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TOTAL PRODUCTIVE MAINTENANCE METHODOLOGY AS A TOOL TO DEVELOP PEOPLE IN A MANUFACTURE AREA

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Abstract. *Total Productive Maintenance is a methodology developed by Japan Institute Plant Maintenance with focus on maintenance area and improves efficiency through the analyses of the Overall Equipment Efficiency. This paper presents an application of the Total Productive Maintenance methodology as a tool to develop people operators and change their culture, in this approach the operators are responsible by clean, organization, problem solving analyses, resources and costs control from their machine stations. The authors have created the model process for this new approach, with four levels and each step duration is around six months with planning, trainings, execution actives and audits. The accomplished results show gains around 30% in manufacturing efficiency measured by Overall Equipment Efficiency, Total Productive Maintenance knowledge level increase and Operators promotions.*

Keywords: *Total Productive Maintenance, Culture, Overall Equipment Efficiency, Productivity*

1. INTRODUCTION

Nowadays, companies increasingly seek excellence; finding new methodologies that can broaden your results for quality of life, economic, among others. A tool to highlight in this article is the TPM (Total Productive Maintenance), which in turn belongs to the list of Lean Manufacturing (Lewis, 2000).

Principles of Lean Manufacturing have gained notoriety in the 1980s through a research project conducted by Massachusetts Institute of Technology who studied the management practices and improvement programs adopted by market leaders (Womack; Jones; Roos, 2001).

Lean Manufacturing seeks to reduce the time between the application client and delivery by eliminating waste. It promotes the identification of which adds value in view of the customer, the interconnection of the steps needed to produce goods in the stream of value, so that it proceed without interruptions, diversions, returns, delays or scraps, and the operation of this flow driven by demand (Liker, 2004).

To plan the implementation of Lean Manufacturing practices, Rother and Shook (1999) advocate the application of VSM (Value Stream Mapping), which is a planning tool that facilitates the visualization of the flow of information and materials. The VSM tries to portray in a comprehensive manner the system of production and aims to build maps that represent both the flow of information (from the client request to the production schedule) as the flow of materials (from raw materials to the finished product) (Womack; Jones; Roos, 2001).

The tools of action of Lean Manufacturing that are most commonly applied in production systems are different.

As an example, it has been Five Esses (5 S) which constitute an important practice so as to cause the change to establish the subject. For this, each of "esses" considered promotes a fundamental attitude to rationalize the work as follows: 1st S: Seiri, organization, 2nd S: Seiton, order, 3rd S: Seiso, cleaning, 4th S: Seiketsu, standardization / health and 5nd S: Shitsuke, discipline (Ribeiro, 2006). So, Five Esses supported TPM.

Another important tool, highlighted in this article, is the TPM, which organizes the maintenance function in order to improve effectiveness (efficiency and effectiveness) in the use of equipment, relying on a combination of practices such as autonomous maintenance and planned maintenance (Nakajima, 1989).

Most of the companies leading the TPM tool driving it in the following steps: defining the goals of reducing the downtime; assembling the project team (mechanical, trainer, operator); assignment of roles and responsibilities for participants, identification and prioritization of equipment; Kaizen events and programming (Silva et al., 2011).

Performing each event follows the procedure: preparation machine, assigning responsibilities to team members to improve and release of equipment for the implementation of improvements.

For the assessment of the overall impact of this tool companies use OEE (Overall Equipment Efficiency), which is an indicator, that measures simultaneously: availability, performance and quality. This indicator is the product of these measurements (OEE = Availability x Performance x Quality) (Nakajima , 1989).

As an example, a result, a company has the following indexes of availability, performance and quality, 75, 70 and 97%, respectively. Thus, the OEE reaches the value (0.75 x 0.70 x 0.97 = 51%), which corresponds to an average value of companies in Brazil (Silva et al. 2011).

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It is worth mentioning that as the discrete manufacturing companies, considered world class standard, seeking an OEE value of at least 85%, the shares of this project were developed to pursue the achievement of this goal, the company.

The traditional method for the implementation of these tools is to conduct Kaizen events and results achieved must be monitored on a daily basis through visual controls that promote the principle of management in sight (Laraia; Moody; Hall, 1999). In a certain area, the level reached in the implementation and application for each tool mentioned can be compared on a graph "Radar" facilitating monitoring.

