Operational Yield Improvements through Application of Lean, 5S, Employee Engagement, Root Cause Investigations and Culture Change

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Abstract:

This paper will show how we reduced human related scraps in a high volume semiconductor manufacturing environment. Understanding the current reality of the operator is paramount. Along with data mining existing information so we could focus efforts and resources using Pareto analysis. We applied well-known Lean principles, 5S methodology, root cause investigations, employee engagement and culture change to achieve these improvements. A 40% reduction in human scraps over a corresponding nine month period was accomplished with no capital expenditures.

INTRODUCTION

Skyworks Solutions wafer fabrication plant in Woburn, Massachusetts has an ambitious goal of scrap reduction. With the combined effort of the following programs, a 40 percent reduction in human-related scrap was achieved. This significant reduction took place in a nine-month period in 2017. The comparative nine-month data was measured in 2016.

KEY FOCUS AREAS

1. **Root Cause Analysis and 5-Why investigation**

   We created a web-based Root Cause Investigation (RCI) system to contain and solve problems immediately using the plan-do-check-act cycle (PDCA) and 5-Why as the systematic problem solving methods. The RCI system also enabled data mining such as Pareto analysis, trends and commonality studies to determine future actions and capital expenditures. All human-related incidents, including scraps and near misses required a RCI form to be completed by the operations supervisor with the operator involved and any support personnel such as process engineering, equipment engineering and the training group area trainer. This aided our efforts to understand the operator's current reality at the location of the incident to drive corrective actions by determining if the activities were not structured and standardized, or if the connections were not established to clearly define transfer of material and information between every customer and supplier, or if the flows were not simple and specific.

   Driving to Root Cause is paramount in understanding current realities of our processes on the manufacturing floor and proposing new solutions. With our systematic process of driving to root cause we are able to spread our knowledge of Continuous Improvement as well as effectively employ our knowledge and experience of others onsite. This team building encourages synergy and allows our team to utilize our diverse strengths.

   Having our RCIs and 5-Why Analyses on an easily accessible intranet helps us in several ways. The presentation of the information allows easier communication and reference of the incident, investigation and corrective actions. We can search and compare incidents and proposed solutions over a longer period of time. Data mining is made easier to focus on correlating factors and trends. We can add updates on the actions and new proposals.

2. **Wrong Recipe Selection (Misprocesses)**

   Pareto analysis identified the leading cause of human scrap was wrong recipe selection. This data enabled justification and approval for implementation of Auto-Recipe-Download through tool interface. However, to address the immediate needs, we implemented buddy checks and quick check stations as well as documentation changes, training enhancements, communication and audits.

3. **Reducing Wafer Breakage**

   The second leading cause of human-related scrap was dropped lot boxes. RCIs of dropped lots identified that the leading contributor to dropped lots happened when removing lots from the bottom shelf of work in progress (WIP) racks. All WIP racks were standardized with visual aids so the bottom shelf width is only one lot box

deep instead of two. The relative heights of the shelves compared to the floor were also standardized. Stainless steel perforated liners were deployed to the WIP racks to reduce vibrations when placing lots on the racks.

To further reduce dropped lots and reduce wafer breakage, the lot box and cassette handling was standardized. An in-person cassette and lot box training program was deployed to each operator, engineer and equipment technician onsite in a small team setting. An audit system was also deployed to monitor lot box and cassette handling, as well as positive reinforcement and constructive confrontation. To further reduce human-related breakage, a cross functional Human Breakage Team was formed, employing the 8D process. D1=Team Formed, D2=Problem Defined, D3=Containment, D4=Determine Root Cause, D5= Verify Permanent Corrective Actions, D6=Implement Corrective Actions, D7= Prevent Recurrence, D8=Recognize Team

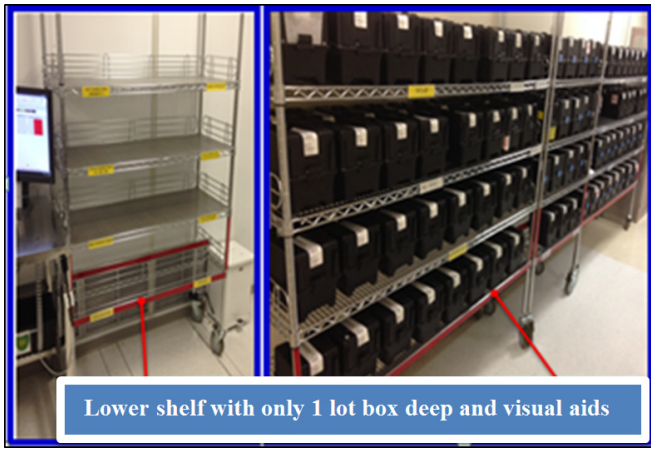

Figure #1 WIP racks to reduce dropped lots

4. **5S = Sort, Straighten, Shine, Standardize, Sustain**
   5S methodology is centered on reducing employee frustrations involved with everyday work by removing waste and improving efficiencies by setting workplace standards. At each workstation, there are visual aids to help recognize any variation in work area layout to easily identify abnormalities from the ideal state. Using a simple intranet-based tool, we deployed an audit system that allows us to respond to abnormalities within each 12 hour shift. With this system, we are able to run operations more efficiently and consistently. Embedding 5S into our operational culture, we are able to sustain and continuously improve.

