Rapidly Scaling Production Given Shorter Business Cycles for CS Manufacturers

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Abstract

Many CS Manufacturers face constant pressure to deliver new technology to meet tighter business demand cycles. Today's newer mobile applications release to market every 6-12 months. In the Compound Semiconductors space this means that manufacturers must be able to deliver high product output in a very short time window. As a reference, the average product ramp cycle in other commercial applications such as laptops is 18 months. Time-to-Ramp is a common challenge and adversely affects profit margin, and if extended, becomes more critical with each subsequent product innovation/generation. More importantly, time-to-supply delays can make or break companies as top-tier application providers seek better and better service levels. Most companies tend to deal with these shortening cycles by over stocking finished goods product (FG) and thus hurting their cost accounting metrics. The MAX Group explores a case study with a CS Manufacturer that achieved a successful 2.5X ramp in an 18-month period.

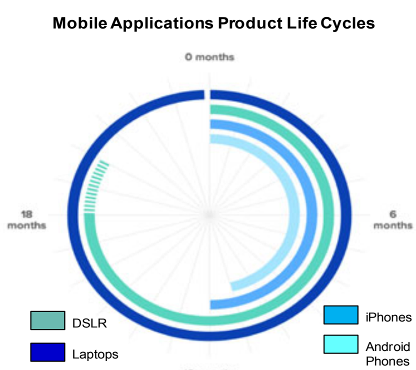

Fig. 1. Mobile Applications Life Cycle.

INTRODUCTION

Manufacturing agility is an absolute requirement in achievement of shorter time-to-supply cycles in a mixed development / manufacturing environment. Today's newer mobile applications are released to market every 6-12 months. In the Compound Semiconductors space this means that manufacturers must be able to deliver high product output in a very short time window. To make this happen cultural change is required from a technology development-centric mentality to manufacturing-centric practices. Ideally, but not always, both cultures already co-exist during the development and ramp-to-volume phases in manufacturing. When they do not coexist, the MAX Group will take the client on a managed and expedited path to benchmarked operational excellence and significantly shorter time-to-supply cycles.

This paper shares a recent MAX case study with objectives to support a 2.5 times aggressive scale up of production capacity in an 18-month period. MAX teamed with a leading CS Manufacturer to implement best Operational and Engineering Practices and Organizational structure effectiveness and precision in operational and maintenance work, respectively.

MAX has spent the last 10 years working with CS Manufacturers deploying approaches to address three key pillars and increase manufacturing agility:

1. Operations Practices
2. Engineering Practices
3. Effective Organizational structure

Some of the targeted areas for improved agility in operations, engineering and maintenance included; WIP management, factory management/supervisory effectiveness, line balance & dispatch, maintenance practices, industrial and equipment engineering practice benchmark, project management skills assessment, yield/SPC, layout, KPIs, roles & responsibilities, escalation, rounds, passdown, break management, hot- and hold-lot policies, 6S, among others.

MAX will share recent implemented practices from one of our CS customer targeting these pillars to develop a foundation for growth, flexibility and a manufacturing centric infrastructure. The result is a cohesive team aligned around applicable KPIs to create a laser-focused organization based on precision of teamwork, standard work methods and execution in planning, operations, and engineering.

METHODOLOGY

The first step taken was to address operational efficiencies. We focused on operations first because it yields faster results than activities related with Engineering or Organizational changes. From an operational perspective, MAX was engaged to help assess, make recommendations and implement solutions to many components of factor management practices including:

- Key Performance Indicators (KPIs)
- Roles & Responsibilities
- WIP Management
- Factory Management & Supervisory Effectiveness
- Line Balance & Dispatch
- Industrial Engineering Practice Benchmarking
- Shift Escalation, Rounds, and Passdowns
- Break Management
- Hot and Hold Lot Policies
- 6S & Quality Policies

These topics fall under the world-famous, successful methodology of SuperKit™, which MAX has perfected over the exposure of over 60 fabs world-wide. As a result, the MAX team identified several improvement opportunities in how the factory was being managed, made recommendations on what and how to implement solutions, and managed the implementation for most of them.

