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INTEGRATION OF SMED AND TRIZ IN IMPROVING PRODUCTIVITY AT SEMICONDUCTOR INDUSTRY

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ABSTRACT

Rapid equipment changeover is a vital driver in enabling a 'World Class Manufacturing' organization besides the other core elements of continuous production flow and Lean based activities. With respect to the above statement, a case study on a test equipment changeover was conducted at Intel Technology Sdn. Bhd. The core objective of this study is to reduce the changeover duration by identifying opportunities and enhancing the overall process. Well renowned changeover techniques of SMED were integrated with the problem solving tool called TRIZ to counter problems like non standardized and non optimized practices in the current changeover process. The techniques helped to minimize, substitute or eliminate the changeover activities. Most of the solution focused mainly on task simplification and also hardware redesigning. The changeover process improvement and duration reduction helped the organization mainly in capital and cost savings with other intangible improvements especially in productivity. This case study has helped to demonstrate that though SMED and TRIZ are 2 different techniques with individual strengths and weakness but the integration of these techniques have helped to optimize the changeover process to meet the objective.

Keywords : *Rapid changeover, semiconductor, test handler, SMED, TRIZ*

1.0 INTRODUCTION

The ever-growing technological envelope and the shrinking of product life cycle have ultimately changed the overall face of today's global economy where trends are more volatile and impulsive with end-customers are more vivid in their choices and selection of products. The 'ripple' of these effects has strongly influenced in the semiconductor industries especially manufactures supporting High Mix Low Volume (HMLV) products. It is well noted that the number of transistors that can be placed inexpensively on an integrated circuit has doubled approximately every two years which precisely describes a driving force of technological and social change in the late 20th and early 21st centuries and the trend has continued for more than half a century and is not expected to stop until 2015 or later [1]. This has directly impacted the once flamboyant semiconductor industries which are now facing competitive pressures to meet the ever-changing demand from end customer and at the same time the challenge in reducing the overall operation cost.

Kulim Microprocessor and Chipset Operations (KMCO) was erected as one of Intel's biggest offshore facilities in 2007 and was ramped-up aggressively to support the High Mix Low Volume (HMLV) semiconductor manufacturing. Being the largest factory

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with both assembly and testing capability, the main 2 challenges for KMCO is to produce quicker cycle time (time taken to manufacture a product from start of assembly to finish product ship out) and to demonstrate a low cost competitive advantage especially with other Electronics Manufacturing Subcontractors (EMS) . The above 2 challenges are linked together by one similar gating issue which is the conservative manufacturing flow which focuses on batch-based production that in return produce large inventory build-ups, high storage cost and overall lower equipment utilization. This manufacturing method opposes exactly the concept of Lean Manufacturing which dictates on identifying and eliminating Non Value Added (NVA) activities in accordance to achieve optimum performance. The ability and competency to be flexible is much easier to be said than done as the complexity to design such facility could be both costly and sophisticated especially for long term sustainability.

This project will focus on the case study of reducing the changeover time for an Automated Testing Equipment (ATE) called the 'Extreme Test Handler' in a semiconductor industry by integrating 2 well known problem solving methodologies; the Single Minute Exchange of Die (SMED) techniques together with the Theory of Inventive Problem Solving (TRIZ) principals.

2.0 LITERATURE REVIEW

2.1 Rapid Changeover in Lean Manufacturing

Numerous studies have been conducted on the linkage between quick changeover to the implementation of Lean Manufacturing. Lean is an integrated approach in designing and improving work towards a customer focused ideal state through engagement of all people aligned by common principles and practices [2]. Others prefer the simple and basic concept that Lean is to identify and eliminate wastes from every aspect of the business [3]. Table 1 below summarizes the typical 7 deadly waste in Lean context [4]. Rapid changeover is one of 12 Lean Tools accepted globally and is defined as the ability of an equipment to convert and support two or more product in shortest time frame. Figure 1 shows a general changeover process and the total elapsed time that is measured from the ramp down period of current product to the time the new product is fully ramped up [5]. It is necessary to optimize line changeover efficiency especially in a High Mix Low Volume (HMLV) electronics assembly environment before Lean Manufacturing is implemented [6]. Traditionally, improvements in changeover process are approached only through the evaluation and elimination of the Non Value Added (NVA) activities. Studies have shown the existences of the 7 'deadly' waste in an inefficient changeover and highlighted the goal of an efficient changeover is to reduce waste specifically transportation and motion [7].

Table 1 : The seven 'deadly' waste in Lean context [4]

No	Waste	Description
1.	Overproduction	Producing items earlier or in greater quantities than needed by the customer. Generates other wastes, such as overstaffing, storage, and transportation costs because of excess inventory. Inventory can be physical inventory or a queue of information.
2.	Waiting	Workers merely serving as watch persons for an automated machine, or having to stand around waiting for the next processing step, tool, supply, part, etc., or just plain having no work because of no stock, lot processing delays, equipment downtime, and capacity bottlenecks.

3.	Transportation	Moving work in progress (WIP) from place to place in a process, even if it is only a short distance. Or having to move materials, parts, or finished goods into or out of storage or between processes.
4.	Overprocessing	Taking unneeded steps to process the parts. Inefficiently processing due to poor tool and product design, causing unnecessary motion and producing defects. Waste is generated when providing higher quality products than is necessary.
5.	Excess Inventory	Excess raw material, WIP, or finished goods causing longer lead times, obsolescence, damaged goods, transportation and storage costs, and delay. Also, extra inventory hides problems such as production imbalances, late deliveries from suppliers, defects, equipment downtime, and long setup times.
6.	Unnecessary Motion	Any motion employees have to perform during the course of their work other than adding value to the part.
7.	Defects	Production of defective parts or correction. Repairing of rework, scrap, replacement production, and inspection means wasteful handling, time, and effort.

