PRODUCTIVITY IMPROVEMENT BY REDUCING THE TOOL CHANGE TIME USING SMED METHODOLOGY

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Abstract: *SMED (Single Minute Exchange of Die) is one of the many Lean production methods for reducing time in a manufacturing process. The present paper deals with reduction in tool change time in one of the prime automotive batteries industry using SMED technique which increases productivity of the industry. In this project first the problem is identified in SBD (Small Battery Division) Plant based on analysis of one month data of plant capacity. After analysis, the bottleneck is identified for production of the plant using Pareto Analysis which indicates that the maximum tool change time due to Calibration and Assembly. Next SMED Methodology implemented on major areas to reduce the tool change time. The causes for recursive activities searched and ideas implemented to eliminate them provided. After implementing SMED technique the total tool change time for Calibration from 2192 to 1194 seconds and Assembly from 42 to 24 minutes reduced.*

Key words: *SMED (Single Minute Exchange of Die), Lean Production, SBD (Small Battery Division), Pareto Analysis, Calibration and Assembly.*

1. INTRODUCTION

Nowadays market demand is increasingly time to time and there is no time to waste and shortage of man power throughout the world. Everything done fast and without neglecting the quality issue and delivers it to customer right on time. Reduction in time is direct way to increase the productivity and profit. Short changeover times have always been critical in manufacturing industries. So there is a need to reduce the time by using some New Lean Methodology. In global industry different techniques are used for reduction of time. Out of all these (as shown in Fig.1), SMED (Single Minute Exchange of Die) technique introduced by Mr. Shiego Shingo in 1950's Japan for reduction of time.

The phrase “single minute” does not mean that all changeovers and startups should take only one minute, but that they should take less than 10 minutes (in other words, “single digit minute”). SMED was developed by shigeo shingo in 1950's in Japan to the emerging needs of increasingly smaller production lot sizes required flexibility for customer demand. The need of SMED is mandatory due to increased demand for variable

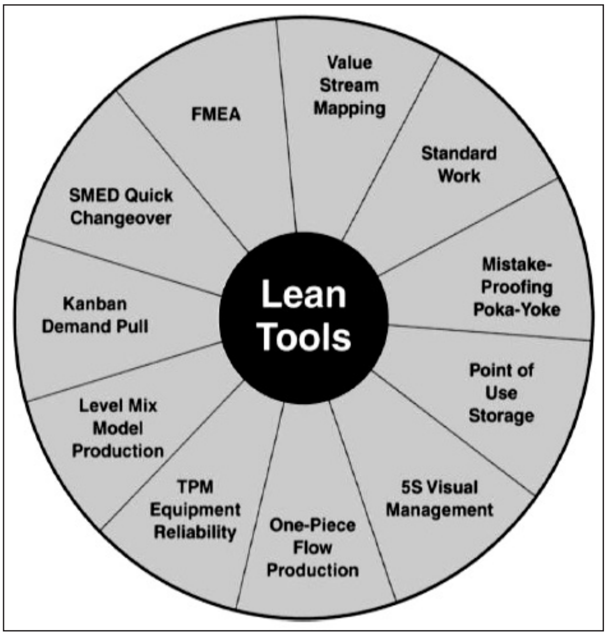

Fig 1. Lean Tools

products and reduced product life cycles. It helps the company to keep reduced inventory and effective utilization of the equipment. SMED analysis has to be started up with detailed process map and time study. It needs analyzing everything that happens during the changeover to understand the possibilities of activities that can be moved outside the changeover window. Non value added activities has to be eliminated or to be converted to external. If an internal activity is inevitable, it has to be simplified with the help of jigs, fixtures etc. Implementation of SMED starts from identifying the change over process and sorting it into internal and external activity.

1.1 Internal activity: Activities that are done after stopping the machine.

1.2 External activity: Operations that can be done without stopping the machine.

1.3 Setup Time: Setup time, or changeover time, is defined as the time from completion of the last good part of one lot to completion of the first good part in the next lot.

2. LITERATURE REVIEW

Mr. Rahul, R. Joshi and Prof. G. R. Naik (2012) [1] were implemented SMED in a small scale industry. After the SMED technique was applied to the bottle neck Operation, the total time taken to perform the operation was decreased by 20 percent from 480 sec to 385 sec. The Company Started producing the Number of Components increased from 168 to 176 per day and Number of Components per month increased from 4200 to 4400. The Cost reduction about 30% is achieved by application of SMED.

