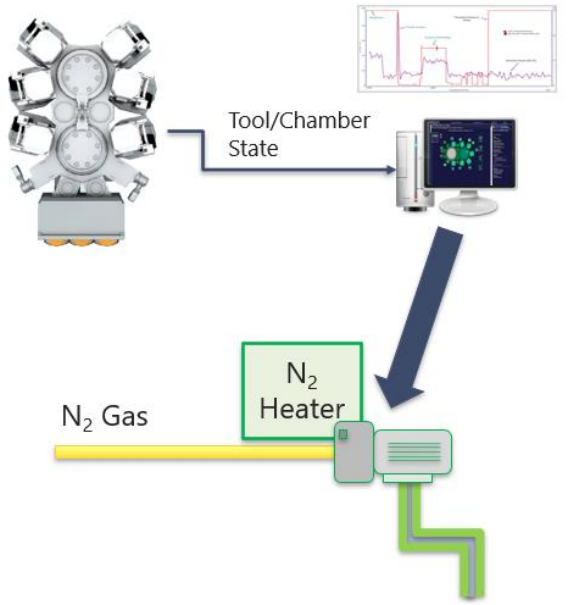

Fig 2. Example Resource Savings using context-based control

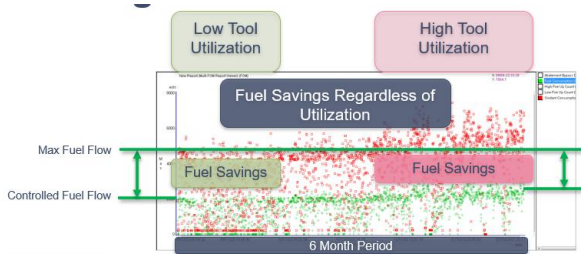

Fig. 3 – Actual data showing >50% reduction of natural gas consumption by toggling abatement state based on instantaneous tool-state knowledge