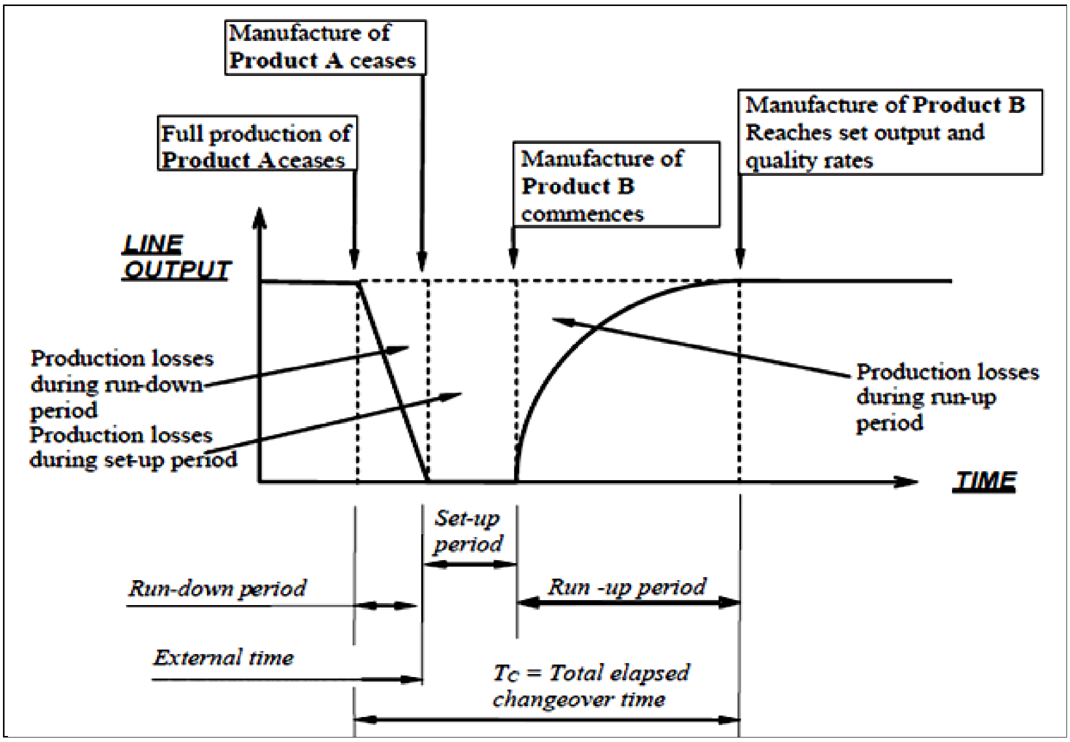


Figure 1 : General changeover process [5]

2.2 Single Minute Exchange of Die (SMED)

Single Minute Exchange of Die or better known as SMED took its first step in 1950's as a concept from the brain child of Shigeo Shingo's efficiency experiment at Toyo Kogyo Mazda plant in Hiroshima, Japan. SMED emphasizes that changeover improvements are sought primarily by rearranging internal and external elements where the whole changeover process can be completed in less than 10 minutes. Figure 2 shows the original approach by Shingo's to achieve the quick changeover with conceptual stages using pre defined techniques [8]. SMED became the cornerstone of Lean Manufacturing especially in setup time reduction by waste elimination and enabling smaller batch sizes of lots to be processed, demonstrating JIT and as an element for continuous improvement or 'kaizen' [9].

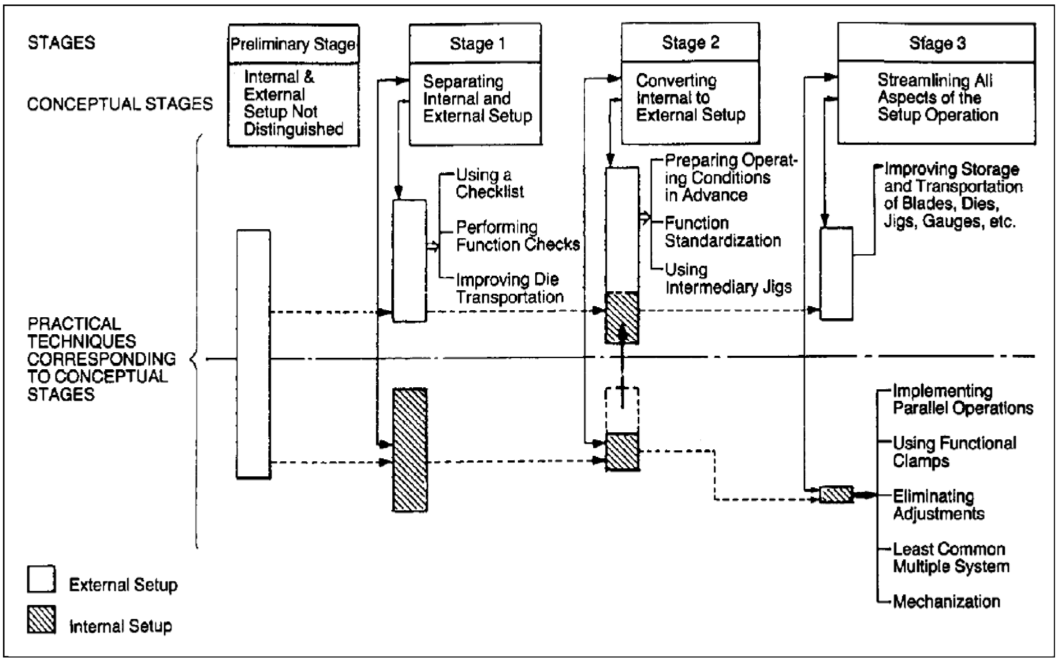


Figure 2 : The Shingo's conceptual stages and SMED techniques [8]

Some of the advantages of SMED techniques are the skills level requirements are low, quick and simple which help to eliminate the need to hire or train highly skilled workforce. SMED techniques also promote World Class Manufacturing as it helps to easily identify the 'waste' NVA activities and eliminate them systematically. SMED is a world renowned methodology with proven record of helping organizations delivering outstanding business results and improvement in customer satisfaction levels [10]. Another highly significant contribution of SMED is the emphasize on active employee involvements in both problem solving and decision making which has shown in outstanding setup time reduction cases [11].