Thus, this paper presents a different methodology of Kaizen, which seeks to motivate its employees, which is the key to successful implementation of new programs.

Finally, this paper presents a system developed and deployed a Forge Shop belonging to an auto part, in the state of São Paulo. The purpose of this article is to present the application of Total Productive Maintenance by analyzing Overal Equipment Efficiency in the manufacturing area. The following is the methodology implemented.

2. METHODOLOGY: TPM TO DEVELOP PEOPLE IN A MANUFACTURE AREA

The Semi-Autonomous Team is a process developed in the Enterprise Plant to create a problem solving culture in the all hierarquy level. This methodology have used the same system from Total Productive Maintenance (methodology developed from Japan Institute Plant Maintenance) (JIPM, 2001; Loss Prevention, 2004) that have 7 levels “Figure 1”, but we have used this process to develop people and became operators more autonomous and control the process and costs in your area. On this new methodology (SAT – Semi-Autonomous Team) we have 4 levels as “Figure 2”.

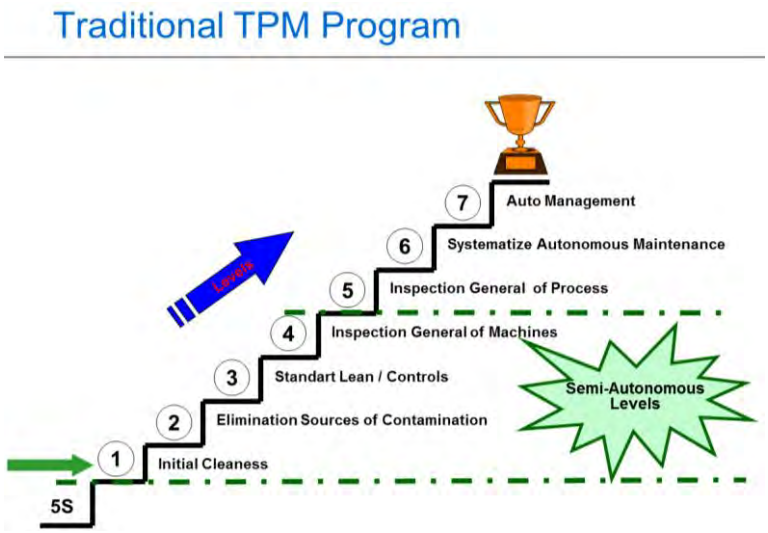

Figure 1.Traditional TPM program from Japan Institute

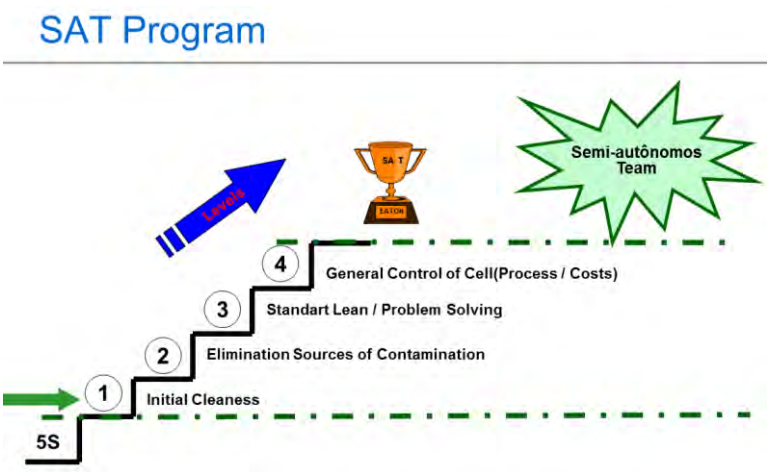

Figure 2. Semi-Autonomous Team program

When we start to develop and implement this process, the first thing that we did was to draw the flow chart and specify the elements inside the Semi-autonomous Team process “Figure 3”, so we defined the time, steps, inputs,

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outputs, actives process, participants and tools that we need to training and develop operators. This process was started in 2009 as a pilot on the Forge shop Area, in 2011 we defined the process and 2012 we draw the process and flow chart.

The Critical Cells and Team Definition is the third step on the Semi-autonomous Team process. On this step we define the structure (team) that will coordinate the program, the structure need four coordinators "Figure 4": Maintenance Autonomous Leader, Specific Improvement Leader, Planned Maintenance Leader and Training Leader. We have defined the schedule to ensure that the critical cell will be chosen objectively from the data and not by feeling.

