Statement of Work (SOW)
iNEMI Board Assembly TIG
Board Assembly and Test Process Optimization

Version #2.0
Date: May 1, 2013

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iNEMI Support Staff: Jim Arnold

Basic Project Information

Background/Context
There are several maintenance management tools available to manufacturers for use in controlling and minimizing waste in manufacturing systems: Kaizen, Continuous Improvement, Integrated Shop Floor Data Collection (SFDC), Closed Loop Process Control, Online Statistical Quality Control Systems, and Total Preventive Maintenance (TPM), etc. TPM, as part of the maintenance management, is the tool most often involved when assessing machine utilization [1].

Overall equipment efficiency (OEE) parameters are some of the most visible metrics offered for an assembly line. OEE measures the efficiency of the machine during its planned loading time by combining the availability and performance of the equipment with the quality of parts made. Planned downtime does not affect the OEE figure. Unplanned down time, idle time and what otherwise is characterized as floundering time [2] is considered to be underreported. The origin of these types of down time is often found in sources other than failure of machine capability and performance [3]. Information about theoretical and design processing time, related to line configuration and machine capability, is required to determine equipment efficiency [4]. As acquired, the machine utilization data is just numbers. These numbers, once properly processed, are used to identify, isolate, and eliminate the root causes of poor performance as well as helping to implement techniques to increase productivity, reduce cycle time, and increase the quality of the product (i.e., better utilization numbers). Despite continuous improvement in
automation, software tools, and computing and monitoring capabilities, often the utilization rates remain below 90%, possibly due to a combination of factors, such as:

- Utilization is dependent on product complexity, machine features, and user expertise (capability to interpret and react in real time to the amount of available data). On the other hand, it is possible that a machine with added built-in features (self-diagnostic, additional apps, etc.) may be underutilized from the software capability perspective due to user level limitations in understanding the advanced features. Furthermore, defining software application routines at the engineering level and locking them in place for accessibility at operator level, while useful as a failsafe mechanism, downgrades the flexibility and limits the built-in choices.
- The incentive to improve the reported numbers may not be urgent in some cases due to a stable customer pool [5].

For the purpose of board assembly optimization, assembly line utilization depends on a large number of sequential (kit release, feeders change, program download, conveyors adjustment, etc.) and associated parallel (work order release, kitting, stencil cleaning, tooling, machine programming, etc.) processes. Moreover, all other activities included in the process flow, from planning to first article inspection, must be taken into account.

Additionally, changeover time can have a significant impact on the line utilization figures, especially in the case of high-mix low to medium volume products. Decreased changeover times have several obvious advantages, such as reduced cost, increased throughput, reduced inventory, and faster response to customer needs (decreased lead time), overall leading to increased flexibility [6].

References:

3. Ombu Enterprises LLC, "Equipment Utilization Metrics."

Purpose of Project

The purpose of this project is to create a first cut set of recommendations that will improve the board assembly and test equipment utilization in production lines requiring frequent changeover or that are used for new product introduction. Typically, the utilization of these types of assembly lines is unacceptably far below the theoretical potential of the installed equipment. The impression exists that consistent application of best practices could yield significant improvements in production output for the same installed equipment.
Scope of Work

We will create a list of all activities currently involved in the changeover of production lines and the time associated with these activities. Subsequently, this list will be expanded to include the optimal time for these activities using current best practices. In a benefit versus effort analysis, a number of recommendations of best practices will be created for the “low hanging fruit.” Recommendations for follow-on projects would contain a list of benefits that are less easily achieved, but would be worthwhile to develop in a separate activity.

Identify the areas of overlap and start a parallel project to begin working on other topics of interest or concern. These teams could work together on the identification of similarities while staying focused on the main objectives of each. Based on the diversity of expertise needed to eliminate inefficiencies, other iNEMI projects may need to be formed under the Board Assembly or Test TIG.

IS / IS NOT Analysis

<table>
<thead>
<tr>
<th>This Project IS:</th>
<th>This Project IS NOT:</th>
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<tbody>
<tr>
<td><strong>Board Assembly and Test Process Optimization</strong></td>
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<tr>
<td>Create a list of the problems that cause time loss in NPI or Product changeover</td>
<td>Not a standards development</td>
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<tr>
<td>Analyze the list and quantify the problems identified</td>
<td>Not providing solutions in this first phase</td>
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<tr>
<td>Identify and discuss possible solutions associated with each of the problems</td>
<td>Will not go beyond impacts on Board Assembly and Test Processes</td>
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<td>identified</td>
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<tr>
<td>Create a prioritized list based on efforts versus benefit analysis for each of</td>
<td>May be restricted to either Assembly or Test depending on interest and expertise of</td>
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<td>the problems</td>
<td>the project team</td>
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<tr>
<td>Output: Proposals for follow-on projects to work on specific solutions</td>
<td>Not biased towards specific geographies, production processes, or suppliers</td>
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<td>Output: Recommendations on how to attack the “low hanging fruit”</td>
<td>Not a repeat of prior or existing work</td>
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Outcome of Project

By the end of the project the team will have completed the following items:

1. Identify the top 5 production changeover delays. These items will be prioritized based on an objective severity metric defined by the team, such as the average number of minutes needed for changeover reported by members. They may include both manufacturing or test process steps and
will be defined such that they apply to the majority of electronics manufacturing companies (i.e., not specific to one company or industry).

2. Define the underlying issues (root causes) that contribute to these delays, and prioritize them to the extent possible.

3. Identify potential solutions to these root causes that can be pursued, possibly off line or as part of a different project.