Some of the major setback of the SMED techniques is the sustainability issue due to lack focus and commitment by management in the long run. Other disadvantage is that the low focus on hardware part redesigning that is not so clearly described through the available SMED techniques [12].

2.3 Theory of Inventive Problem Solving (TRIZ)

TRIZ (pronounced TREEZ) is the Russian acronym for *''Teoriya Resheniya Izobreatatelskikh Zadatch''* or the Theory of Inventive Problem Solving. TRIZ introduced by Russian engineer and scientist Genrikh Altshuller in 1946, is a problem solving method based on logic and data, not intuition, which accelerates the ability to solve problems creatively. TRIZ also provides repeatability, predictability, and reliability due to its structure and algorithmic approach [13]. This proven algorithmic approach to solving technical problems began when Altshuller studied thousands of patents and noticed certain patterns. From these patterns he discovered that the evolution of a technical system is not a random process, but is governed by certain objective laws. These laws can be used to consciously develop a system along its path of technical evolution -

by determining and implementing innovations. One result of Altshuller's theory that inventiveness and creativity can be learned has fundamentally altered the psychological model of creativity**.**

Problem solving within TRIZ can be described using a four-element model as below;

i. Element 1: The problem-solver should analyze his specific problem in detail. This is similar to many other creative problem-solving approaches.
ii. Element 2: He should match his specific problem to an abstract problem (or general problem).
iii. Element 3: On an abstract (general) level, the problem-solver should search for an abstract (general) solution
iv. Element 4: If the problem-solver has found an abstract (general) solution, he should transform this solution into a specific solution for his specific problem.

As there are different TRIZ tools corresponding with different levels of abstraction as shown in Figure 3, this process may vary in the heights of abstraction, and also in the number of loops, which the problem-solver is passing through [14].

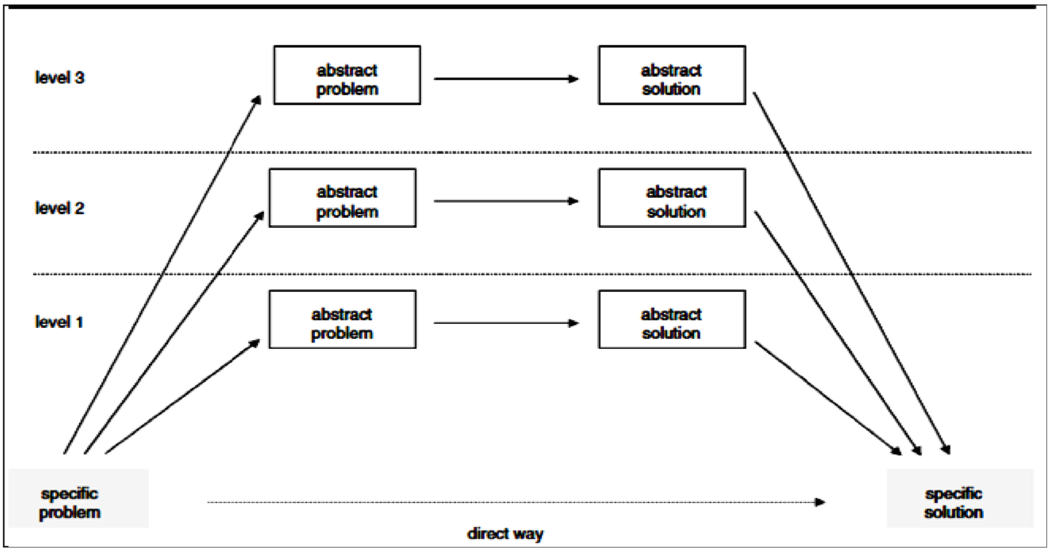


Figure 3 : Problem Solving in TRIZ with different level of abstractions [14]

TRIZ offers a comprehensive set of tools to analyze and solve problems in different perspectives. Lev Shulyak [15] has summarized TRIZ tools into 3 different categories mainly as shown as below;

i. Principal - the tools to overcome contradiction which consist of generic suggestions for performing an action to and within a technical system
ii. Standards - structured rules for the synthesis and reconstruction of technical systems where it helps to combat complex problems
iii. Algorithm for Inventive Problem Solving (ARIS) - it provides specific sequential steps for developing a solution for complex problems

Although the benefits of TRIZ can be seen from entertainment industry to the latest system development but it’s influence globally is jeopardized mainly due to it’s fuzzy boundaries. The many different interpretation of the TRIZ terminologies also made it hard to globally standardized the trainings and textbooks. Nevertheless, many solid efforts are in progress to enhance the TRIZ shortcomings and improve its usability globally.

3.0 RESEARCH METHODOLOGY

To systematically investigate the case study in indentifying the problems and proposing counter measures, a detail sequence of methodology was used. Both qualitative and quantitative data were collected and were categorized into primary and secondary type data collection. The methodology also included the strategic planning of the SMED and TRIZ technique integration to counter the problems.

3.1 Primary Data Collection

A primary data collection is the most important part in the data collection methodology. The 3 different ways the primary data were collected are through direct observation, self experience and lastly through informal interview.

Direct observation is also known as *‘’Gemba’’* by the Japanese and commonly use in the Lean environment. It simply means going directly to the point of activity and perform a direct observation personally. In direct observations, the key point is to ‘actively’ observe with no participation in the overall observed activity. Key objective of any direct observation is to understand the activity, connections and flow. Direct observation is well known in identifying opportunities in the process to eliminate waste or *‘muda’* based on the 7 deadly waste. Some of the typical tools used to assist direct observation process is the top down chart, spaghetti diagram and process maps.

Next is the self experience process which is a holistic approach to better understand the changeover process. The observer will now involve directly in the changeover process or ‘getting the hands dirty’ by performing the actual task. This is a more active approach where personal experience on performing changeover i.e. pre improvement and post improvement will allow more understanding of each steps, the time taken and the opportunity to identify the gaps and improvements needed. Key note for an effective and fruitful self experience is to document all findings, revise and continuously improvise before training others.