The focus from this step is to ensure that the right resources (people) will work on the right machine (critical).

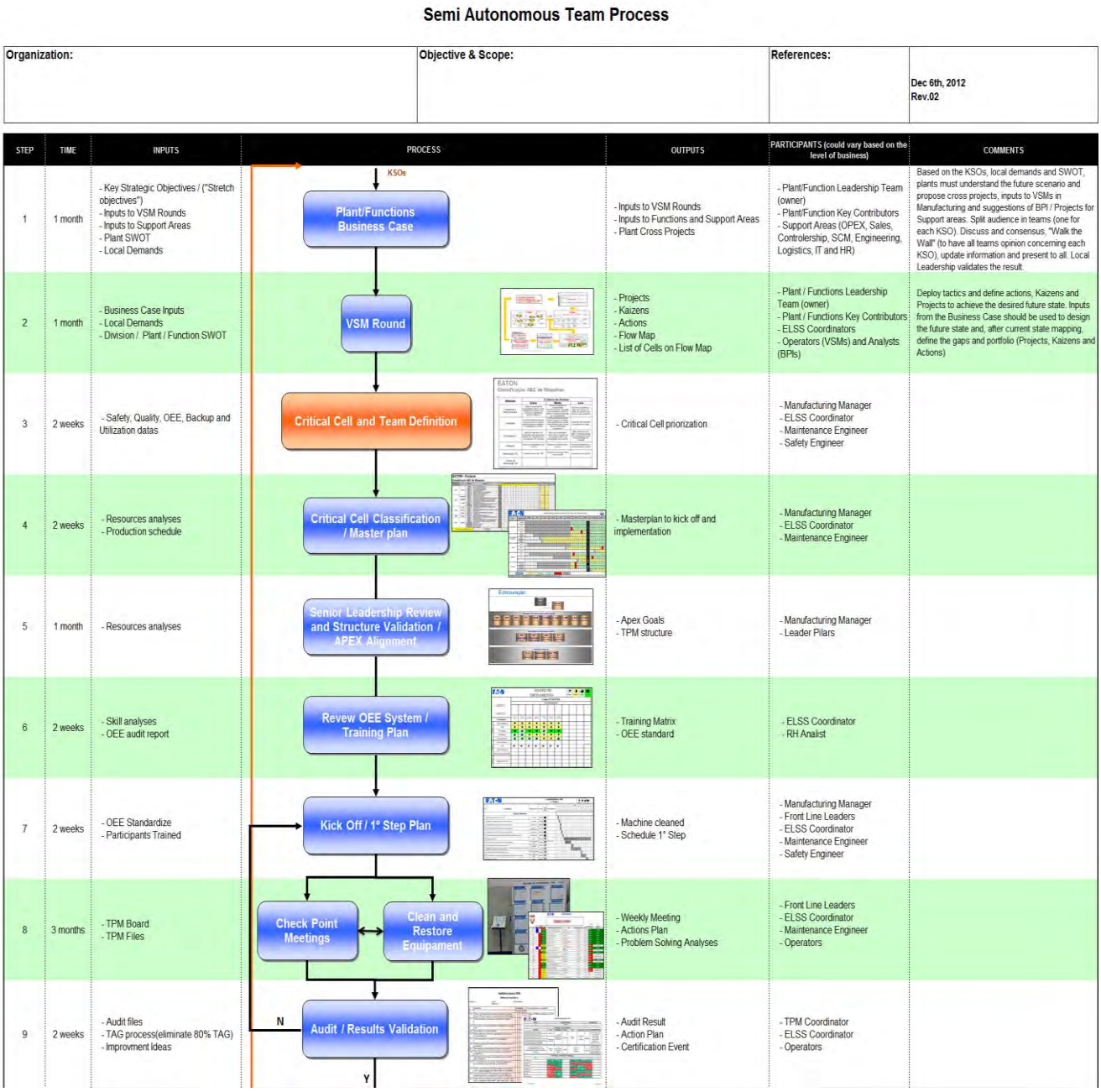

Figure 3. Semi-autonomous Team process and flow chart

M.Souza, I. Silva
Semi-Autonomous Team

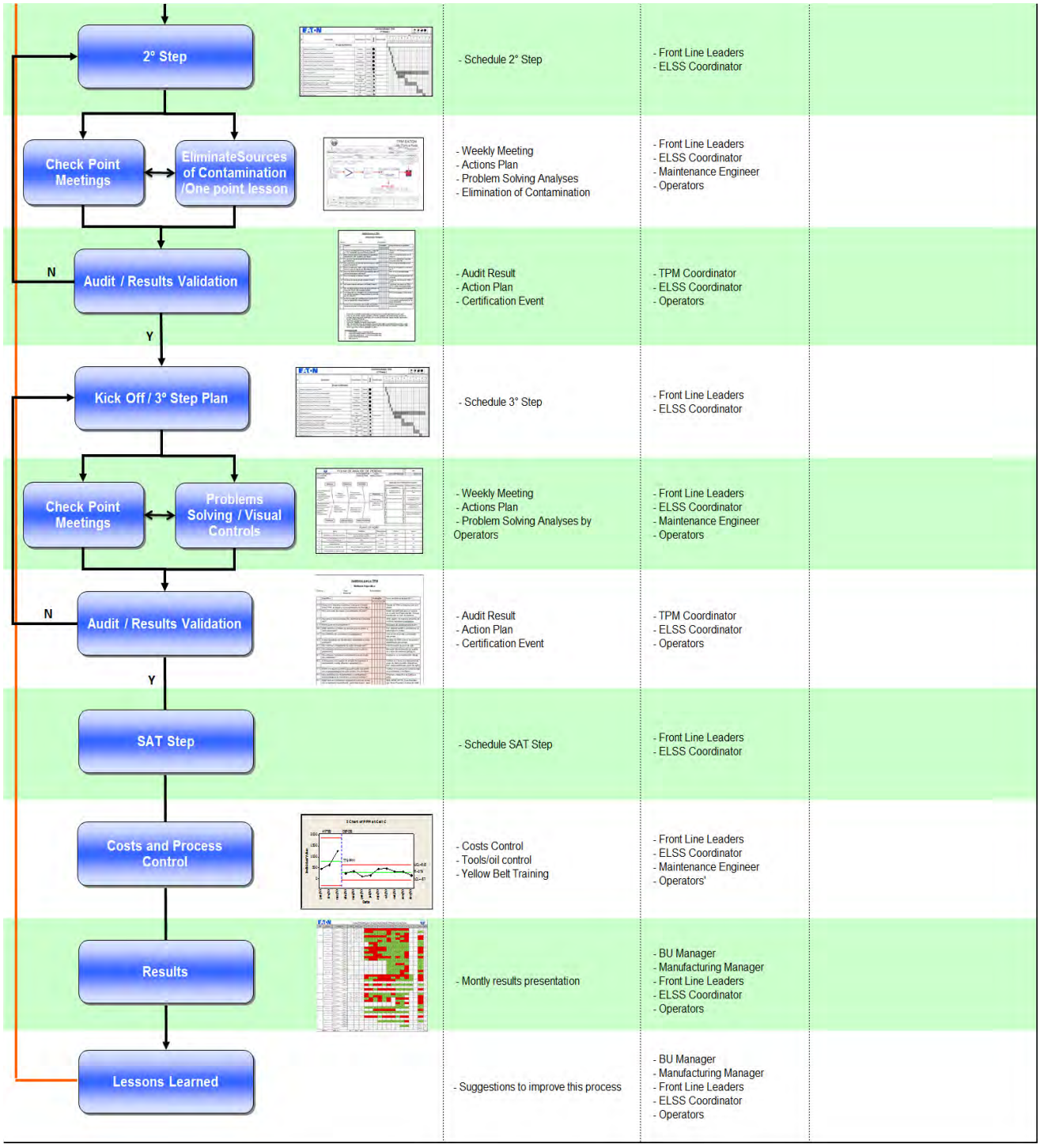

Figure 3. Semi-autonomous Team process and flow chart(Continuation)

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Figure 4. Pillars from the Semi-Autonomous Team Structure

2.1 Critical Cells Classification and Master Plan

The Critical Cells Classification and Master Plan is the fourth step on the Semi-autonomous Team process.

On this step we prioritize the machines according the schedule from previous step and we define plan to execute during the year.

The focus from this step is to planning the actives (for one year) and what will be the next critical machine to implement the methodology.

2.2 Senior Leadership Review and Structure Validation / APEX Alignment

The Senior Leadership Review and Structure Validation is the fifth step on the Semi-autonomous Team process.