Antonio Carrizo Moreira, Gil Campos Silva Pais (2011) [2] were implementing the SMED methodology, it is impossible to defend that simple process – based innovations, as the separation of internal from external operations and the internal to external operations are among the key drivers to productivity improvement. The main purpose of the case study was to decrease the setup times of the three groups of machines in ALFA. The reduction of the setup times allowed to reduce the wastefulness in 362 960€, which represent about 2% of ALFA's sales Volume.

Vipan Kumar and Amit Bajaj (2015) [3] In this paper they have implemented the SMED technique with the 5'S implemented in three mechanical press machines (25 tones, 50 tones and 150 tones) and its workplace. They calculated the setup time of change the tool and die in the machine before and after implemented the SMED technique. After calculated the data we found that total setup time of three mechanical press machine before SMED implemented was 265 minutes and after SMED implemented was 196 minutes, then we have saved in setup time was 69 minutes.

S.Palanisamy and Salman Siddiqui (2013) [4] In this paper, new approach for setup time reduction with MES is proposed to overcome the drawbacks of the conventional SMED and to increase its efficiency. MES techniques are effective methodologies in selecting the best setup technology among the available alternatives as well as it takes into consideration after factors including: design modification planning, data collection, material movement and maintenance. After implementing the methodology the changeover time of crimping process was reduced by 69% which resulted in increase of production by 18.86%.

Arun Abraham, Ganapathi K.N and Kailash Motwani (2012) [5] The elimination waste in the entire operation improves productivity, reduces the cost which in turn delights customer and helps organizations in moving towards their vision and goals. After Implementing SMED the tool change time has been reduced from 7 hours to 2 hours in overall. 75% of tool change time reduction is achieved. The capacity had been increased from 60000 thousand clamps per day to 105000 clamps per day in three shifts.

3. EXPERIMENTATION & ANALYSIS

Experimentation and Analysis is done in different steps as shown in Fig.2 which are briefly described.

3.1 Problem Definition

The Fig.3 shows that present plant capacity of different section in SBD (Small Battery Division) plant. It found that every section of plant working well and producing required target (1156000 batteries per month) expect two section i.e. Formation (1125000 batteries per month) and Assembly (1141000 batteries per month). Formation and Assembly section are the bottleneck for the production of the plant and hence problem is defined.