As it was not possible to involve all the ‘changeover’ technicians in the direct observations, quick fix to that will be through conducting some informal interview by asking same specific questions to each individual. Interviews with the personnel directly involve in changeover could help in mining data and information on the practice, ideas, setbacks and other vital information to help during the improvement stage

3.2 Secondary Data Collection

Secondary data collection is equally an important part in the research methodology. Secondary data are information that can be obtained through historical data review, technical specification study, literature review and lastly personnel/technician skill sets.

Historical data of the previous duration of changeover performed can be easily retrieved from the internal database system. This information is vital to understand the actual scenario versus the target goal especially for the changeover process. The historical trends may show obvious gaps and help to estimate the severity of the problem statement.

The technical specification and training documents are another source of secondary information that contains detail information of the equipments, hardware parts and also the changeover steps or activities to be performed. It also contains all the safety and hazard information that personnel need to adhere. The review of the documents will give a more holistic understanding of the changeover process.

Literature review will help to critically analyze studies done previously by researchers that share similar interest on research area or problem statement. This will help to understand the available opportunities and prevent the 'reinventing the wheel' scenario.

Reviewing and analyzing the individual technician information such as skill sets and competency, education background and training adequacy will help to eliminate other 'noise' factors.

3.3 Overall Flow

The overall research methodology flow can be summarized as shown in Figure 4.

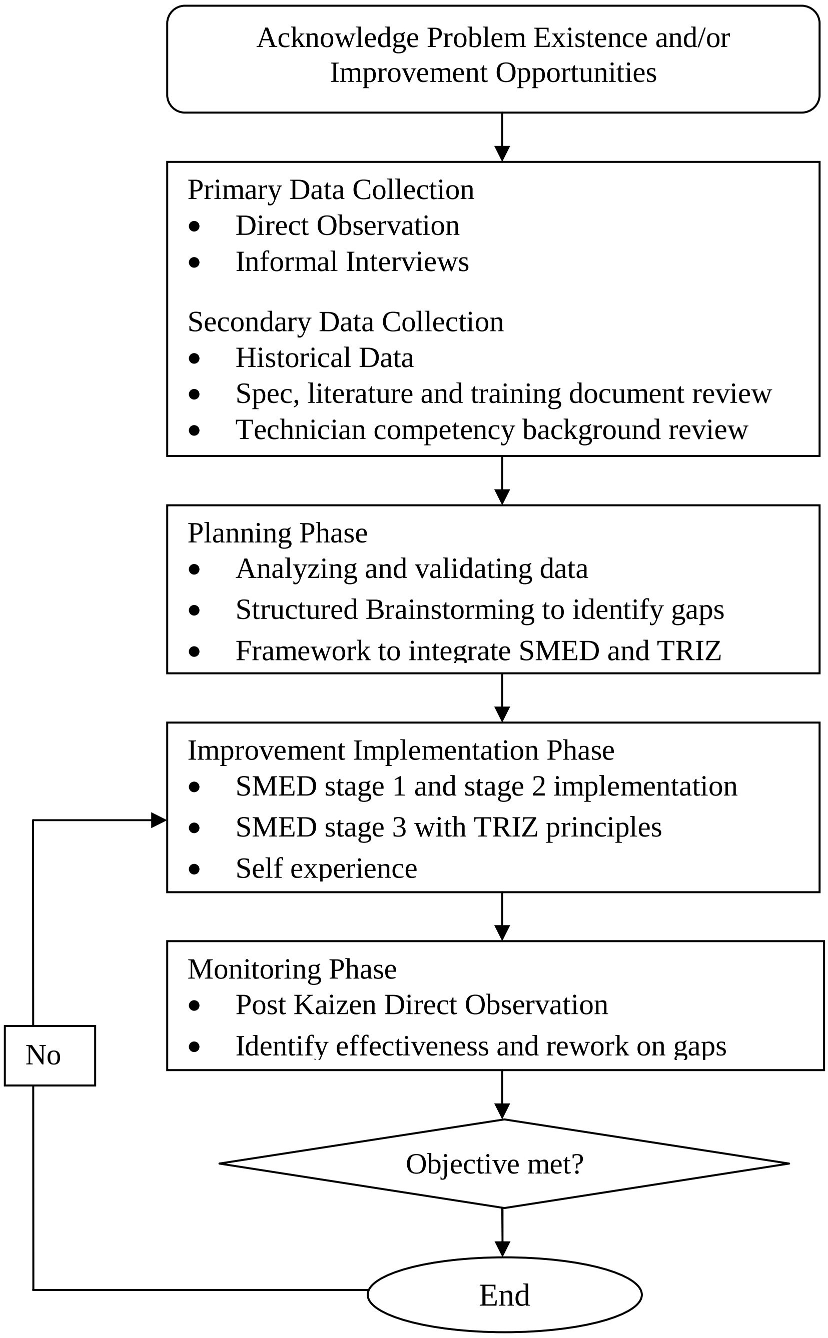


Figure 4 : The research methodology flow

4.0 PROBLEM IDENTIFICATION

The current changeover process takes almost 4 hours (240 minutes) to complete with many non optimized and non standardized practices.

4.1 Background and Justification

The motivation and justification to improve the current changeover process is driven mainly by 3 factors which is the utilization, non robust manufacturing and the rising cost issue.

Historical studies on the case study organization showed the total production utilization average is around 70% versus the target goal of 90%. The lost on the remaining 20% are contributed to many other factors and among other is due to the changeover process which add ups to 8.4%. The long hours of changeover duration contributes to the higher equipment idling time and the non standardized process initiates higher assist and other downtime.

Due to complex changeover process and unpredictable market demand, equipment dedication policy was widely practiced resulting in a non flexible manufacturing. This non robust practice engaged the organization in frequent miss of shipment due to non timely response to demand.

The above 2 factors, induce higher overall cost especially the increase in the cost per unit that hits the bottom line of the organization's revenue and profit. With lower utilization and tester dedication policy, the organization is pushed further to purchase more capital equipments.

