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A Case Study of Implementation of Overall Equipment Effectiveness on CNC Table type boring & milling machine of a Heavy Machinery Manufacturing Industry

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Abstract: *This Case Study Examines the Overall Equipment Effectiveness (OEE) of CNC Table Type Boring and Milling Machine. I.e. (Juaristi) of a Heavy machinery manufacturing Industry. This OEE Tool is a route map to boost the effectiveness of manufacturing process and Equipment. (I.e. loading time, job setting, machining, machine utilization etc) Present situation and all time raises question for any company is how they can optimise the performance of their existing machines and equipment. The answer is OEE which extracts all the reason for delay of the job. OEE not just only measures Inefficiency but also categorises those into 3 categories for better understanding of manufacturing procedure. In this case study we carried out OEE on CNC Table type boring & milling machine to find out the bottleneck and hidden losses. After carrying out OEE we see that productivity is improved up to a significant percentage.*

Keywords: *OEE, Juaristi, Availability, Downtime, Productivity.*

I. Introduction

In this Journal case study is carried out on CNC Table Type Boring & Milling machine (i.e. Juaristi) of a Heavy Machinery Manufacturing Industry. In today's Era Company survival depends on their timely production with effective machinery Equipment and quality product. Companies have undergone significant changes day by day so it is necessary to conduct continues study of the existing machinery system. So that company can identify that their system is working on full captive load or not. To answer this OEE tool is used.
OEE is a productivity improvement tool developed by **Seiichi Nkajima** in the 1960's to identify how effectively machines are being utilised. OEE is a performance indicator and their result is categorised into three different parameters i.e. Availability, Performance and Quality.

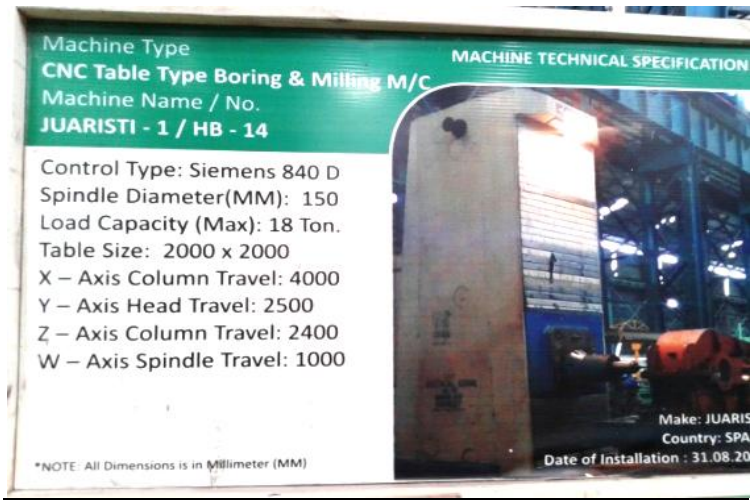
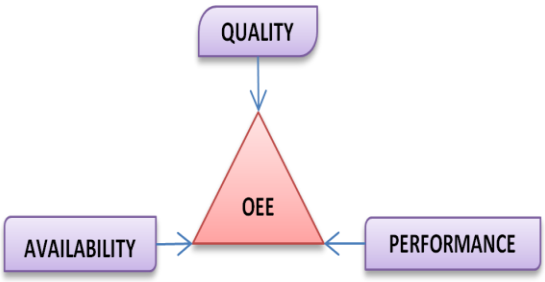


Fig- (1.1) CNC table type boring & milling machine specification

OEE is a tool for benchmarking with world class OEE and then optimizing the efficiency of machine. OEE conveys how well our manufacturing facilities are performed relative to its full load capacity during the planned production time.



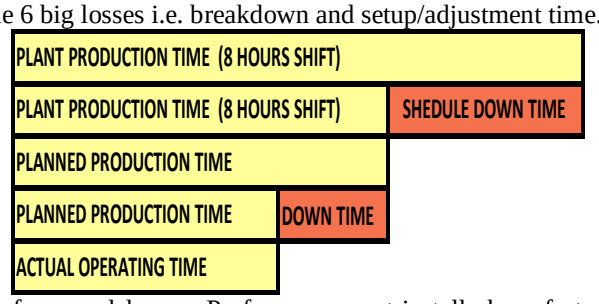
1.1- Classification of OEE factors:
OEE is classified into three metrics:-

- Availability
- Performance
- Quality

Availability: -This metric describes how actually the machine is available for production. Availability accounts with down time losses. Down time are those events which can be stop planned production for a particular time. For e.g.:- machine is stop due to overheating, tool not available, voltage trip suddenly, coolant supply stopped due to technical fault , job change over time.

$$Availability = \frac{Actual\ operating\ time}{Planned\ production\ time}$$

It accounts the first two of the 6 big losses i.e. breakdown and setup/adjustment time.



