The Best MES Selection Process & Benchmark Survey For a Semiconductor Fab Case Study

Danny Rosner, Ariel Meyuhas

MAX I.E.G. LLC, 180 Old Tappan Rd, Old Tappan NJ 07675
danny_rosner@maxieg.com, ariel_meyuhas@maxieg.com

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Abstract

This extended abstract provides an overview for an MES selection and benchmarking project performed by MAX in a semiconductors FAB. The abstract will outline the methodology used to gather the requirements and select the suitable system as performed by MAX for our client.

Problem Statement

A Manufacturing Execution System (MES) is a necessary tool for the operation of any large volume manufacturing facility. The system is a key element to guarantee integration of all the components, ensuring high efficiency and quality throughout the entire process.

The MES is typically integrated into the vast majority of the manufacturing routines. Starting from the way we do simple tasks such as moving and processing lots on the production floor to more complex tasks like managing dispatch priorities, assuring quality, yield management, reporting and much more.

As the MES plays such a significant part of the manufacturing process, companies often tend to customize and enhance the system's basic functionality by "patching" interfaces, integrating satellite systems, using external reporting tools and other workarounds that provide solutions for their constantly changing needs.

This was also the predominant situation of a Semiconductors company in the US that decided to engage MAX to help select an alternative MES package. They needed a system that would better suite their business and operational needs. The system they were using was Applied Materials (AMAT) WorkStream, a widely used legacy MES, for over 20 years with one of the largest install base in the semiconductor industry. To meet the ever-evolving operational requirements, our client developed many workarounds, interfaces and links between the MES and other homegrown or purchased systems. In addition, they were using hundreds of non-standard reports developed for their variety of business needs with external tools.

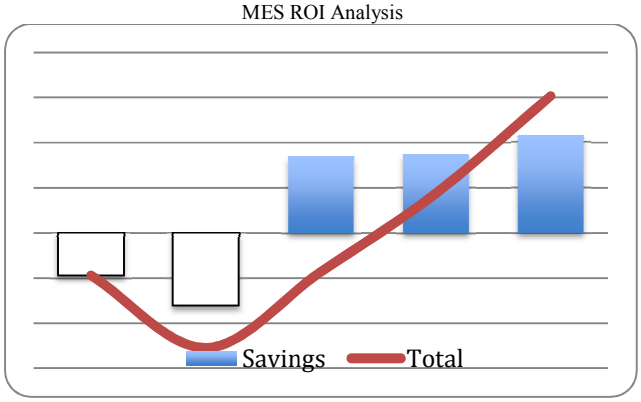
Finally, hardware support issues arose with the server farm used to run WorkStream. The client's IT department was forced to upgrade the hardware used to run the system in order to stay current with vendor support. The client's management team felt it was a proper time to review the cost and benefits of keeping WorkStream and invest more capital in upgrading it to handle new hardware requirements vs. completely replacing WorkStream with an off-the-shelf solution that will provide better functionality, usability and will meet the long term IT hardware roadmap for the company. This time honored dilemma will be solved through a detailed cost of ownership analysis coupled with an extensive study of off-the-shelf MES packages. To accomplish this, our client selected MAX to lead this effort and work with the internal experts to find the best option for its future.

This article will provide insight into the evaluation and selection process conducted with the client and will shed light on the most current semiconductors' MES packages benchmark performed during this study.

Cost of Ownership Model

Cost of Ownership (CoO) is a commonly used modeling method that enables a **business case comparison** designed specifically to find the lifetime costs of acquiring, operating, and changing a product. In the client's case, we compared the CoO of keeping WorkStream alive vs. replacing it with a modern solution.

Chart 1
MES ROI Analysis



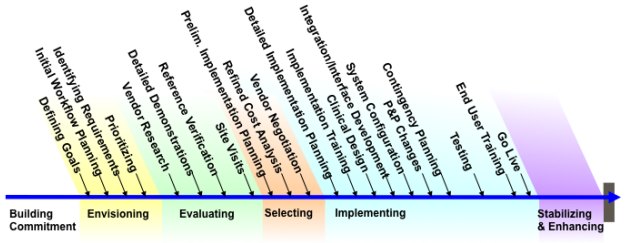
MAX created a CoO model considering cost and savings aspects assuming the lifetime of the system would be 15 years. The results are shown in Chart 1. Cost parameters included vendor license fees, professional services, training,

IT hardware and integration, maintenance contracts, labor cost etc.
Savings parameters included IT savings, operating efficiency of the Fab, production control, paperless system, error rates and misprocessing etc.
The model clearly showed that replacing WorkStream with a modern MES would be the chosen option and the business case study showed an ROI for implementation of the MES within slightly over a year of production.