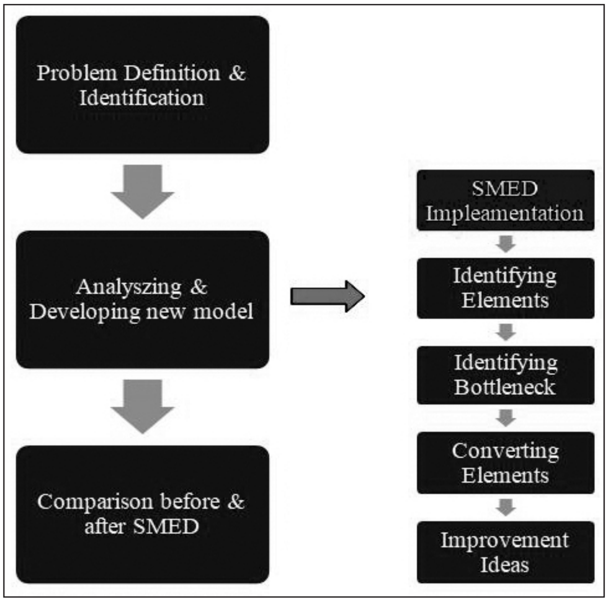

Fig 2. Flow Chart for Experimentation & Analysis

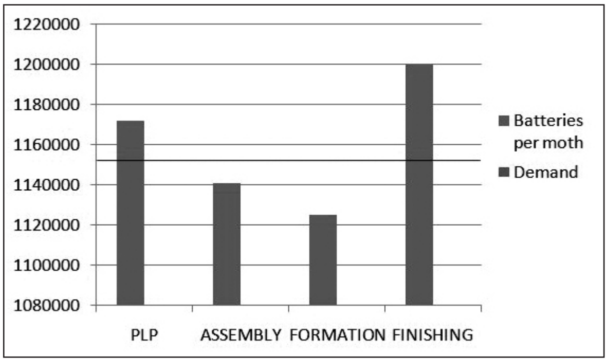

Fig 3. Plant Capacity

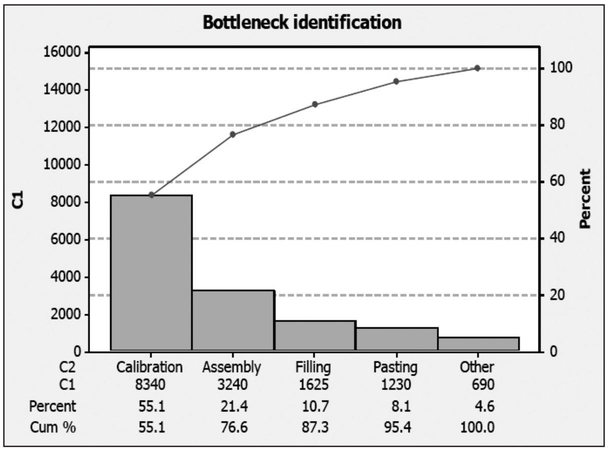

Fig 4. Pareto Analysis for Problem Identification

3.2 Problem Identification

One month Tool change data has been collected and analyzed using Pareto analysis. The Fig.4 shows that Calibration and Assembly processes taking more time for tool changing than other processes. It found that calibration and assembly are the bottleneck and hence the problem is identified. The less time in tool change will improve the productivity of the company.

Table 1: Identifying Internal and External Activities

Serial No.	Activity	Type of Activity	Time in Seconds (Before SMED)
1	House Keeping	Internal	900
2	Filling 1 Sample	Internal	98
3	Movement & weighing	Internal	300
4	Calculating & 2 sample Filling	Internal	98
5	Movement & Weighing	Internal	300
6	Calculating & 3 Sample Filling	Internal	98
7	Movement & Weighing	Internal	300
8	Calculating	Internal	98
Total Time for Calibration = 2192 seconds			

3.3 Analysis

CASE 1: CALIBRATION

3.3.1 SMED Implementation

1. Identifying Internal and External Activities

The Table 1 helps to find out the time taken for different activities and identifying the internal and external activities in calibration process. All the activities were doing under internal activity (activity done when the machine is stopped). In calibration process, housekeeping, movement and weighing takes maximum time than the other activities. The total time for calibration process is 2192 seconds.

2. Bottleneck Identification

The Pareto analysis chart is drawn from the Table 1 data. The Fig.5 helps to find out the maximum time taken for the activity than other activities and the causes for the recursive activity. Movement and weighing activity is the 80% of causes for the more tool change time. So the area under the curve needs to focus for reduction of tool change.

3. Converting Internal Activities to External Activities

In order to achieve the single digit setup time, needs to covert internal activities (activity when the machine is stopped) to external activities (activity when the machine is running), So that the machine uses more effectively. In this stage, Fig. 5 helps for the conversion of activities. In Table 2 the activity movement and weighing needs to convert from internal activity to external activity.

4. Improvement Ideas

One better suggestion for conversion is that all samples are collected at a time and production is started with parallel to weighing samples. Movement is eliminated and weighing and calculation activities are done after taking all samples which gives the better result. In the final Step the improvements studies done and checklists formed. The causes for recursive activities were searched as possible and ideas implemented to eliminate them were provided.

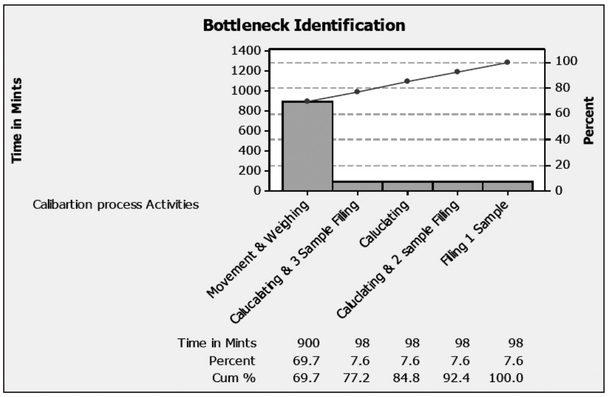

Fig 5. Pareto Analysis on Calibration Process

From Table 3, it is clear that more time is wasted for movement and weighing of the samples.