Performance: - It accounts for speed losses. Performance metric tells how fast and effectively the operator carries out the job as soon as possible within the budget hours. It identifies and focuses on those factors which cause delay in production and speed reductions some of the causes are (Improper casting, miss fed, operator Inefficiency, and machine vibrations.)

$$Performance = \frac{Budgeted\ allotted\ time}{Actual\ completion\ time}$$

Quality: - Quality metric accounts for quality losses i.e. good product among all fabricated product. In this case study we consider rework time as one of a parameter for quality. After completion of job due to machine and operator Inefficiency rework is carried out for dimensional accuracy of the job. This quality metric shows how well the operator carried out the process for producing a job. This metric shows quality of machine as well as operator skill to run the machine effectively. Quality losses are due to scrap, rework, incorrect, dimension, incorrect sequence of operation, in process damage.

$$Quality = \frac{Actual\ time\ to\ turn\ out\ job}{Actual\ time + Rework\ time}$$

Over all Equipment Effectiveness (OEE):-
OEE is the product of these three metrics i.e. Availability, Performance, Quality.

$$OEE = Availability \times Performance \times Quality$$

1.2- Six Big losses:

Losses are those activities which consume input and resources without giving any valuable output in terms of monetary value. So for that Seiichi Nakajima categorises these losses in six frameworks.
Losses which are identified in this case study are shown below.

S.No	Big Losses	Reasons for losses	Category
1-	Breakdown	- Machine failure - Tool breakage - Machine program hang - Electric power trip - Unplanned maintenance - General breakdown - Heavy vibration occurs due to uneven casting - Tool unavailability	Downtime losses
2-	Set-up and adjustment	- Operator unavailability - Crane unavailability - Fixture are not up to mark - Helper inefficient	Downtime losses
3-	Small stops	- Obstructed product flow - Drill jams - Component jam - Coolant stop - Misfed - Housekeeping of machine - Frequent dimension check due to lack of confidence and documentation.	Speed losses
4-	Reduced speed	- Low grade of tool used - Low maintenance of equipment - Operator procrastinates job - Level of machine operator training	Speed losses
5-	Production start-up reject	- Casted/fabricated job damage during setup	Quality
6-	Production reject	- In process damage - Scrap - Rework - In correct dimension due to wrong program	Quality

Table: 1.2.1- Losses identified during case study

II. Methodology

This case study is carried out at Heavy Machinery Manufacturing Industry situated near Raipur, Chhattisgarh. Methodology which is adopted for the study is direct observation of machines. Here both primary as well as secondary data is being gathered for the case analysis.

After several visits and direct observation of machines and analysing previous machine utilisation record problem is identified that machine is not working up to its full load production capacity. So management wants to implement productivity improvement tool. So for this brief literature study is carried out and finally OEE tool is selected to carry out the study. Previous machine utilisation records and dispatch hour records are used as secondary data while for primary data direct observation of "Bottom Balancer frame" which is a sub part of EOT (Electrical Over travel crane) is selected. This sub part is machined on CNC Table type Boring and milling machine. The budgeted hour given by planning department is 30 hours for completion of job and this data is being carefully analysed according to the literature. And finally the result is obtained in terms of OEE percentage.

Fig- Bottom Balancer frame

This case study is carried out step by step these steps are shown below in flow diagram.