Our methods for sustaining each of the 5S stages:

Sort – Remove all items not necessary for current production.

Sustaining Sort - A dedicated SORT bin with a 5S logo is placed in each area. Items that do not belong in the area are placed in the 5S bin. The bin prevents valuable items from being thrown away and successfully keeps the area free from unneeded and unwanted items. The SORT bin enables the owner to retrieve the item before it gets removed permanently.

Straighten – Set home locations for all movable items for efficient use.

Sustaining Straighten – All movable items have home locations. We have deployed four methods of visual systems: computer desktop wallpaper, digital picture frame, sticker and/or label. All workstations have defined work zones. A work zone is a pre-determined area of a work surface where operators and engineers can perform their job function. This is a temporary staging area to perform their current job function only. Any peripheral items that are required to perform that specific job are at the work station and have a home location. We use desktop wallpapers to show the home locations and ideal state of the workstation. This is agreed upon by all members of the affected workstation and we audit to this standard. In the absence of a computer monitor, we use any one of the three other methods of visual systems.

Figure #2 Workstation with visual aids

Shine –Area and items are clean and free of debris, stains, marks, and scuffs.

Sustaining Shine – We implemented a wipe down and inspection during each shift to ensure all surfaces and areas are clean and free of debris. This mandatory wipe down is triggered by music that plays for fifteen minutes during the shift to signal this Shine task.

Standardize – All standards are developed and deployed to keep areas in an ideal 5S state.

Sustain Standardize – A checklist was generated and posted via monitor display. Each area has a monitor wall-mounted displaying a 5S checklist to follow during audits. Each checklist highlights key inspection points for the audit.

Sustain – Checks for all methods deployed

Sustaining Sustain - Deploy 5S Weekly Scorecard and audit checks for any discrepancies or findings for each of the 5S Areas. During this process we have carefully integrated 5S into a cultural value.

5. **Shared Learnings**

Weekly quality talks were established across all shifts led by each Operations Supervisor. In weekly team meetings, we discuss every human scrap incident with root cause and corrective actions, show yield goals, current continuous improvement projects, 5S scorecard and solicit feedback. Open discussion is encouraged. These pre-packaged presentations are created by the Continuous Improvement team and are continuously scrolling on the digital displays in the Fab and Test gowning rooms. We established a quarterly recognition program for Most Improved Shift in reducing human-related scraps. The shift with the highest quality improvement receives a pizza party and each member of the shift receives a cash reward through the company recognition program.

6. **Culture Change**

RCIs identified certain human behaviors that contributed to human scrap. Examples: Employees interrupting others verbally or through physical contact when selecting recipes, employees were not yielding the right-of-way to people carrying or fetching the lot box, not keeping a steady pace while walking, being loud and startling others. To address these, we established a Culture of Courtesy Program and rolled it out across the site for all Fab and Test employees. The presentation is continually scrolled on monitors in the Fab and discussed during various weekly quality talks. The Culture of Courtesy Program, coupled with the 5S methodology drove the culture change. All new Fab employees are trained during orientation and include wafer handling, 5S methodology and how to sustain 5S, as well as the Culture of Courtesy Program.

We continuously promote and exemplify the mantras included in the Culture of Courtesy and are seeing others do the same. Many technicians have also adopted these practices and constructively confront each other when appropriate. We are proud of this effect and continue to echo and shepherd this new culture. The benefits of this culture extend from safety and quality improvement to increased morale and better communication. We believe this cultural shift is fundamental to our improvement and just as important as following proper operations procedures.

With our current and new employees we strive every day to not only display the successes of this new culture, but to reinforce and sustain the Culture of Courtesy.

