Margin creation and CAPEX avoidance through OEE improvement in a Semiconductor Assembly and Test Foundry (OSAT)

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Keywords: OSATS, BGA, Wire-Bond, Bottleneck, Capacity Ramp, Capital Expenditure Avoidance, OEE

ABSTRACT

The global Semiconductor Assembly and Test Services (SATS) industry revenue is estimated at US$25Bn and anticipated to grow at an estimated rate of 5% during the period 2015 - 2021 to reach US$39Bn. While the growth propels the industry, it is also challenged to be highly cost effective. A cost reduction roadmap along with high operating efficiency is the key to win business for OSATS - Outsourced Semiconductor Assembly and Test companies. The MAX Group was engaged by one of the top 5 OSAT companies in the world with multiple factories located primarily in Asia. At first, the client engaged MAX to study and analyze two of its factories using our proprietary ORE™ program which identified a significant capacity improvement opportunity. After a successful completion of the ORE™ Study, the client engaged our teams for further 12 months to realise this significant improvement in factory output. This case study presents the details of the MAX Methodology tailored for the OSAT industry segment.

INTRODUCTION

The reality - Eroding product ASP are increasing pressure and demand for sustained gross-margins on OSAT companies. All OSAT companies in our industry have already set aggressive goals to lean their manufacturing plants to stay competitive, but we see only few actually realizing those goals.

In not-too-distant past, chip packaging has shifted to an outsourced assembly & test model more quickly and extensively than front-end processes have. In fact, industry experts believe that the outsourced share of this segment could reach beyond 50 percent of the market by 2018.

As the technology race enters OSAT business, an increasing need to package smaller and advanced chips becomes the deciding factor for a front-end company to select its assembly & test partner. The advantage only accrues to a company that effectively optimizes resources for high volume production and sustaining efforts providing differentiability and increased capital availability for deploying advanced-packaging technologies to their business offering.

This is why our actual OSAT business content is dramatically increasing. As Phase-1; MAX Team completed an ORE™ (Overall Resource Effectiveness) Study within 6 weeks. One of the key deliverables of this statistical study is a measure of operational losses, along with quantified capacity gain for the site. The study identified over 40 percent factory throughput opportunity related to bottleneck OEE and floor management operational effectiveness. We agreed with the site and corporate management on a 32 percent Capacity Improvement target improvement for the factory. This would directly translate to significant impact on gross margin for the company.

Packaging technologies can be broadly classified into the following categories:

- Flip Chip BGA (includes bumping)
- WB BGA (Wire-Bonded ball grid array)
- Lead Frame
- Testing
- Overall (Turn-key)
Defining, deploying and customizing a capacity improvement program for an OSAT factory, requires both expertise and courage; owing to a harsh business model that entails – high capital intensity, short cycle times, stringent “on-time delivery” and “customer request shipment” dates, high product mix, sub 20 percent forecast accuracy and seasonal demand. MAX team leveraged its broad experience and knowledge base, segment expertise and effective factory management techniques to execute an improvement program that handled these OSAT business complexities.

**METHODOLOGY**

The ORE™ Study was followed by Phase-2; a 12 month Implementation program to realise the improvement opportunity found during the initial factory assessment. MAX team signed up to deliver a 26 percent throughput improvement in first 6 months due to a rapid ramp in customer loading. MAX management had signed up for an aggressive yet performance based contract to deliver these results. The MAX team deployed 2 on-site Assembly & Test Operation experts for the course of the project.

The ORE™ Implementation program was designed by including elements of best-in-class strategic and tactical measures from disciplines of shop-floor management, equipment engineering, process re-engineering, industrial engineering, tool maintenance, change management and IT systems. MAX has developed a World Class manufacturing management suite – MAX SuperKit™ that comprises of all the shopfloor management procedures, templates, tools, checklists, forms and training materials focused on delivering bottleneck performance improvement. Supporting these shopfloor management methodologies; real-time visual dashboards showcasing metrics and key performance indicators for front-line management and factory personnel were developed as a part of SuperKit™.

SuperKit™ is designed to exhaust every operational efficiency loss and maximize equipment utilization by better operating each equipment type and train floor management personnel to effectively run a shift. Implementation of SuperKit™ is a fine balance of change-management and at the same time challenging the operations managers on shift-to-shift performance. At every stage of training and implementation MAX team was on-site covering 24 X 7 operations ensuring 100 percent compliance to methodology induction, day-to-day project deliverables and required escalations.