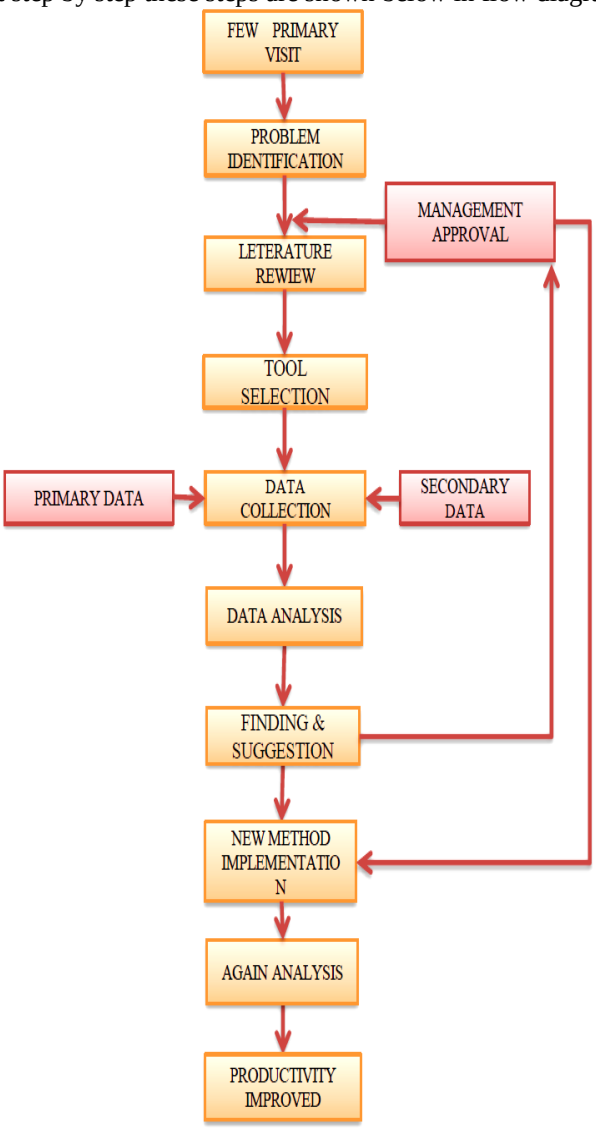


Fig: 2.1- Process flow diagram

III. Analysis And Result

Data is being collected manually by continuous observation from 5-10-2015 morning 6am to 6-10-2015 night. i.e. (40 hours, 5-Shift) data is being gathered in excel format after this collected data is being analysed. According to OEE tool method a calculation excel sheet is prepared after finding present OEE situation of machine. Bottlenecks are identified and recommended suggestions are implemented. And then again data being gather in same manner and analysis is carried out and we find that over all Equipment Effectiveness (OEE) of CNC Table type boring and milling machine is increased upto a certain level of percentage.

1.3- Excel format for data collection:

OVERALL EQUIPMENT EFFECTIVENESS (OEE)										
MACHINE :- JUARISTI			**JOB MATERIAL :-** Mild steel (E-350) Grade			**NO OF SHIFT :-** 5 Shifts				
DRG. NO:- 11001.89.20.220			**JOB TITLE :-** Bottom Balancer Frame			**OBSERBER NAME:-** VIJAY LAHRI				
TOTAL BUDGETTED HRS:- 30			**TOOL INSERT MATERIAL :-** Carbide Insert used			**Project No-** Cp3/140185-001				
S.No	**Shift**	**Job setting**	**Date & Shift duration**	**Operation details**	**Down time**	**Down time reason**	**Budget Hrs**	**Actual Hrs**	**Remark**	
1-	A & B	First	5/10/15 (6am-10pm) 16 hrs shift	Job load at 8:00 am Job setting time-8:00am to 9:20 am Program making and tool preparation 20 min Bore of 140 dia 4-NOS Rough cut, Bore of 160 dia Rough	120 min 15 min 45 min	120 min No load 15 min more due to crowd in canteen Tool insert unavailable	30	39	Issue of tool insert from store is a time consuming process which increase down time	
	C	First	5/10/15 (10pm-6am) 8 hrs	Bore of 160 mm dia complete Bore of 140 mm dia finish cut complete 4-NOS Bore facing 6-NOS complete	30 min	Insert not available			Store Department takes much time to issue new inserts.	
2-	A	First	6/10/15 (6am-2pm) 8 hrs	Groove 146*15 width 3 NOS both side Groove 164*10 width 2 Nos both side Drill 17.5*16 , Tap M20*30 deep completed	60 min	Operator not available			working on other machine	
	B	Second	6/10/15 (2pm-6pm) 8 hrs	Job unload than rotate setting adjustment Drill 26 mm dia complete Bore 45^+.02 finish complete Job completed and rework is carried out.	15 min	More time in tea break			Here 1 Hrs more for Rework due to some unfinished drill and bore end surfaces.	