4.2 Case Study Review

The case study of this project is based on the multinational semiconductor company called Intel Technology Sdn. Bhd. located in Kulim High Tech Park. The case study company is a global leader with cutting edge technology to manufacture, assemble and test microprocessor and other chipsets products. The organization in focus is Kulim Microprocessor and Chipset Operation (KMCO) which is a High Mix Low Volume (HMLV) platform factory.

The 2 main stream chipset products are called Nebula Peak and Nexus Peak. These are the new generation chipset with I/O and integrated graphics function to support the microprocessor device. Though both products are from the same family of technology, they are designed for different market segment. Both products are similar in functionality but have different physical attributes. Due to this difference, the products require different equipment configuration for assembly and testing.

The products mentioned above undergo an average 20 manufacturing process before the end product is shipped to the customer. The scope of this case study is focused on the testing operation where the product's die are electrically tested using high technology testing equipment.

The equipment is the M4542AD Dynamic Test Handler or also known as the Extreme Test Handler. This is a highly sophisticated equipment which is integrated with a tester unit and a test interface unit to perform a functional electrical testing on semiconductor devices under extreme temperatures. The main focus of this project is to improve the changeover process for the test handler.

4.3 The Current Changeover Process

The current changeover process involves 8 'Internal' activities and 1 'External' activity as shown in Figure 5 with the average time taken to complete a typical changeover by a trained technician (based on the 13 weeks data from Q4' 10).

The biggest bottleneck of current changeover process is the hardware part setup phase which takes around 160 minute to replace 11 hardware parts. The changeover process includes 2 different validation steps and 1 calibration phase. The remaining stages are pre and post setups. The detail of each steps are shown in Table 2.

The current changeover process improvement are hindered by 3 main issues namely due to the existence of non optimized processes, the non standardized practices and lastly the inclusion of many Non Value Added (NVA) activities throughout the steps.

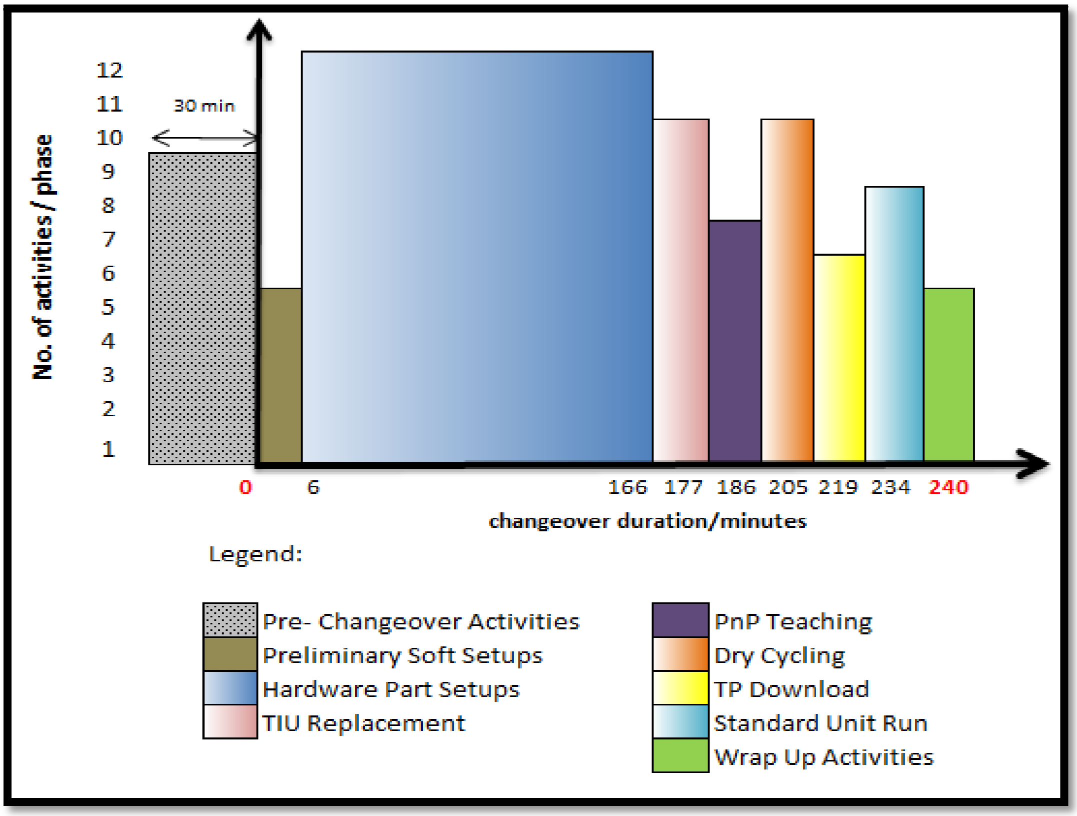


Figure 5 : The current changeover process

Table 2 : The current time taken to complete each changeover step

Sequence No.	Activity and Milestone	Details	Average Time (minutes)
Pre Changeover Activities		Supervisor communication and alignment with technician End lot process for the last production run	Not included in changeover time
1	Preliminary Soft Setup Activities	Official start of changeover process with the change in AEPT Tagging of equipment i.e. sticky pad or barricading area Preparation of change kit and toolsets	6
2	Hardware Part Setups	12 major hardware part setups Bottleneck of the overall changeover process	160

3	TIU replacement	Interface unit that need to be replaced	11
4	PnP 'Teaching' Process	Required calibration process each time hardware parts are replaced	9
5	Dry Cycling with Mechanical Units	1st validation process on the hardware part setup Using 5 trays of mechanical units Ensure end of cycle, 100% pass with no mechanical defects	19
6	TP download	Software coding to instruct tester to perform electrical testing	14
7	Standard Unit Run	2nd validation performed using good production samples of 1 full tray Validation under real production atmosphere Ensure all units pass with 100% yield	15
8	Wrap Up Activities	Housekeeping and cleaning up work area Official end of the changeover activity by change in AEPT	6
		TOTAL	**240** Internal Time

5.0 COUNTER MEASURE PROPOSALS

From the problems identified earlier, techniques and methodologies from SMED and TRIZ are proposed as counter measures as shown in Figure 6. To systematically tackle the issues, the counter measure proposal will focus on 3 main areas namely process, equipment and human.