**SuperKit™ Overview:**

1. Supervisor Shift Pass-down Procedure
2. Supervisor Rounds Procedure
3. Manager Rounds Procedure
4. Shift Production Meeting
5. Escalation Policy
6. DL Performance Tracking
7. Tool Performance Tracking
8. Supervisor Training for MAX SuperKit™
   a. Lean Principles
   b. Theory of Constraints
   c. Little’s Law
   d. Line Management
   e. Inventory Management
9. Break Scheduling and Coverage
10. Roles and Responsibilities
11. Visual Fab

To overcome legacy methods of line management and align all supporting functional groups with new shop-floor management methodologies; a daily cross-functional “manufacturing-centric” meeting was established. MAX personnel developed meeting structure and ensured rapid adoption through Senior Management attendance, alignment, buy-in and engagement.
Figure 2 illustrates percent improvement achieved via 12-month ORE™ Implementation program and a rapid 26 percent capacity gain in first 10 weeks of SuperKit™ deployment.

While SuperKit™ sanitized and greatly improved shopfloor management practices; the client was ready for engineering engagement to deep-dive into tool and process improvements. A Tiger Team format was developed by MAX to ensure high visibility, accountability and sustainability across Equipment, Process, Sustaining, Maintenance and New Product (NPI) Engineering teams. The cross functional team with specific deliverables, clear ownership and swift action ensured projects completed on or before expected due dates. The MAX SpeedModel™ is a critical methodology used in increasing UPH and Capacity of any equipment. Significant NVAs were identified and eliminated in process design and equipment functions.

Each Tiger Team is also supported by a local management representative, who assisted the team in prioritizing projects, alignment with corporate objectives and swift budgetary approvals through all functions. Tiger Teams brought in conformance and standardization while ensuring sustainability of newly incorporated process designs and procedures.

Figure 3 represents weekly tool utilization trend across WireBond operation: a metric to evaluate new and sustaining Tiger Team activities.

Challenges
A significant quantity of major tool groups within the bottleneck operation were close to 20 years old, requiring a lot of engineering efforts to drive tool performance. Hard and soft dedication of tool capacity to key customers involved longer sign-off loops from customers on process changes; making it challenging to improve existing parameters and recipes. MAX team was able to drive performance for aged tools through systematic part upgradation, recipe changes, buy-off procedures, cluster qualification, engineering headcount restructuring and QA procedures. Additionally, an EOL case was presented to site management to replace old tools with newer models with ROI gains in less than a year in terms of overall capacity addition.

Lack of external recruiting within the operations team, resulted in a mid-management team holding great pertinence yet lacking innovative thinking and willingness for continuous improvement. MAX team initiated a personnel assessment and evaluation system – including technical, managerial and operational skill examination; to help the Senior management evaluate its front-line manager’s competencies, weaknesses and enhance HR planning for manufacturing.
RESULTS

The task of delivering customized improvement program to a High Volume – High Mix OSAT factory with complex manufacturing processes was a goal that the joint team accomplished very successfully as shown in the figure below. Our client successfully transformed the manufacturing site to a value creating organization by engaging MAX to accelerate capital asset utilization through effective shop-floor and engineering projects and by introducing proven operational excellence methodologies.

Figure 4 represents percentage increase in Output capacity from ORE™ study’s baseline performance.

![Weekly % Improvement in Output](image)

**Figure 4**

SUMMARY AND CONCLUSIONS

As innovation continues in the front-end of the semiconductor market, the pressure on back-end assembly & test companies is increasing; these factories are expected to run at much higher levels of operational efficiency and technical differentiation in a bid to avoid price and capacity wars.

MAX provides a high precision ORE™ study that gives customers an accurate and tangible view on improvement opportunities in terms of Throughput gain, Cycle time reduction, CAPEX avoidance and Yield improvement. This study is best followed up by implementation of MAX Factory Improvement Program that has a clearly defined path, strategy, methodology and most importantly an execution team led by global semiconductor professionals who will stand by their customers.

Achieving operational excellence is an imperative for OSAT business. Organizations that can best utilize their capital resources and adjust their business models to the changing technology landscape will be well positioned to break the boom-and-bust cycle by generating strong commercial profits in the years to come.

ACKNOWLEDGEMENTS

The authors would like to thank the client organization for giving this opportunity and the factory personnel who were completely integrated and vested into the MAX program.