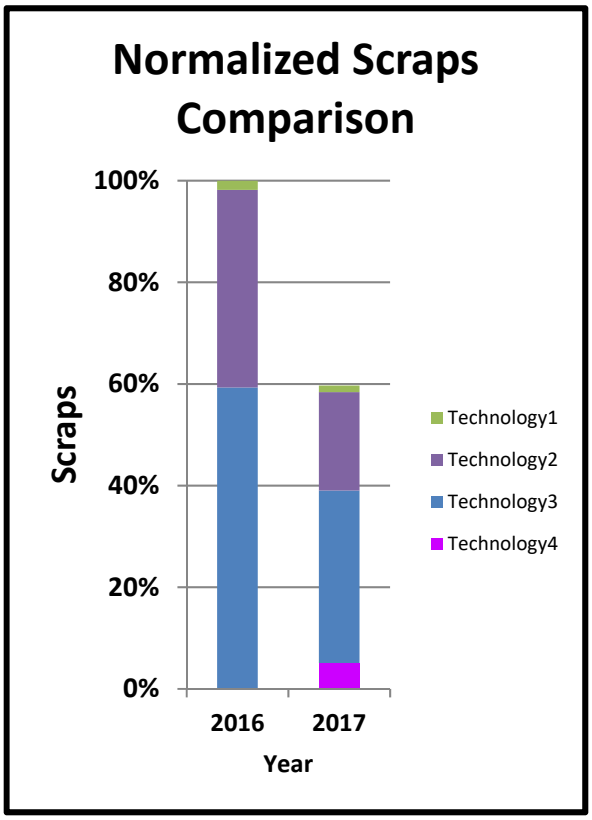

Figure #3 Normalized scrap comparison- 2017 reduction compared to 2016 across all technologies

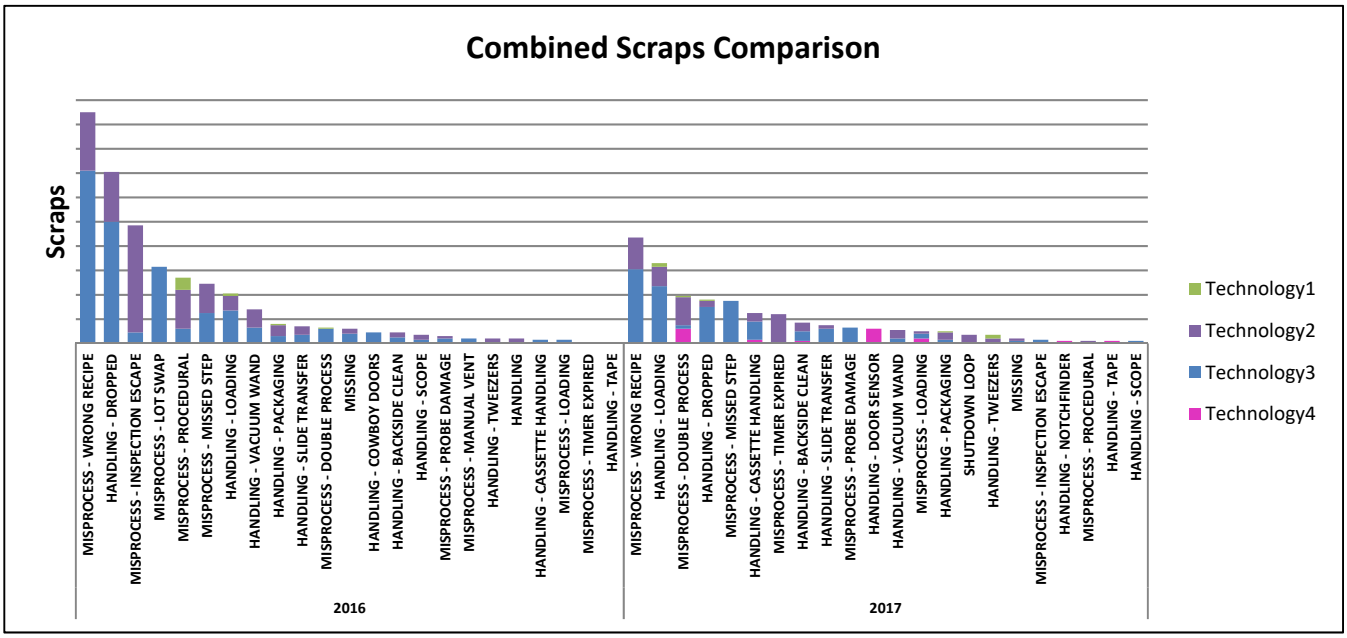

Figure #4 Human Scrap Pareto comparisons between 2016 and 2017

CONCLUSIONS

Ambitious scrap reductions are achievable through the application of well-known techniques of PDCA, Lean, 5S, 8D and Root Cause Investigation principles, coupled with employee engagement and culture change. With the combined effort of the above programs, we achieved a 40 percent reduction in human-related scraps over a nine-month period. Refer to Figures 3 and 4.

ACRONYMS

5S: Sort, Straighten, Shine, Standardize, Sustain

8D: D1=Team Formed, D2=Problem Defined, D3=Containment, D4=Determine Root Cause, D5= Verify Permanent Corrective Actions, D6=Implement Corrective Actions, D7= Prevent Recurrence, D8=Recognize Team

RCI: Root Cause Investigation

PDCA: Plan-Do-Check-Act cycle.

WIP: Work in Progress