Approach and MES Selection Process

Understanding the important impact an MES would have on the FAB's efficiency and due to the complex nature of replacing a manufacturing system, the client's management team decided to conduct a full scope requirements gathering and a careful system selection process. A team of leaders from different manufacturing, IT, support and strategic planning areas was assembled for the task under the guidance of MAX. MAX role was to run this project and provide the industry's best-known practices for MES selection.

Chart 2
MES Selection & Implementation – High-Level Process Diagram



Requirements Gathering

In order to map out the requirements, MAX initiated three sub teams to review the process. All were assigned to evaluate the process from different angles.

A. *The functional requirements team*

The team mapped out the FAB process from end to end, carefully reviewing each activity, the information systems used, and inputs and outputs that are required to complete the process. The team's work resulted with a list of functional requirements and satellite systems required interfaces for the future MES.

B. *Integration Team*

The team mapped out every query, report and link between the MES and any satellite system. The team gathered information about the functionality and owners of each item. The team also generated recommendations for systems, databases and reports consolidations based on required functionality.

C. *IT and Hardware Requirements team*

The team gathered hardware requirements needed. They mapped information about the number of users required, privileges, data stored requirements, mapped and listed high level functionality needed for any equipment that might require a communication or connection to the MES.

The core team, using the information gathered, mapped out all the systems and scoped the project boundaries. For each system it was decided if it would be in scope, would be out of scope or if it might be in scope depending on the solution offered by potential vendors. During the vendor evaluations, only in scope and potentially in scope categories were reviewed.
Once all the processes were mapped, the operational procedures performed were revisited. Many activities were found to be redundant as they were added to the process to comply with inefficiencies typically found with legacy MES such as eliminating manual QA verification steps and eliminating paper lot travelers. This step proved itself as extremely important since it gave our client a fresh opportunity to review how daily business is conducted on the floor in reality and identified opportunities to further cleanup waste. In addition, industry best-known production management practices were designed into the future MES implementation process.
This requirements gathering step yielded a consolidated list of more than 250 functional, integration, and hardware/software requirements put together in a final requirements document that would be the basis for an RFP. The following table shows the categories and groups used to specify and group the list of requirements.

Table 1
Requirements category classification table

APC / SPC	Core Function	Engineering Data Collection	QA	User Interface
Charting	Allow Lot Wafer Annotations	Annotation	Customer satisfaction	Automated data entry
Communication	Change & Configuration Control	Calculations	Customer support	General
Configuration Control	Chip Level Tracking	Customizable GUI	Vendor stability	send emails based on triggers
Out of Control Action Plan	Flows	System To System Interface		
Reporting	Lot Genealogy	User Interface to collect data	**Reporting**	**YMS**
Rule Checking	Lot Qualification Tracking		Data Warehouse	Yield Management System
System To System Interface	Next ID generator	**Entity Tracking**	Engr/Operations	
What If Capability	Step or Operation	Track reusable entities in the fab	Feeds	**Software infrastructure**
	Unit Tracking		Geneology	Database connectivity
System	Wafer Defect Inspection	**Equipment Automation**	Integration	Database platform
Audit trail on all transactions	WIP Description	Recipe automation	Metrics	Reporting platform
Automation	WIP Tracking	Tool Diagnostics	Production	
Interface to Databases	Work Instructions	Process automation	Project	**Hardware infrastructure**
Interface to SAP			WIP	Client platform
Migration from Workstream	**Discrepancy Reporting**	**Equipment Tracking**		High availability/disaster recovery
Security control	Discrepancy reports	Machine level state tracking	**Required Paper**	MES application server
Software maintenance	Track all non-conformances		Required Paper	MES database server
System Capacity / Speed		**ERP/MRP**		Reporting server
	Dispatching	Chip Request	**Resource Tracking**	Server virtualization
Training	Dispatching	Inventory	Ancillary supply tracking	Storage platform
Operator qualification tracking	Scheduling	Lot Request Management System		

Based on the functionality requirements, all the items were categorized into a functional group. Among the categories shown in Table 1 are - core features, dispatching, equipment automation, ERP/MRP, hardware and software infrastructure, SPC/APC, EDC, user interface, reporting, required paper and more. Each category and feature was ranked in importance with a scale based on a Critical, Required, "Nice to Have" or "Delighters" ranks.

Evaluating and Selecting an MES Solution

There are many MES solutions available in the market; each has advantages and disadvantages. The best MES solution would be selected based on FAB operational needs, affordability and transitioning cost and effort. Savings of a

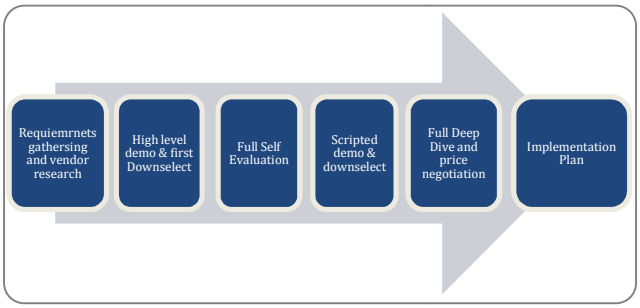
few seconds by simplifying a process, a task, or a GUI, would add up to a significant savings over the years.
The joint MAX-Client team had researched and gathered a list of 14 MES solutions available to be reviewed (see Table 2). Since this client has multiple manufacturing sites, the systems included major MES solutions used in the semiconductor industry. In addition we evaluated MES solutions that were in use by the client in other manufacturing sites and might have an integration and a financial edge, and other major vendors in related industries.