The major proposals will focus directly on the process optimization which involves identifying and separating elements, eliminating Non Value Added elements, improving parallel activities and streaming some of the tasks. The techniques used will also be focused on hardware setup optimization where significant hardware parts are identified for modification or redesigning. Last but not least, the integrated techniques will also be applied across the human dynamics and procurement improvements.

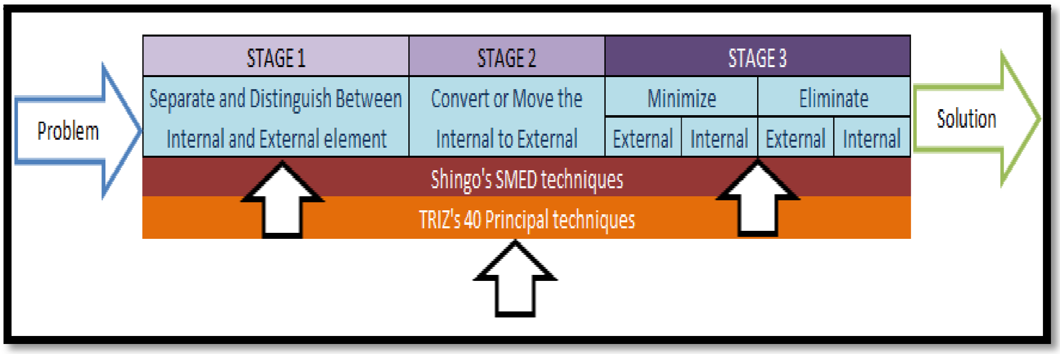


Figure 6: The generic proposal model

6.0 RESULTS AND DISCUSSIONS

With the counter measures proposed are purely based on the integration of SMED and TRIZ techniques, some major breakthrough was able to be materialized.

6.1 Hardware Part Setup Optimization

The biggest success was the improvement in the Contactor chuck 'nest' design where the generic part was modified using the TRIZ's 'Dynamization' technique with SMED 'Functional Clamper' technique. The 'Dynamization' technique highlights the ability of an object to be flexible and movable as oppose to static and rigid. Dynamization technique suggests partitioning the current next design and identifying a relative movable part. With SMED's functional clamper idea, a new nest was designed which is able to fit different size units with just simple lever movements. The new 'nest' design helped to reduce the setup of 21 steps to 6 steps with duration reduction from 120 minutes to 4 minutes. Figure 7 shows the comparative old and new nest design. Figure 8 shows the new design with both flexibility and adjustability.

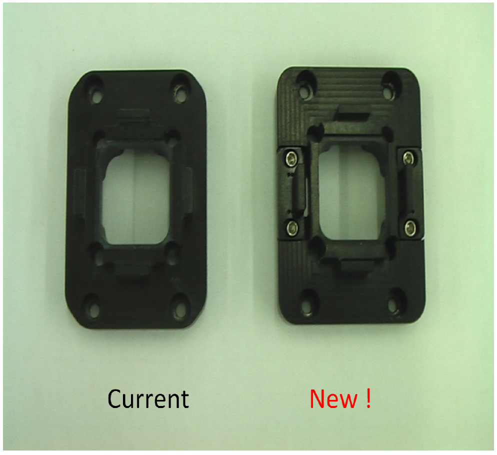


Figure 7 : The comparative design net size

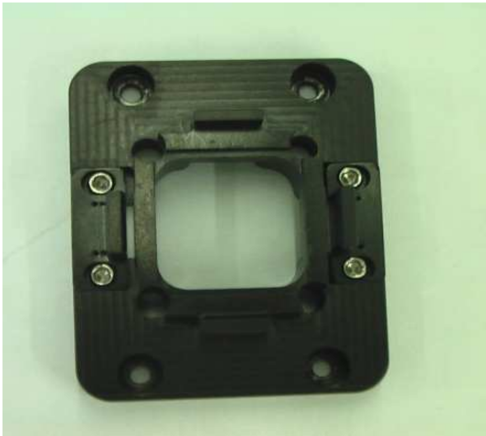


Figure 8 : The new adjustable

The other significant hardware setup change is the introduction of 1-turn screw method which helped mainly in reducing much of the NVA steps of turning and adjusting screw based hardware parts. The proposal of 1 turn screw implementation was demonstrated on the X pitch block converter and this help to reduce duration from 4 minutes to 1 minute.

Also using SMED technique like 'Function Checks' and TRIZ technique 'Local Quality', 5 'fungible' hardware parts were identified which helped to reduce the number of parts to replace from 12 to 7.

In summary, the techniques applied help to reduce hardware part setup from 160 minutes to 11 minutes.

6.2 Process Flow Optimization

With the introduction of TRIZ techniques like 'Segmentation', 'Taking Out', 'Merging' and coupling with SMED ' Function Check' and 'Parallel Operations' the changeover process was further streamlined and improved.

The improvement of upfront setup helps to integrate 3 steps into 1 external step and help to eliminate the NVA activities. Two or more activities were executed in parallel mode to minimize the internal time and idling time. Activities of similar function were grouped together and performed as a standardized activity at a defined stage or is fully eliminated (or substituted) if identified as NVA. A few new ideas to enhance the work like usage of trolley and magnifier was introduced.

In summary, the other process which initially took 80 minutes; now only require 30 minutes to complete.

6.3 The Human Dynamic and Procurement Improvement

All identified personnel and technician were re-trained based on the new enhance and optimized process. Training material and documents were revised and updated. All new learning were documented together with the Best Known Methods (BKMs) and shared with other organization with similar equipments. Training emphasized on both theory and practical learning and all personnel and technicians will need to be fully tested or certified before he/she can perform a changeover. This is important to ensure everyone is aligned on the business process and changeover process standardization. Each shift were encouraged to have more of their personnel and technician trained to ensure an adequate headcount and enable the dissemination of headcount around the shifts more easily.