To start, we established a shift agenda for Supervisors and a clear production meeting agenda to be followed by a detailed description of frequent routines to monitor constraint areas and toolsets. Figures 2 and Figure 3 illustrate these.

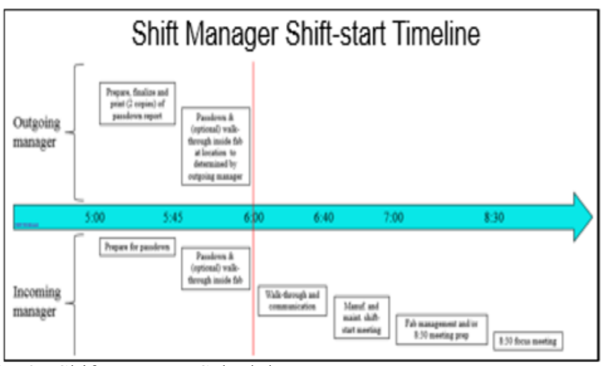

Fig. 2: Shift Manager Schedule.

Production Meeting Agenda

Duration (min)	Category	Topic	Details	KPI	New Item?
5	General	Safety	Major events (accidents or incidents)	n/a	Yes
		Quality	Excursions or major scrap	n/a	Yes
15	Last 24-hour performance	**Past**: last 24 hours of major items and lingering effects - After a holiday and/or weekend, include the performance since the last regular business day - Highlight the impact from disruptions /	Key tools (metrology, pinch-points, etc), DefCon4, potential DefCon4	Availability	No
				Moves	No
				Drumbeat	No
				UPH losses	Yes
				Dispatch compliance	Yes
				Utilization or idle with WIP	No
	Present situation	**Present**: current line conditions	WIP and mix conditions and impact	WIP distribution, quantity (delta to target) and mix	No
				Priority lots	No
				Held lot > 24hrs	No
				Aging WIP	Yes
			Key tools (metrology, pinch-points, etc), DefCon4, potential DefCon4	Key tool status and ETAs	No
	Next 24-hour performance	**Future**: next 24-hour forecast performance highlighting major activities and their impact - Include any expected performance during an upcoming holiday and/or weekend - Impact of upcoming projects or tasks such as tool install/moves, disruptions / interruptions and/or facilities work	Upcoming PMs, long/difficult repairs, holiday shut-down, tool install/moves, or facilities work	Moves	No
			Staffing	Manuf., maint., PTs, LTs, engineers	Yes
			Proactive or key plans, such as preparing for a WIP bubble and any	WIP re-balance duration	Yes
			Review and align on priorities	n/a	Yes
5	Other	Additional topics	Escalations	n/a	No
			Action items	n/a	No
			Request for help or support	n/a	Yes

Fig. 3. Daily Production Meeting Agenda.

In any strong manufacturing organization KPIs are important to drive a level of expectation. We focused efforts towards implementing indicators that matter to people on the shop-floor. These indicators are easy to establish and they set a higher level of efficiency when it comes to manufacturing performance. In this example, we cared about wafer output so key focus was implemented on critical toolsets to monitor their OEE losses and opportunities within WIP management.

Figures 4 and 5 illustrate examples of critical Indicators for people on the floor. These were established to gain visibility at the operator level on critical areas of the Fab.

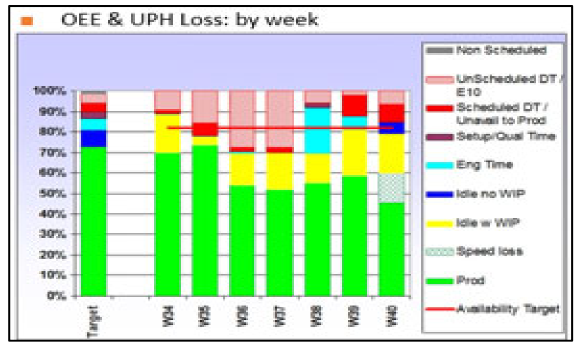

Fig. 4. Daily Production Meeting Agenda.