On this step we reviewed with the senior leadership the critical machines, team, planning to the year and validate the goals to the team.

The focus from this step is to ensure the alignment with the senior leadership.

2.3 Review the Efficiency System and Training Plan

The Review the Efficiency System and Training Plan is the sixth step on the Semi-autonomous Team process.

On this step we review or implement the Overall Efficiency Equipment System and define the trainings necessary for the each step(the Training Matrix, “Figure 5”

The focus from this step is to ensure that we have a right trainings and measurement system to evaluate the process evaluation.

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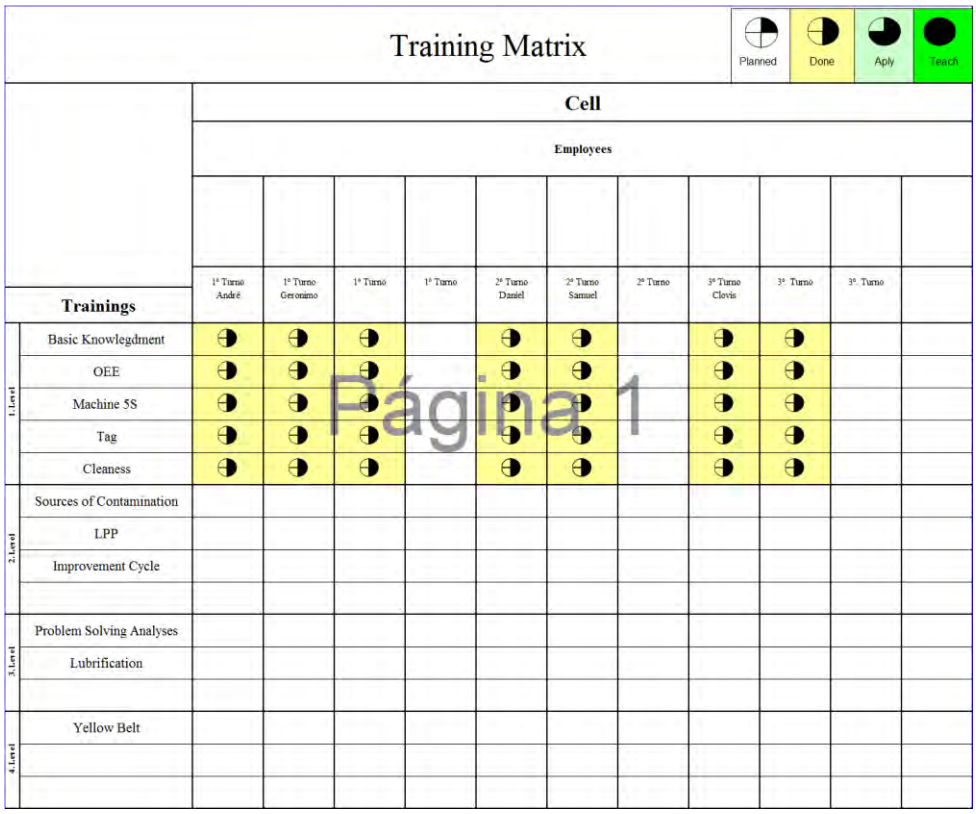


Training Matrix

Planned | Done | Aply | Teach

	Trainings	Cell / Employees: 1º Turno André	1º Turno Geronimo	1º Turno	1º Turno	2º Turno Daniel	2º Turno Samuel	2º Turno	3º Turno Clovis	3º Turno	3º Turno
1.Level	Basic Knowlegdment	◑	◑	◑		◑	◑		◑	◑	
	OEE	◑	◑	◑		◑	◑		◑	◑	
	Machine 5S	◑	◑	◑		◑	◑		◑	◑	
	Tag	◑	◑	◑		◑	◑		◑	◑	
	Cleaness	◑	◑	◑		◑	◑		◑	◑	
2.Level	Sources of Contamination										
	LPP										
	Improvement Cycle										
3.Level	Problem Solving Analyses										
	Lubrification										
4.Level	Yellow Belt										