Table 2: Converting Internal to External Activity

Serial No.	Activity	Type of Activity	Time in Seconds (Before SMED)
1	House Keeping	Internal	900
2	Filling 1 Sample	Internal	98
3	Movement & weighing	External	300
4	Calculating & 2 sample Filling	Internal	98
5	Movement & Weighing	External	300
6	Calculating & 3 Sample Filling	Internal	98
7	Movement & Weighing	External	300
8	Calculating	External	98

Table 3: Before and After SMED

Serial No.	Activity	Time in Seconds (Before SMED)	Improvement Idea	Time in Seconds (After SMED)
1	House Keeping	900	No Change	900
2	Filling 1 Sample	98	No Change	98
3	Movement & weighing	300	Eliminated	0
4	Calculating & 2 sample Filling	98	No change in filing and calculation eliminated	98
5	Movement & Weighing	300	Eliminated	0
6	Calculating & 3 Sample Filling	98	No Change in filing and calculation eliminated	98
7	Movement & Weighing	300	Eliminated	0
8	Calculating	98	Eliminated	0
Total		2192		1194

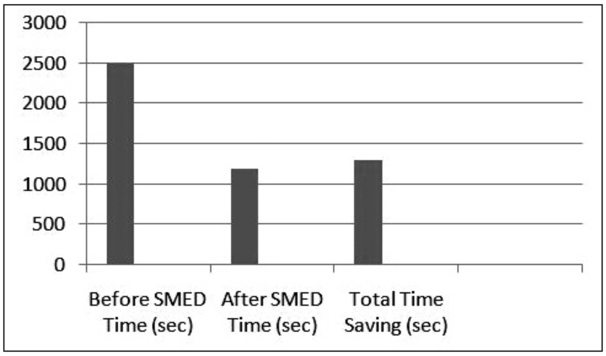

Fig 6. Comparisons Before and After SMED

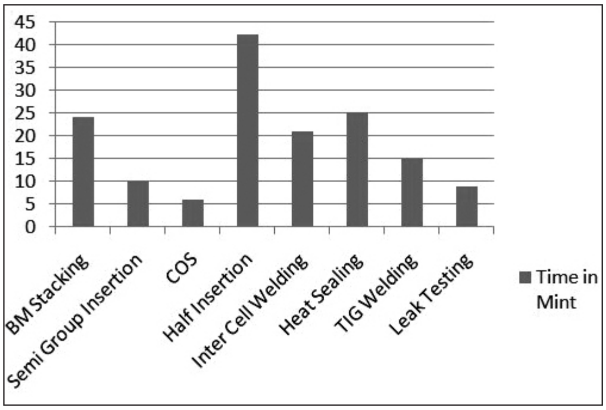

Fig 7. Analysis on Tool Change Time in Assembly Process

5. Comparison before and after SMED

Fig.6 shows that the comparison between before and after SMED time taken for the calibration process drawn from Table 3 data. Before SMED tool change time for calibration process is 2192 seconds and after SMED is 1194 seconds. The total time saving after SMED is 998 seconds.

CASE 2: ASSEMBLY

3.3.2 Bottleneck Identification in Assembly Process

The Fig.7 graph shows the analysis on tool change time taken in Assembly. Fig.7 helps to find out the maximum time taken for operation in Assembly. The maximum time consuming while tool change was the Half Insertion is 42 minutes.

3.3.3 SMED Implementation on Half Insertion

1. Identifying Internal and External Activities

The Table 4 helps to find out the time taken for different activities and identifying the internal and external activities in Half Insertion process. All the activities were doing under internal activity (activity done when the machine is stopped). In Half Insertion process, Fork Insertion and Base plate replacement takes maximum time than the other activities. The total time for Half Insertion process is 42 minutes.