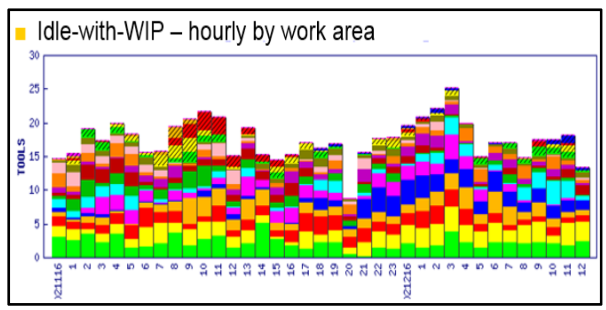

Fig. 5. Tools Idle with WIP - Dynamic Snapshot.

ENGINEERING & MAINTENANCE

Following operational practices, we worked in parallel with Engineering and Maintenance activities. It is typical that changes in these areas are harder to embed and the gains take longer to be realized. In this case study, we worked with Equipment Availability for some critical process toolsets. MAX led an effort to measure and improve Maintenance effectiveness by utilizing MAX's Precision Maintenance Programs (MPM™). This program had two primary goals that both MAX and its client tackle together:

First, to improve Equipment Availability performance and Coefficient of Variation of Availability (Variability of Availability). This allowed for higher output on critical PVD toolsets in the Fab. Figure 6 below illustrates a 24% improvement over a 12-month period and also a better M-

Ratio (Figure 7) because of the dramatic reduction in unscheduled failure events.

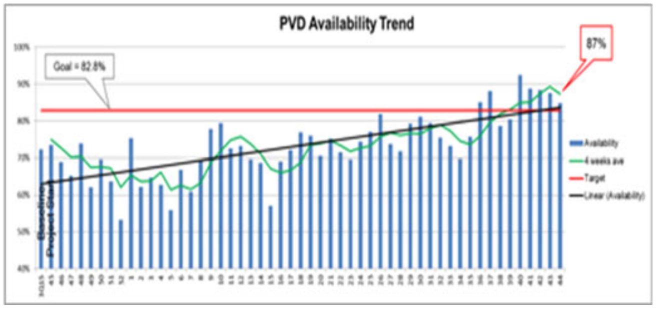

Fig. 6. Critical PVD Toolset Availability

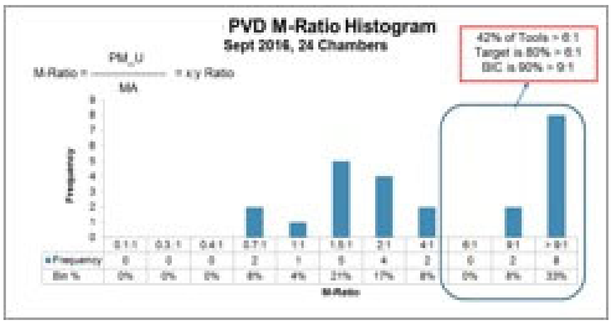

Fig. 7. Critical PVD Toolset M-Ratio.

Under availability performance, MAX implemented a scoring methodology specific to every PM event, namely the Perfect PM Score (P-Score™). The P-Score categorizes planned maintenance work as follows:

- PM Planned or Unplanned
- Target Interval Between PMs sustained or not
- Event achieved First Time Right or not
- Failures right after the event or not
- Next Planned Event performed per target or not

Then a further drill-down (Figure 8) for every category follows the 5Y methodology to determine cause-effect and pertaining corrective actions to achieve continuous improvements.