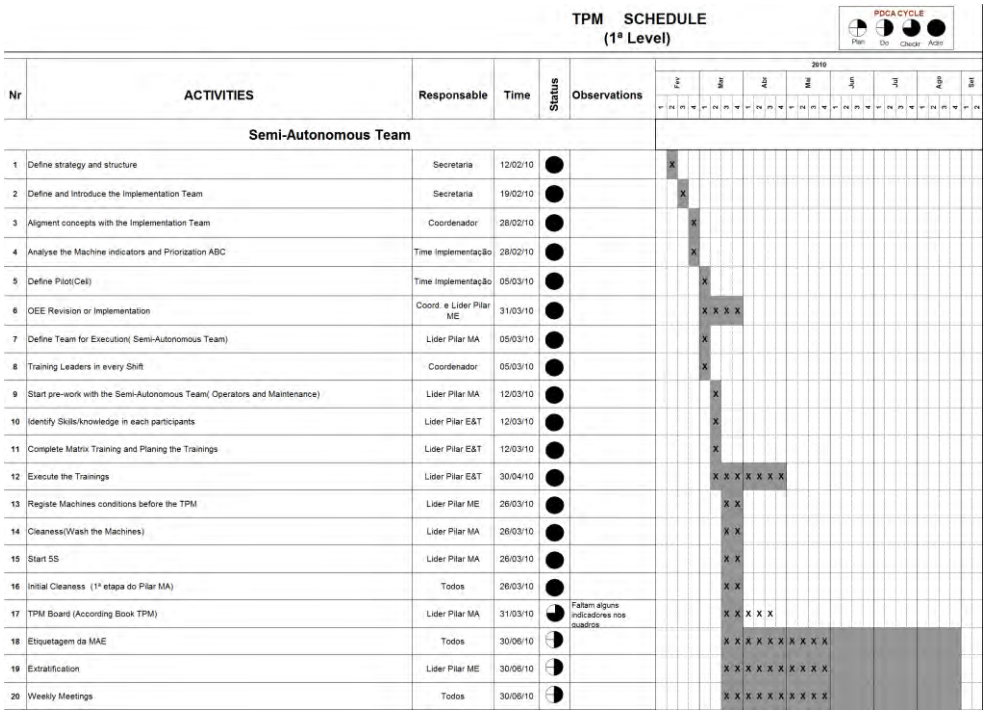
Figure 5. Training Matrix

2.4 First Level Kick Off

The First Level Kick Off is the seventh step on the Semi-autonomous Team process.

We have finished the planning steps on the whole process and on this seventh step we define the schedule and start to execute the actives, train the team and to clean the machine to restore the basic conditions.

The focus from this step is to define the schedule “Figure 6” to execute the First Level on Semi-Autonomous Team Process.



TPM SCHEDULE (1º Level)

PDCA CYCLE: Plan, Do, Check, Actio

Nr	ACTIVITIES	Responsable	Time	Status	Observations
	Semi-Autonomous Team				
1	Define strategy and structure	Secretaria	12/02/10	●	
2	Define and Introduce the Implementation Team	Secretaria	19/02/10	●	
3	Aligment concepts with the Implementation Team	Coordenador	28/02/10	●	
4	Analyse the Machine indicators and Priorization ABC	Time Implementação	28/02/10	●	
5	Define Pilot(Cell)	Time Implementação	05/03/10	●	
6	OEE Revision or Implementation	Coord. e Lider Pilar ME	31/03/10	●	
7	Define Team for Execution(Semi-Autonomous Team)	Lider Pilar MA	05/03/10	●	
8	Training Leaders in every Shift	Coordenador	05/03/10	●	
9	Start pre-work with the Semi-Autonomous Team(Operators and Maintenance)	Lider Pilar MA	12/03/10	●	
10	Identify Skills/knowledge in each participants	Lider Pilar E&T	12/03/10	●	
11	Complete Matrix Training and Planing the Trainings	Lider Pilar E&T	12/03/10	●	
12	Execute the Trainings	Lider Pilar E&T	30/04/10	●	
13	Registe Machines conditions before the TPM	Lider Pilar ME	26/03/10	●	
14	Cleaness(Wash the Machines)	Lider Pilar MA	26/03/10	●	
15	Start 5S	Lider Pilar MA	26/03/10	●	
16	Initial Cleaness (1ª etapa do Pilar MA)	Todos	26/03/10	●	
17	TPM Board (According Book TPM)	Lider Pilar MA	31/03/10	◕	Faltam alguns indicadores nos quadros
18	Etiquetagem da MAE	Todos	30/06/10	◑	
19	Extratification	Lider Pilar ME	30/06/10	◑	
20	Weekly Meetings	Todos	30/06/10	◑	

Figure 6. First Level Schedule

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2.5 Clean and Restore the Equipment

The Clean and Restore the Equipment is the eighth step on the Semi-autonomous Team process.