1.4- Present OEE Calculation:

OVERALL EQUIPMENT EFFECTIVENESS WORKSHEET							
Job Title : Bottom balancer frame **Machine :** CNC Table type Boring and Milling machine **Date :** 5-10-2015 to 6-10-2015						**OEE**	
OEE DATA							
Number of shifts:	**5**						
Shift Duration :	**8 Hrs shift (6am-2pm , 2pm-10pm , 10pm-6am)**						
Shift length :	480		**Minute per Shift**				
Short Breaks:	4	Breaks@	**15**	**MIN EACH**	60	**Minute**	
Meal Break :	0	Breaks@	**60**	**MIN EACH**	0	**Minute**	
Down Time:	285	**Minute**		**Sheduled maintenace:**	0	**Minute**	
Change Over Time :	120	**Minute**		**House keeping of m/c**	60	**Minute**	
Rework Time duration:	60	**Minute**		**Total time**	120	**Minute**	
Planned Production Time:	2280	**Minute**					
Operating time :	2400	**Minute**					
Actual completion time :	2340	**Minute**					
Budgeted time for job :	1800	**Minute**					
Actual operating time:	1875	**Minute**					

OEE CALCULATIONS			
OEE FACTORS	**CALCULATION**	**OEE**	**OEE %**
Availabilty:	Actual Operating time/planned production time	0.8224	82.23%
Performance:	Budget time/ actual completion time of job	0.7692	76.92%
Quality:	Actual Min/(Rework Min + Actual Min)	0.975	97.50%
Overall OEE:	Availability × Performance × Quality	0.6168	62%

WORLD CLASS OEE		
OEE Factors:	**World class OEE**	**My OEE**
Availabilty:	90%	82.23%
Performance:	95%	76.92%
quality:	99.90%	97.50%
Overall OEE:	85%	62%
FORMULA		
Actual operating time = Planned production time- Total down time		
Planned production time = Plant operating time - Planned down time		
Plant operating time = Shift length × No of shift		
Total Down Time = Down time + Change over time		