Table 2
MES Systems evaluated

Apriso	Camstar	Cape
CM-Navigo	Eyelit	FAB 300
Factory Works	Miracom	Smart Factory
Msart MES	Solumina	WipTrack
Wonderware	WorkStream	

An initial screening (down-selection of candidates) was performed to all of the systems reviewing a high level of their functionality, components, support models, integration capabilities, target markets, market share, vendor's HW/SW roadmap, strengths and weaknesses, customer feedback, high level price range and more. The initial screening included a phone discussion with the vendors' representatives, short demonstrations and brief offline discussions with clients and users of the systems.
The initial screening step resulted with a list of eight MES vendors, all of which seem to have potential of supporting the FAB needs.
The selected vendors were provided with the document of functional requirements gathered. Each requirement was marked with its criticality to the Fab team. The vendors were asked to follow the process outlined in chart 3 below.

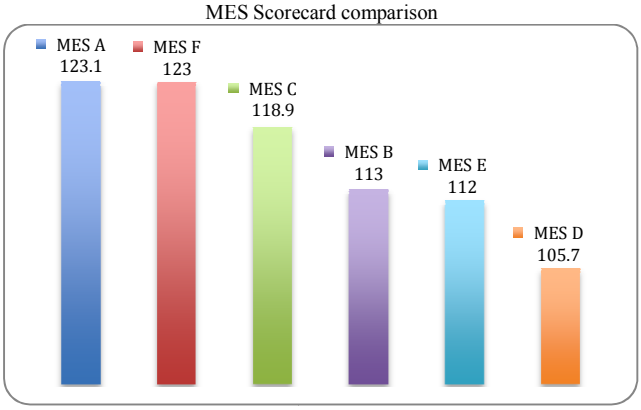
Chart 3
MES Selection Process outline



Initial demo provided by the vendors was geared towards the needs of the company with initial requirements from the client's FAB.
After reviewing the demos, each vendor was scored based on different criteria. The criteria included operator's ease of use, engineering flexibility, WIP tracking capabilities, dispatching, SPC & EDC, reporting and more.

Based on the vendors' demonstrated ability to fulfill the requirements, six vendors were selected to proceed with an in-depth review.
The six remaining vendors were asked to prepare an in-depth demo and were provided with a list of items to be presented. In addition, the MES vendors were asked to complete a self-assessment of their system's ability to meet each of the technical requirements gathered. The self-assessments were validated during the in-depth demos.
The in-depth demos included multiple vendor down selection steps. The systems were evaluated using a specially developed scorecard.
The scorecards accounted for multiple levels of importance and weights for each solution and requirement, and the team conducted several reviews of each vendor's score for each requirement to assure that the vendor is really fulfilling the requirement put forth. This exercise is particularly important to maintain an "apples-to-apples" comparison between the remaining vendors and figure out the balance between tangibles and intangibles with each solution.

Chart 4
MES Scorecard comparison



The vendor down-selection phase resulted with two MES solutions that were deemed to be the best match for the company's overall requirements. A final review meeting with all relevant stakeholders was held to conclude on the winning system and award the bid to the chosen vendor; a system was selected.

Following this successful project conclusion, MAX documented the entire selection process and developed the most extensive and detailed MES benchmark survey. The benchmark covers all MES solutions brought forward in this abstract and includes information about the system functional capabilities, support model, automation and tool integration capabilities, client base, client feedback and more. For more information please contact MAX at marketing@maxieg.com.

CONCLUSION

An MES plays a significant role in the FAB's operations and efficiency. The MES evolves during the years and should be occasionally checked to assure it can fulfill the FAB needs and does not accrue heavy un-needed expenses.

If an MES selection process or revisit is done, it is recommended to spend the time and effort needed to assure the best selection is made.

Selecting the right MES might introduce a significant improvement to the FAB's efficiency and could have a fast return on the investment.

ACRONYMS

CoO: Cost of Ownership
EDC: Electronic Data Collection
ERP: Enterprise Resource Planning
HW: Hardware
MES: Manufacturing Execution System
MRP: Material Requirements Planning
RFP: Request For Proposal
ROI: Return On Investment
SPC: Statistical Process Control
SW: Software
WIP: Work In Process