On this step we start the meetings with the four Pillar Leaders, planned maintenance, problem solving analyses, identify the nonconformance and solve then.

The focus from this step is to start the execution to restore the equipment basic conditions.

2.6 Audit and Results Validation

The Audit and Results Validation is the ninth step on the Semi-autonomous Team process.

On this step we realize a audit with questions to the four pillar and check the results sustainability through the operators culture, leaders discipline and Overall Efficiency Equipment trend

The focus from this step is to validate that the Team is read to move to next Level.

2.7 Second Level

The Second Level is the tenth step on the Semi-autonomous Team process.

We have passed from the First Level and then we need to define the schedule to second level and define goals, actives and trainings to achieve the results more challenging.

The focus from this step is to define the schedule to execute the Second Level on Semi-Autonomous Team Process.

2.8 Eliminate Sources of Contamination and One Point Lesson

The Eliminate Sources of Contamination and One Point Lesson is the eleventh step on the Semi-autonomous Team process.

On this step we identify the Sources of contamination as leaking oil and the team analyses each this sources and define actions eliminate then.

After solve the problem or implement the improvement the team need to do the One Pont Lesson to explain and train the new operators. One Point Lesson is a kind of instruction in just one page.

The focus from this step is to eliminate the problem (Source of Contamination) on the root cause.

2.9 Second Level Audit and Results Validation

The Second Level Audit and Results Validation is the twelfth step on the Semi-autonomous Team process.

On this step we realize a audit as like on the first level, but with more questions to check the Second Level and if the Sources of Contaminations were eliminated, at least 50 percent.

The focus from this step is to validate that the Team is read to move to next Level.

2.10 Third Level

The Third Level is the thirteenth step on the Semi-autonomous Team process.

After the team pass from the Second Level we need to define the schedule to third level and define goals, actives and trainings to achieve the results more challenging.

The focus from this step is to define the schedule to execute the Third Level on Semi-Autonomous Team Process.

2.11 Problem Solving Analyses

The Problem Solving Analyses is the fourteenth step on the Semi-autonomous Team process.

On this step team is read, developed to lead the problem solving analyses “Figure 7”, find the root cause from wastes that more impact the Overall Efficiency Equipment during the whole week and define the actions to eliminate these wastes causes.

The focus from this step is to become the operators responsible for the problem solving analyses.

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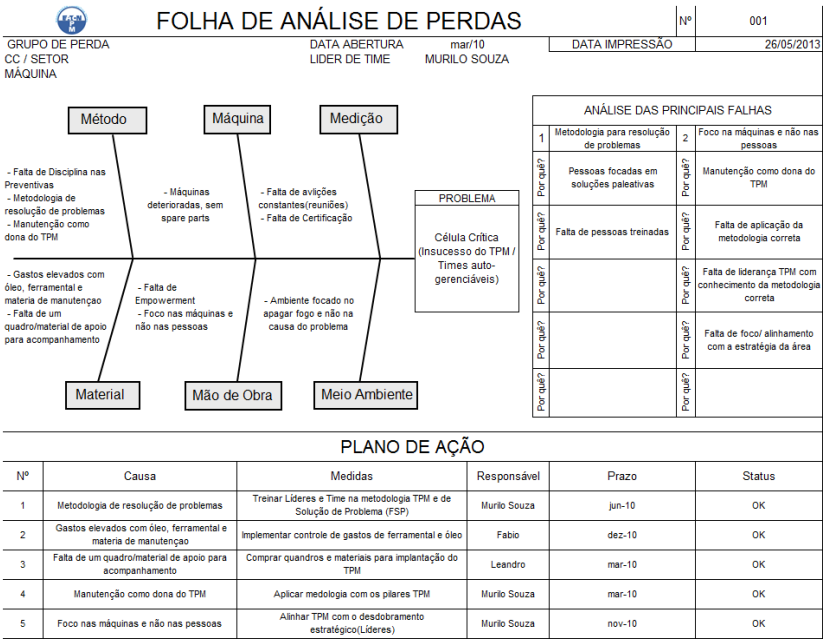