4. Quantify the opportunity and value realistically to be gained from improvements, in the following four areas:
   a) Improving the capacity of current equipment by reducing capital expense.
   b) The ability to quickly change from one product to another improves the ability to respond to rapidly changing customer demands.
   c) Time loss, risk and impact caused by incorrect or mis-handling of material on the manufacturing line.
   d) Improvements in capacity.

**Business Impact**

1. One major concern of any business is capital equipment expense. Improving the capacity of current equipment could reduce capital expense. This type of savings goes directly to the bottom line. While capacity is also affected by non-changeover items, reducing the time required for changeover will increase machine capacity and lead to reduced capital costs.

2. The ability to quickly change from one product to another improves the ability to respond to rapidly changing customer demands. Some electronics businesses have more fluid customer schedules than others, so schedule flexibility will be an added benefit for certain businesses.

3. Change leads to errors and defects. The more complicated and longer a change takes, the more opportunities for mistakes. The results of this project could potentially reduce defects and scrap from incorrectly built parts.

4. Improving capacity reduces Work-in-Progress increasing material and product turn-over, reducing costs associated with inventory.

5. Shorter production cycle times allow faster prototyping and small volume (industrialization) production resulting in faster New Product Introduction and shorter time-to-market.

**Previous Related Work**

Several papers have been written pertaining to efficient line changeover within the wider SMT Industry. Many of these also reference Lean SMED based activities. However, many of the studies are related to offering or promoting specific products or services rather than being industry wide studies. Thus there is a clear lack of unbiased guidance for many companies in this increasingly popular environment.

The following are good references related to efficient line changeover:

- Farlow Douglas, SMT: Surface Mount Technology; March 2005 Vol. 19 Issue 3, p44 – This article reports that optimizing Line-Changeover Efficiency is a necessity to implement lean manufacturing in high mix, low-volume electronics assembly environments.
- William Edward Swaim, Auburn University; August 6, 2011 – SMT Line Improvements for High Mix, Low Volume Electronics Manufacturing - A Thesis submitted to the graduate Faculty of Auburn University.

**Prospective Participants**

Strive to include representatives of all facets of the industry, including customers, suppliers, and manufacturers.

- Software
- Materials / Logistics
- Equipment
- End Users / Manufacturers / Foundries
- At least 3 OEM, ODM, EMS, OCM

**Project Plan**

**Schedule with Milestones - Preliminary***

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<tr>
<th>Phase 1</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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**Phase 2 - TBD**

*NOTE: A more detailed plan can only be developed when we have agreed on the scope of each task.*
Phase 1 – Detailed Task Information

Task 1 Monitor related research or development within the industry and academic communities
- Resources: Project member participation in teleconferences.
- Materials and Processes: Proposal: A commonly maintained list of academic or industry literature relevant for the project.

Task 2 Create a list of the problems that cause time loss in NPI or Product changeover
- Resources: Project member participation in teleconferences and email discussions.
- Materials and Processes: A common spreadsheet format for collecting and reviewing the information.
- Testing Procedures / data validation: Probably not needed. This phase is more of a “brainstorming session” where every problem, small or large, should be brought to the table.

Task 3 Analyze the list and quantify the problems identified
- Resources: Project member participation in teleconferences and email discussions.
- Materials and Processes: A common spreadsheet format for collecting and reviewing the information.
- Testing Procedures / data validation: To be discussed. Some sort of validation is probably a good idea at this stage, to ensure that we are focusing on the most important problems in Task 4 and onwards.

Task 4 Identify and discuss possible solutions associated with each of the problems identified
- Resources: Project member participation in teleconferences and email discussions.
- Materials and Processes: A common spreadsheet format for collecting and reviewing the information.
- Testing Procedures: Probably not needed, as this is more of a discussion phase.
- This task can partly overlap Task 3, but there’s a risk of jumping to conclusions too fast, and stealing focus from the important task of quantifying problems before trying to solve them.

Task 5 Create a prioritized list based on efforts versus benefit analysis for each of the problems
- Resources: Project member participation in teleconferences and email discussions.
- Materials and Processes: A common spreadsheet format for collecting and reviewing the information.
- Testing Procedures: To be discussed. It’s probably a good idea to validate the estimated “effort” in some way, in order to ensure a correct priority.
Task 6  Develop the follow-on activities and proposals based on the data collected and analyzed

- Resources: Subcommittee(s) to prepare draft, for review by the group.
- Materials and Processes: Documentation and PowerPoint slide deck with summary, conclusions and proposed next steps.
- Testing Procedures: Review within the group.

Task 7  Present summary, conclusions, and next steps to iNEMI membership and industry

- Resources: Subcommittee to prepare the proposal, subject to the review of the group.
- Materials and Processes: Documentation and PowerPoint slide deck with summary, conclusions, and proposed next steps.

Project Monitoring Plans

- Ensure open lines of communication among participants.
- Review all project requirements with participants before the project begins.
- Project participants will meet bi-weekly to review various aspects of the project and make plans for next phases of the project.
- Meeting minutes provided through e-mail.
- Follow-up with individuals on an as-needed basis.
- Provide any project specific monitoring or communications plans, e.g., multiple project meetings to cover multiple regions (EMEA, Asia, Americas).
- Workshops, WebEx teleconferences, and face-to-face meetings as determined by the project team.
- Progress reports will be provided upon request for presentation at regularly scheduled iNEMI meetings (e.g., a short series of PowerPoint slides showing the work in progress at member council meetings).
- Track and document approximate man-months per quarter per team member (this will require the active members of the team to provide estimates).
- Track and document approximate number of people on the project per quarter (this can be tracked through iNEMI's WebEx account).

General and Administrative

Guidelines for this project and all other iNEMI Projects are documented at http://thor.inemi.org/webdownload/join/gen_guidelines.pdf.