6.4 The Overall Optimized Changeover Process

Figure 9 shows the new optimized changeover process with the duration now reduced from initial 240 minutes to 32 minutes. The setup duration was able to be reduced to almost 87% from initial stage with more lean activities.

Table 3 shows the summary of the time study based on the new process. The significant change of Table 3 compared to Table 2 is the reduction of the changeover stages and also the rescheduling of steps either due to parallel operation execution or elimination by operation.

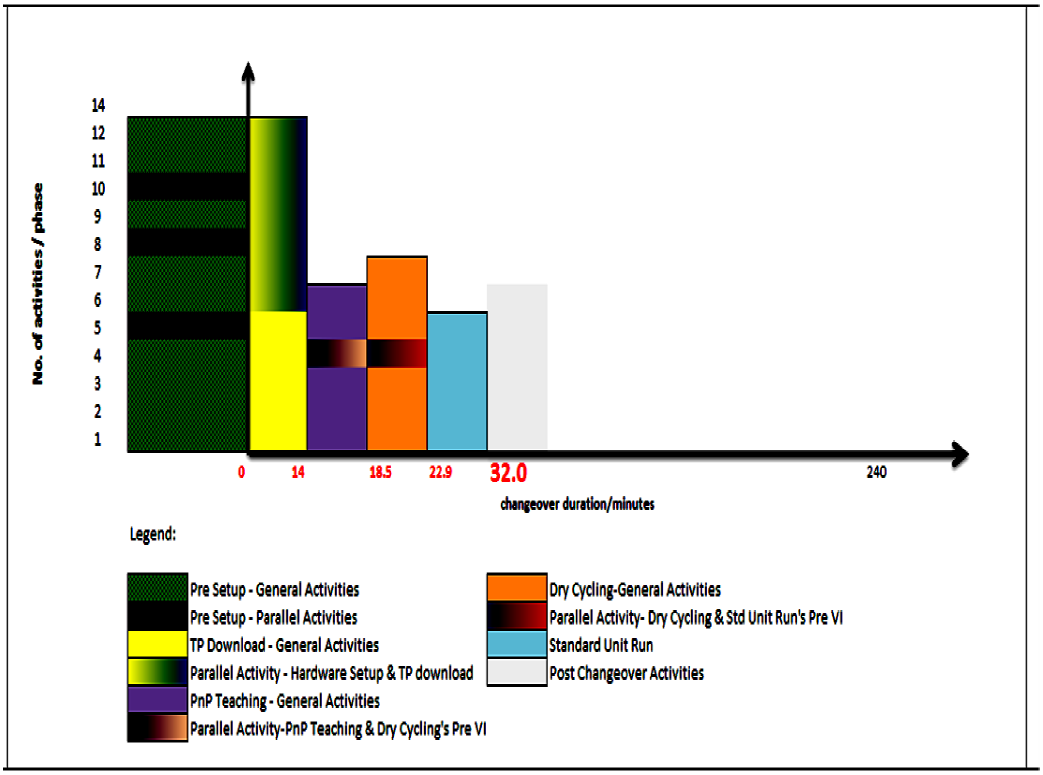


Figure 9 : The new optimized changeover process

Table 3 : The new optimized changeover time study (based on Q2' 11 average)

Sequence No.	Activity	Details	Average Time (minutes)
Pre Setup Phase		Integrates Pre Changeover and Preliminary Soft Setup phase TIU replacement peformed in parallel during end lot process All other activities are prepared upfront	Not included in changeover time
1	TP download	3 steps are performed as 'Internal' task - Perform TP reset, SC initialization and ELI input Actual download and TIU init are performed on the background	14
	Hardware Part Setups	5 parts are fungible and not replaced 5 parts are non fungible and need to be replaced 2 parts were re-engineered to minimize the setup time The hardware setups are performed in parallel during the TP download /TIU initilization	
2	PnP 'Teaching' Process	Improved process with reduced setup time Pre VI for Dry Cycling units are performed in parallel during actual process	4.5
3	Dry Cycling with Mechanical Units	Improved process with Dry Cycling performed with 1 tray of units Reduced pre setup time and no temperature setup Pre VI for Standard units are performed in parallel during actual process	4.4
4	Standard Unit Run	Improved process with reduced setup time AEPT state change is performed towards the end of the process	9.1
Post Changeover Activities		All activities performed post AEPT state change Move all Wrap Up activities to this phase	Not included in changeover time
		TOTAL	**32** Internal Time

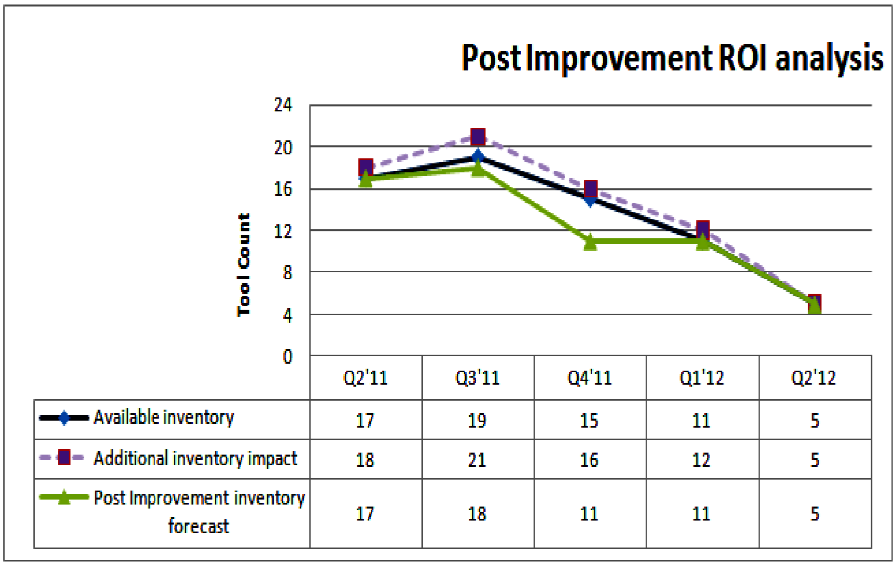
6.5 Return on Investment (ROI) Analysis

Based on the achievement and success in optimizing the changeover setup duration, some of the ROI analyzed as described here.