FOLHA DE ANÁLISE DE PERDAS

GRUPO DE PERDA		DATA ABERTURA	mar/10
CC / SETOR		LIDER DE TIME	MURILO SOUZA
MÁQUINA			

Nº	001
DATA IMPRESSÃO	26/05/2013

Método
- Falta de Disciplina nas Preventivas
- Metodologia de resolução de problemas
- Manutenção como dona do TPM

Máquina
- Máquinas deterioradas, sem spare parts

Medição
- Falta de avilções constantes(reuniões)
- Falta de Certificação

PROBLEMA
Célula Crítica (Insucesso do TPM / Times auto-gerenciáveis)

Material
- Gastos elevados com óleo, ferramental e materia de manutençao
- Falta de um quadro/material de apoio para acompanhamento

Mão de Obra
- Falta de Empowerment
- Foco nas máquinas e não nas pessoas

Meio Ambiente
- Ambiente focado no apagar fogo e não na causa do problema

ANÁLISE DAS PRINCIPAIS FALHAS

	1		2
	Metodologia para resolução de problemas		Foco na máquinas e não nas pessoas
Por quê?	Pessoas focadas em soluções paleativas	Por quê?	Manutenção como dona do TPM
Por quê?	Falta de pessoas treinadas	Por quê?	Falta de aplicação da metodologia correta
Por quê?		Por quê?	Falta de liderança TPM com conhecimento da metodologia correta
Por quê?		Por quê?	Falta de foco/ alinhamento com a estratégia da área
Por quê?		Por quê?	

PLANO DE AÇÃO

Nº	Causa	Medidas	Responsável	Prazo	Status
1	Metodologia de resolução de problemas	Treinar Líderes e Time na metodologia TPM e de Solução de Problema (FSP)	Murilo Souza	jun-10	OK
2	Gastos elevados com óleo, ferramental e materia de manutençao	Implementar controle de gastos de ferramental e óleo	Fabio	dez-10	OK
3	Falta de um quadro/material de apoio para acompanhamento	Comprar quandros e materiais para implantação do TPM	Leandro	mar-10	OK
4	Manutenção como dona do TPM	Aplicar medologia com os pilares TPM	Murilo Souza	mar-10	OK
5	Foco nas máquinas e não nas pessoas	Alinhar TPM com o desdobramento estratégico(Líderes)	Murilo Souza	nov-10	OK

Figure 7. Problem Solving Analyses

2.12 Third Level Audit and Results Validation

The Third Level Audit and Results Validation is the fifteenth step on the Semi-autonomous Team process.

On this step we realize a audit like on the previous levels, but with more questions to check the Third Level and if the operators were developed to lead the Problem solving analyses.

The focus from this step is to validate that the Team is read to move to next Level.

2.13 Semi-Autonomous Team Level

The Semi-Autonomous Team Level is the sixteenth step on the Semi-autonomous Team process.

After the team pass from the Third Level we need to define the schedule to the last level and define goals, actives and trainings to achieve the results more challenging.

The focus from this step is to define the schedule to execute the Last Level on Semi-Autonomous Team Process.

2.14 Costs and Process Control

The Costs and Process Control is the seventeenth step on the Semi-autonomous Team process.

On this step the team is trained and developed to control the costs from the oil, tooling, electrical energy, overtime and others costs.

The team receive the six sigma train(Yellow Belt) to control the process variation and implement the six sigma projects

The focus from this step is to become the operators responsible for the costs and able to solve the process variation.

2.15 Results

The Results is the eighteenth step on the Semi-autonomous Team process.

On this step we report the measured gains from the Semi-Autonomous Team process.

The focus from this step is to show for the leadership how important is this process and motivate the Team.

2.16 Lessons Learned

The Lessons Learned is the last step on the Semi-autonomous Team process.

After the team pass for all Steps, we need analyze where we were well and were bad and we need improve when we going to implement in another critical machine.

The focus from this step is to search the continuous improvement ever, cycle after cycle.

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3. CONCLUSIONS

The important fact to be noted in the application of this methodology TPM OEE in the SAT (Semi-Autonomous Team) system is the gain motivation of people, who had been worked in the Forge Shop. You can also highlight the results through leadership that motivated employees. The OEE measured at the end of this phase of deployment achieved a gain of approximately 30% effectiveness.

Finally, the best result is the lesson learned that can be replicated to other machines, other cells.

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5. RESPONSIBILITY NOTICE

The authors (Murilo Souza and Iris da Silva) are the only responsible for the printed material included in this paper.