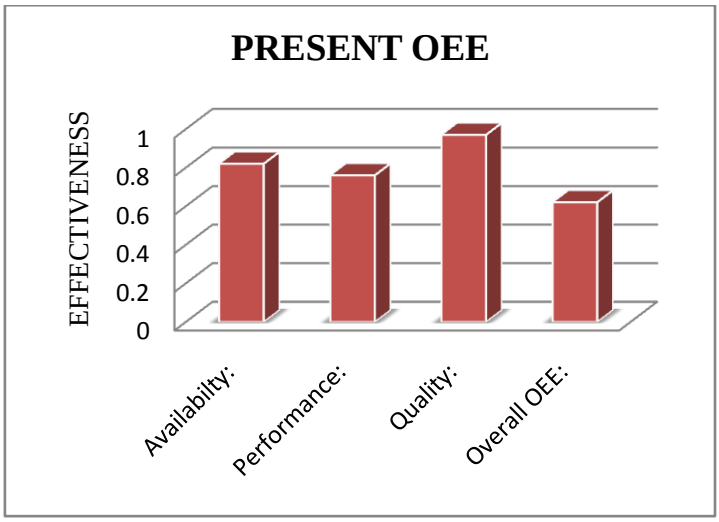


Fig: 3.2.1- Present OEE of CNC Machine

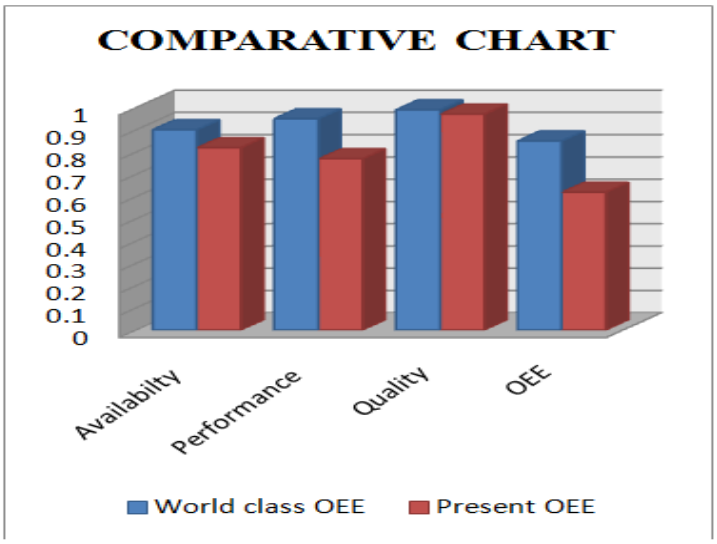


Fig: 3.2.2- World class OEE and Present OEE

1.5- Finding and Suggestions:

After the analysis of present situation we found that CNC Table type Boring and milling machine is working much below the world class OEE i.e. 65% OEE compare to 85% world class OEE so there is a scope of improvement.

After carefully analysis and discussion with shop floor Incharge and management we find some feasible suggestions for improvement of OEE. These suggestions are based on the visual recorded data in excel sheet.

These suggestions are as follows:-

1- During observation we found that housekeeping of machine is carried out during machining hours which accounts for 60 minute delay. So if housekeeping of machine is carried out during lunch time and in break time then delay can be reduced to 50 minute compare to previous 60 minute delay.
2- During observation we found that time taken to distribute snacks takes 30 minute. And time allotted for short break is 15 minute only. So every day 15 minute extra time is taken by operator which causes job delay this can be reduced by increasing canteen staff during short breaks.
3- During observation Tool and Tool insert unavailability is a huge problem it usually takes huge time to find the tools from

Other machines so during this period machine is ideal. We can reduce this delay if company deployed experience manpower in Tool crib room so he will ensure the availability of Tool and Tool insert for all machines. This will largely reduce the unplanned down time. Approximately 60 minute for this machine during the machining of bottom balancer frame.

4- Planning department must ensure the provision of operation process sheet (OPS) so the operator will easily understand the sequence of operation. And drawing should be provided before the job load. So operator can study and make program for that particular job in their ideal time. This step reduces 60 minute delay for the bottom balancer frame during the study of Juaristi CNC machine i.e. CNC table type boring & milling machine.

5- During observation we found that at the time of loading and job setting proper arrangement of clams and fixture is not their prior to the job loading. And helper is not enough trained. This increased the job setting and loading time so there must be prior arrangement of fixture clams and other necessary items prior to the job loading.

1.6- Improved OEE Calculation sheet:

OVERALL EQUIPMENT EFFECTIVENESS WORKSHEET							
Job Title :	Bottom balancer frame					**OEE**	
Machine :	CNC Table type Boring and Milling machine						
Date :	7-10-2015 to 8-10-2015						
OEE DATA							
Number of shifts:	5						
Shift Duration :	8 Hrs shift (6am-2pm , 2pm-10pm , 10pm-6am)						
Shift length :	480		MINUTE PER SHIFT				
Short Breaks:	4	Breaks@	15	MIN EACH	60	Minute	
Meal Break :	0	Breaks@	60	MIN EACH	0	Minute	
Down Time:	205	Minute		Sheduled maintenace:-	0	Minute	
Change Over Time :	65	Minute		House keeping of m/c	10	Minute	
Rework Time duration:	30	Minute		Total time	70	Minute	
Planned Production Time:	2330	Minute					
Operating time :	2400	Minute					
Actual completion time :	2100	Minute					
Budgeted time for job :	1800	Minute					
Actual operating time:	2060	Minute					
OEE CALCULATIONS							
OEE FACTORS	**CALCULATION**				**OEE**	**OEE %**	
Availabilty:	Actual Operating time/planned production time				0.8841	88.41%	
Performance:	Budget time/ actual completion time of job				0.8571	85.71%	
Quality:	Actual Min/(Rework Min + Actual Min)				0.9859	98.59%	
Overall OEE:	Availability × Performance × Quality				0.7471	75%	

1.7- Result:

After implementation of suggestions it is found that Overall Equipment Effectiveness of CNC Table type boring & milling machine i.e. Juaristi is increased from 62% to 75%. But still it is below the world class OEE it means there is further scope of improvement of machine utilization. Here following comparative graph are shown below between present, Improved and world class OEE.