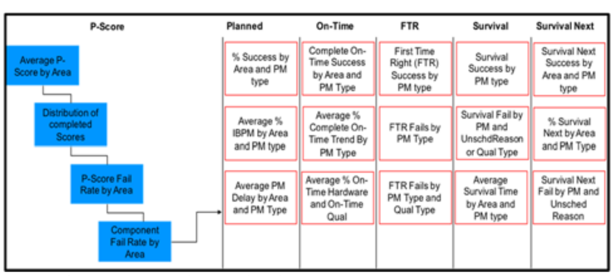

Fig. 8. Perfect PM Scoring Criteria.

Second, make recommendations on the equipment and maintenance practices. These vary from engineering and technician skills of Fab Maintenance teams to management of spare-parts to successfully and efficiently lead the site from an R&D/engineering-centric to high-volume manufacturing mindset. In order to be effective, we aligned with our customer on what were the most important items for our team to focus. Together, we developed a matrix of activities for MAX to deliver best-practices and make sure the customer adapted within their culture.

Topic	Gap		Priority
KPIs	• Maintenance Section Managers (MSMs) are being measured for overall equipment availability, not speific shift performance • No specific daily KPI's for MSMs • OEE reviews are not practiced (UPH, Availability)	No Implementation	1
Spare parts management	• Advanced PM parts storage: Supermarket • Replenishment mechanism in place, but still cases missing kits	Some Implementatioin	1
Toolbox design and maintenance	• Personal PM carts for most technicians, tools in good condition • Measurement tools are not under calibration control	Good Implementation	1
PM Efficiency/Effectiveness	• High unscheduled downtime • High number of early PMs • High failure rate within 24/48 hours after the PM • Not optimized PM content, increased duration	No Implementation	1
Tech Effectiveness	• Lots of time spent outside the FAB • Big difference in knowledge levels between the shifts • Lack of standardization in common tasks	No Implementation	1
PM/Repair Specs	• Very condensed, no detailed description of tasks • No online system, printed copies	No Implementation	2
Golden Tool Matching	• Not practiced	No Implementation	2
Response and Service Levels	• High waiting tech	No Implementation	2
PM/Repair Kitting	• Opportunity to improve kit assemblies - hard to find the parts	Some Implementatioin	2
CMMS	• Basic features of machine states change • Poor MES logging integrity for PM activity • General logging integrity needs development • Reporting capabilities need development	Some Implementatioin	2
Pit Crews	• Improvement required; shift to shift setup, special PM tool kits, precision of tasks	Some Implementatioin	3

Good Implementation | Some Implementatioin | No Implementation

Fig. 9. Maintenance Topic Baseline Measurement.

As shown above, the priority categorization and state of customer for each activity dictated which items were the most important to work on first. Setting the right KPIs by measuring PM effectiveness and tech resource effectiveness came up on top. The result for this program allowed our customer to continue working on the right priorities for the organization and more importantly allowed for a vehicle to transfer knowledge across different functional areas.

Organizational Effectiveness

The final pillar to make this program successful was to provide an assessment of the effectiveness of the overall Fab Organization. This entailed a 4-fold solution:

1) Identify organizational strengths & weaknesses
2) Evaluate and make recommendations on the leadership skills of the fab management team
3) Suggest a set of metrics by senior management role
4) Define a roadmap to transform the organization from R&D to high-volume manufacturing, namely a cultural change

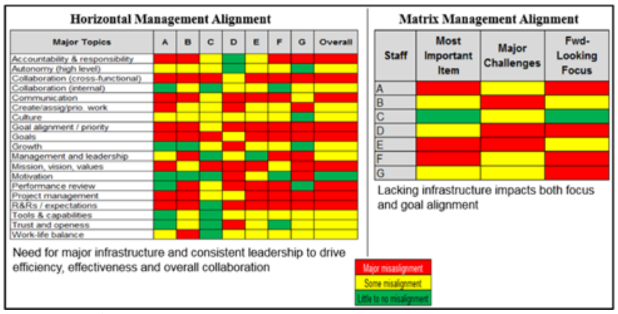

Fig. 10. Fab Management Assessment.