The new enhanced process improved the overall equipment utilization where an equipment average utilization was increased from 70% per shift to 87% per shift. With the significant setup time reduction, the equipments are now able to churn more output units for shipment. The quick changeover allows the factory to be flexible to the changing demand and avoid equipment dedication and batch build policy. These advantages translate into huge cost savings especially on the need to purchase need equipments. Figure 10 illustrates the forecast of capital savings in between Q2'11 to Q2' 12.

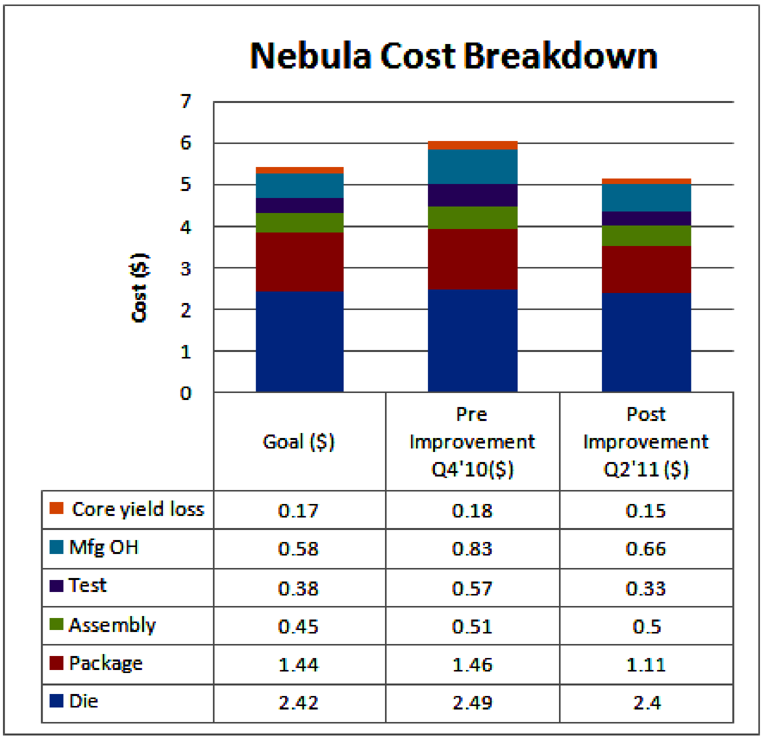
The standardization in the changeover process also helped to reduce the idling time of technicians during changeover from an average 30 minutes to 1 minute. With simpler process flow the training for new employee are more efficient and quicker. This improvement translates into a better headcount management and mobilization.

By enabling higher output without purchasing new tools and an efficient headcount utilization translates into better cost per unit. This is illustrated in Figure 11.



	Q2'11	Q3'11	Q4'11	Q1'12	Q2'12
Available inventory	17	19	15	11	5
Additional inventory impact	18	21	16	12	5
Post Improvement inventory forecast	17	18	11	11	5

Figure 10 : The capital equipment purchase ROI



	Goal ($)	Pre Improvement Q4'10($)	Post Improvement Q2'11 ($)
Core yield loss	0.17	0.18	0.15
Mfg OH	0.58	0.83	0.66
Test	0.38	0.57	0.33
Assembly	0.45	0.51	0.5
Package	1.44	1.46	1.11
Die	2.42	2.49	2.4

Figure 11 : Cost breakdown analysis

6.6 Critical Appraisal

Some of the key learnings extracted from this case study using SMED and TRIZ integration to reduce the changeover duration can be summarized as below.

If only SMED techniques were used throughout the optimization process, the changeover duration could only be reduced to a maximum of 105 minutes from the initial 240 minutes. But with enhancement and integration of TRIZ, more improvement opportunities were indentified and explored to result in a changeover reduction of 30 minutes. TRIZ techniques were particularly useful in hardware modification and segmenting process or activities while SMED helped to identify and improve functionality of parts and activities.

According to Shingo's SMED ideal concept, an equipment changeover or conversion is only considered optimized if the process can be completed in less than 10 minutes. Thus, the achievement in reducing the changeover to 32 minutes is still not fully optimized as the new process still consists validation and calibration steps.

The available TRIZ principals and SMED techniques are aligned mostly to hardware and process improvement but lesser focus or tool proposed for areas like software, IT or network computing which is also part of most processes today. Due to this, the Test Program (TP) download phase cannot be fully optimized.

Though many of the identified problems and proposed /implemented solutions are common sense and logical at basic but the introduction of SMED and TRIZ techniques helped problem solving in a standardized and structured manner.

The most important element that was less focused in this case study was the human factor improvement. Continuous motivation and training to the personnel ensures a better process sustainability and further enhancement.

6.7 Future Studies and Recommendation

Some of the suggested recommendations and studies for the future are described as below.

Continue to pursue improvements to reduce the current test handler changeover to less than 10 minutes by;

a. Eliminating the validation and calibration phases with more empirical data
b. Reducing the TP download phase
c. Improve the hardware setup further especially the non 'fungible' parts by redesign or eliminate the NVA activities

Apply the TRIZ principles and SMED techniques suggested in this case study for any other applicable semiconductor based equipment

Extend the scope of TRIZ by introducing other advance TRIZ's tools such as Standards and ARIS.

7.0 CONCLUSIONS

In this project, a testing equipment's changeover process was explored to identify the source of constraint and opportunities for improvement. Empirical data was collected rigorously through different available qualitative and quantitative methods to validate the problem statement. To systematically improve the process, techniques from SMED and TRIZ were introduced and integrated in process standardization, elimination of NVA activities and hardware setup optimization. The integration of these techniques helped to reduce the changeover duration from 240 minutes to 32 minutes. Some future recommendation suggested from this study is for researcher to enhance the usage of ARIS and Standards techniques that could yield better result. Also the methodology can be used to implement for other equipments in a similar semiconductor industries.

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