Table 4: Identifying Internal and External Activities

Serial No.	Activity	Type of Activity	Time in Minutes (Before SMED)
1	Removing Jig	Internal	3
2	Removing Base Plate	Internal	7
3	Machine Cleaning	Internal	3
4	Removing Bottom Cylinder Rods	Internal	3
5	Fixing New Jig	Internal	6
6	Removing Guide	Internal	5
7	Removing Fork	Internal	4
8	Removing Block	Internal	3
9	Inserting new Fork	Internal	6
10	Inspection	Internal	1
11	Trail	Internal	1
Total Time for Tool Changing = 42 Mints			

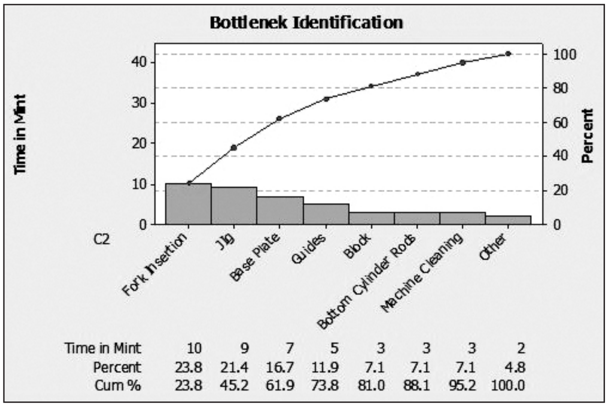

Fig 8. Pareto Analysis on Half Insertion Process

2. Bottleneck Identification in Half Insertion

The Fig.8 Pareto analysis chart drawn from the Table 4 data. The Fig.8 helps to find out the maximum time taken for the activity than other activities and the causes for the recursive activity. Fork Insertion and Base plate replacement activity is the 80% of causes for the more tool change time. So the area under the curve needs to focus for reduction of tool change.

3. Converting Internal Activities to External Activities:-

In order to achieve the single digit setup time, needs to covert internal activities (activity when the machine is stopped) to external activities (activity when the machine is running), So that the machine uses more effectively. In this stage, Fig.8 helps for the conversion of activities.

In table 5 the Fork Insertion and Base placement needs to convert from internal activity to external activity.

4. Improvement Ideas:

Finally the improvements studies done and checklists formed. The causes for recursive activities were searched as possible and ideas implemented to eliminate them were provided.

From Table 6 it is clear that more time is wasted for Fork Insertion operation. One better suggestion for conversion is the Fork jaws are fixed permanently by using permanent fasters. One extra jaw was added at the middle as shown in Fig.10 due to this no need of fork replacement and also which helps for solving the problem of group rejection or damage due to this change 1.2% of group damage or rejections eliminated. One more change was made which eliminates the removing bottom

Table 5: Converting Internal to External Activity

Serial No.	Activity	Type of Activity	Time in Minutes (Before SMED)
1	Removing Jig	Internal	3
2	Removing Base Plate	External	7
3	Machine Cleaning	External	3
4	Removing Bottom Cylinder Rods	External	3
5	Fixing New Jig	Internal	6
6	Removing Guide	Internal	5
7	Removing Fork	External	4
8	Removing Block	Internal	3
9	Inserting new Fork	Internal	6
10	Inspection	Internal	1
11	Trail	Internal	1

Table 6: Before and after SMED

Serial No.	Activity	Time in Seconds (Before SMED)	Improvement Idea	Time in Seconds (After SMED)
1	Removing Jig	3	No Change	3
2	Removing Base Plate	7	Eliminated	0
3	Machine Cleaning	3	Eliminated	0
4	Removing Bottom Cylinder Rods	3	Using Insert	0
5	Fixing New Jig	6	No Change	6
6	Removing Guide	5	No Change	5
7	Insert Fixing at Bottom Cylinder	0	Added	1
8	Removing Fork	4	Using Permanent Fasters	0
9	Remove Block	3	No Change	3
10	Inserting new Fork	6	No Change	4
11	Inspection	1	No Change	1
12	Trail	1	No Change	1
Total		42		24