The approach to execute this assessment included:

- Discussions: Site Manager, (6) Sr. managers, (14) mid-managers, supervisors, individual contributors
- Observations: (9+) meetings (5+ types), decision process, crisis, conflicts, etc
- Review: samples of key documents, such as project plans, org. charts, R&Rs, roadmaps, etc.

Once we identified the strengths and weakness it was clear that the organization still operated as an R&D focused company. This is typical of most CS companies as they evolved from technology development centric into a balance of R&D and Manufacturing. Our approach then proceeded to place our client in an agreement matrix [2]. This chart measures leadership, power, management, and cultural tools and identifies where organizations fall short and where they should be targeting to improve. In our case, we wanted a shift towards the cultural tools region as shown in Figure 11.

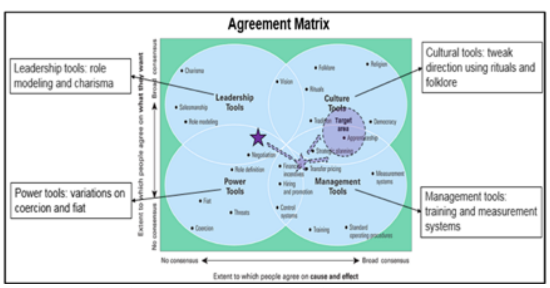

Fig. 11. Organization Agreement Matrix.

The organization (mostly) agreed on what they want, but lacked a clear path on how to achieve it. It needed both power tools (coercion and fiat) and management tools (training and measurement systems) to move from agreement to cooperation.

The last piece of this pillar was an assessment on project management skills. Organizations must have a strong way to manage and execute improvement activities. Our assessment identified our client had weak and absent Project Management practices to provide accountability and discipline to the organization. Again, this is another common trait for CS companies as they focus heavily on R&D and important component to scale PM becomes important.

To summarize, we found a need for major infrastructure changes and consistent leadership to drive efficiency, effectiveness and overall collaboration [3]. Scaling manufacturing can only be successful when one has the right organization and structure and skills to support it.

Conclusion

The Compound Semiconductor industry will continue to experience tremendous growth. When companies grow this fast, they will face many challenges and only those that adapt will survive. Scaling manufacturing will be a factor as consumer applications release cycles shorten more and more. How can a supplier be ready to ramp their production capability in 12 or 6 months?

Our joint client-MAX team successfully achieved a 2.5X ramp in moves as shown below in Figure 12 over a 18-month engagement. The results are not exclusive of the MAX activities; instead it was a complementary effort to reduce risk to achieve these targets.

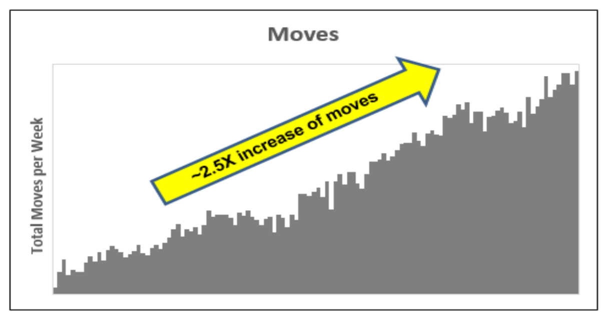

Fig. 12. Organization Agreement Matrix.

In addition to ramping, other benefits included a 15% inventory reduction, sustainable or faster cycle times, and more importantly, our client could define a cultural change roadmap to sustained factory expansion in order to achieve manufacturing capabilities never seen before.

Acknowledgements

The authors would like to thank our client and key stakeholders that welcomed MAX's inputs and allowed for a partnership to be continued for years to come. Special thanks to the site management team and staff for the support during this project.

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