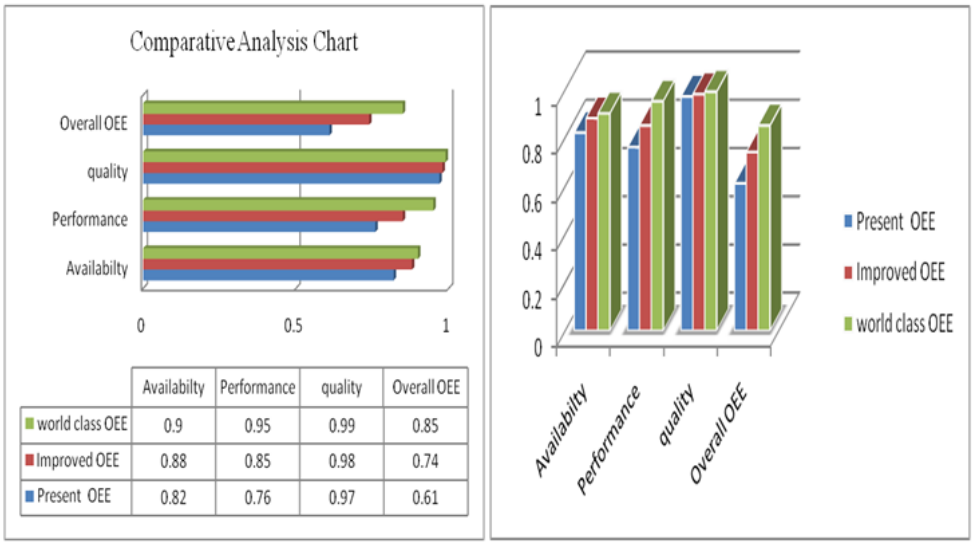


Fig: 3.5.1- Comparative chart for present, improved and world class OEE

	PRESENT	IMPROVED	WORLD CLASS
Availability	0.82	0.88	0.90
Performance	0.76	0.85	0.95
Quality	0.97	0.98	0.99
OEE	0.62	0.75	0.85

IV. Conclusion

At last I conclude that Juaristi i.e. CNC Table type boring and milling machine was continuously running before the case study but company production schedule delayed for every time. So after implementation of Overall Equipment Effectiveness (OEE) cycle time for machining of Bottom Balancer frame decreased from 39 hours to 35 hours. Saving of 4 hours it means by using OEE performance and productivity is improved up to a certain level. As we know that measurement of performance is important, because it identifies current performance gaps between current and desired performance and provides indication of progress towards closing the gap. So by using OEE we can reduce this gap up to a certain level.

Acknowledgement

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References

[1]. http://www.juaristi.com/en/menu,company-video/menu,history/
[2]. Taylor fits- Gibbon, C (1990) "Performance indicator ", BERA Dialogues (2), ISBN 978-1-85359-092-4
[3]. Overall Equipment Effectiveness: A powerful Production/Maintenance Tool for increased productivity/profits. TS192.H3632001, Page 25-42, 1-17.
[4]. Prokopenko, J, (1987), Productivity management, A practical Handbook, International Labour Office, ISBN: 92-2-105901-4.
[5]. Wauters, F –Mathot, J OEE White Paper (online) Zurych (Switzerland): ABB ltd, June 2002 (cit,2005-12-16) PDF Format available at : <URL: http://library.abb.com//overallequipment effectivenesspdf>
[6]. Anonymous, the complete guide to simple OEE, Website: http://www.exor-rd.com,
[7]. Anonymous, OEE Pocket Guide, Website: http://www.vorne.com.
[8]. Hemant Singh Rajput, Pratesh Jaswal, A total productive maintenance approach to improve overall equipment effectiveness, International journals of modern engineering research, Vol 2 Issue 6 pp 4383-4386.
[9]. Krawjeski, L.J. and Ritz man, L.P. (2002), "Operations Management: Strategy and Analysis", 6th ed., Prentice-Hall, Upper Saddle River, NJ.
[10]. Robert C. Hansen, 2001, Overall Equipment Effectiveness: A powerful Production/Maintenance tool for increased profit, first edition, Industries press, Inc.

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