Fig 9. Before SMED

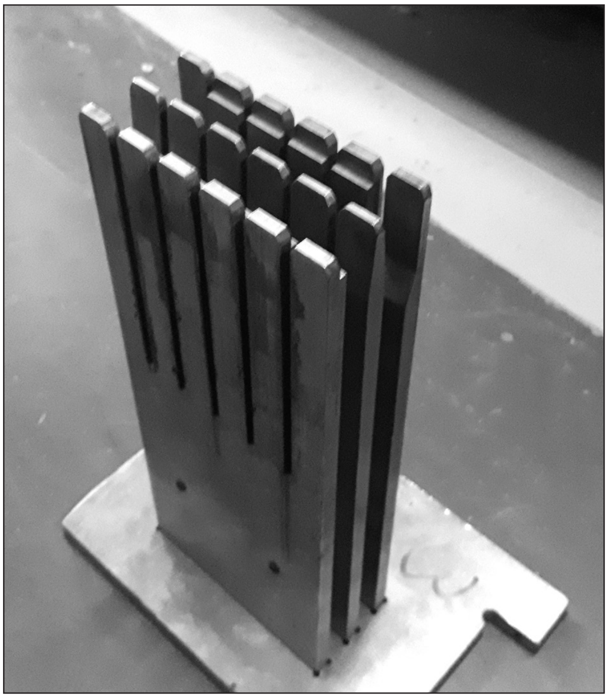

Fig 10. After SMED

cylinder rods activity by arranging an insert at top of cylinder. Due to this change there is no need of replacement of bottom cylinder rods and also both removing base plate and machine cleaning activities were eliminated. Fig.9 and Fig.10 shows that the comparison before and after SMED tool design.

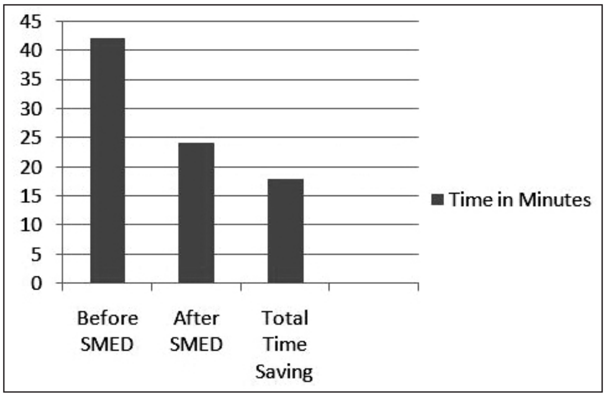

Fig 11. Comparison Before and After SMED

5. Comparison Before and After SMED

Fig.11 shows that the comparison between before and after SMED time taken for the Half Insertion process drawn from table 6 data. Before SMED tool change time for calibration process is 42 minutes and after SMED is 24 minutes. The total time saving after SMED is 18 minutes.

4. CONCLUSIONS

The implemented SMED technique has given the good result for the reduction of tool change time. This study has proved that reduce tool change time with eliminating no value adding at time of changeover. We calculated the tool change time before and after implemented the SMED technique. We concluded that SMED technique has been helpful for tool change time reduction and it directly increases the productivity of industry.

The following conclusions are drawn:

- After SMED implementation on calibration, the total time taken to perform the operation was decreased by 45 percent from 2192 sec to 1194 sec and the total time saved after SMED is 998. .
- As a result of this project, the production capacity has been increased by 4 percent in Formation Section.
- After SMED implementation on Half Insertion, the total time taken to perform the operation was decreased by 43 percent from 42 minutes to 24 minutes and the total time saved after SMED is 18 minutes.
- As a result of this project, the production capacity has been increased by 1.6 percent in Assembly Section.

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REFERENCES

1. Joshi, Rahul, R; Naik, G.R: Application of SMED Methodology- A Case Study in Small Scale Industry, 'International Journal of Scientific and Research Publications', vol. 2, no. 8, August 2012.
2. Monreria, Antonio Carrizo; Rais, Gil Campos Silva: Single Minute Exchange of Die - A Case Study Implementation, 'Journal of Technology Management & Innovation', vol. 6, no. 1, 2011.
3. Vipan Kumar; Amit Bajaj: The Implementation of SMED with 5S in machining processes for reduction of setup time, 'International Journal on Recent Technologies in Mechanical and Electrical Engineering', vol. 2, no. 2, February 2015.
4. Palanisamy, S; Siddiqui, Salman: Changeover time Reduction and productivity Improvement by Integrating conventional SMED Method with Implementation of MES for Better Production Planning and Control, vol. 2, no. 12, December 2013.
5. Arun Abraham; Ganapathi KN; Motwani, Kailash: Setup Time Reduction through SMED Technique in a Stamping production Line, 'Stastical Analysis Systems Journal', vol. 11, no. 2, September 2012 ◘

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