Optimization of Overall Efficiency in Manufacturing Industry by Minimizing Production Cost and Manpower

Sanjay Patnaik[a], Mahendra Kumar Rath[b*], Rashmi Ranjan Panda[c]

[a]Post graduate scholar, Centurion University of Technology & Management, Bhubaneswar, Odisha, India

[b]Associate Professor, Dept. of Mechanical Engineering, Centurion University of Technology & Management, Bhubaneswar, Odisha, India,

[c]Assistant Professor, Dept. of Mechanical Engineering, Centurion University of Technology & Management, Bhubaneswar, Odisha, India.

ABSTRACT

Over last few decades, the Manufacturing sector has made tremendous growth in India. This has helped India growing economically along with huge employment generation. As per the available data, manufacturing sector itself contributes about 16% of GDP of India currently and Govt. of India has a vision to make it to 25% by 2022. The initiatives like Make in India, Invest in India etc. have created a positive environment for more investment in India leading to further scope of growth in manufacturing sector. Even though manufacturing industry has a great share in the development of India, there are a lot of challenges faced by this sector. In the current competitive scenario, growth has been the key factor to sustain for any sector. Growth is highly important to win the confidence of the stakeholders and investors. Compromising on the quality would be probably the worst idea to sustain in the market. So organizations have started looking within and making best efforts to have an optimized process. When Optimization comes into picture, Cost, Productivity and Manpower optimization are the primary concerns to be dealt with. Having realized the importance of optimization, an effort has been made to improve the following parameters for an industry

- Tool Cost Reduction
- Productivity Improvement
- Manpower Optimization

Keywords: Optimization, efficiency, manpower, productivity

***Corresponding Author:** Mahendra Kumar Rath, Associate Professor, Dept. of Mechanical Engineering, Centurion University of Technology & Management, Bhubaneswar,Odisha,India, Email: mkrath@cutm.ac.in

1. INTRODUCTION

S.K. Precision llp, incorporated with MCA (Ministry of Corporate Affairs) on 15th Sept. 2014. It is registered at Registrar of Companies (ROC), Pune. It has a state of the art technology manufacturing center situated at Bhosari MIDC in Pune. The organization produces automotive components, mostly Sensor holders, Sensor boss, Tube connectors and some special nuts. Its major customers include Mahindra CIE, Subros and Denso etc. The manufacturing unit has 10 Turning Centers of Doosan make & Puma GT model. It has also 2 VMC's of Doosan make & DNM 4500 model. Turning centers are having Turrets of 12 Tools and they can run with a maximum speed of 3500 rpm (Rotations per Minute). VMC's are having Magazines of 40 tools and they can run up to max of 12000 rpm.

2. CONCEPT OF INDUSTRIAL OPTIMISATION

Machining has always been regarded as a very important, critical and crucial topic in the Engineering industry. It includes all the traditional and nontraditional machining processes performed on all materials-metals and advanced alloys, polymers, ceramics, composites, and biomaterials.

Machining, in itself is a vast topic, which includes: Machining performance of all materials, including lightweight materials, precision and micro/nano machining, measurement and analysis of machined surfaces, sustainable machining: dry, near-dry, or Minimum Quantity Lubrication (MQL) and cryogenic machining processes, coated and special cutting tools: design and machining performance evaluation, cutting fluids and special coolants/lubricants.

M. Vivek Prabhu et al. (2014) [2] used Genetic Algorithm to achieve the best utilization of the plant resource for optimization of overall equipment effectiveness. They also demanded that to maintain the performance rate above 95% will result in effective utilization of the considered manufacturing system. S.O.Ismaila et al. (2009) [3] used simple queue model and regression analysis to determine optimal number of workers in a manufacturing company to minimize the cost and found 6 additional workers on the production line to achieve a production of 22,750 units per annum. Wan Hasrulnizzam Wan Mahmood et al. highlights that the use of simulation is an effective tool to calculate performance in production line (2011) [4]. They also demanded that productivity improvement in current performance can be achieved by re allocating the number of operators and machines effectively instead of a combination.

In this project, an effort has been taken to improve the overall performance of a manufacturing industry, where machining is the major operation performed to produce the desired output from the raw material. For accomplishing this, major focus has been given over following parameters:

- Tool cost Reduction
- Productivity Improvement
- Manpower Optimization

3. METHODOLOGY

3.1. TOOL COST REDUCTION

Before going through this project, it will be great to present a description about the Insert details.

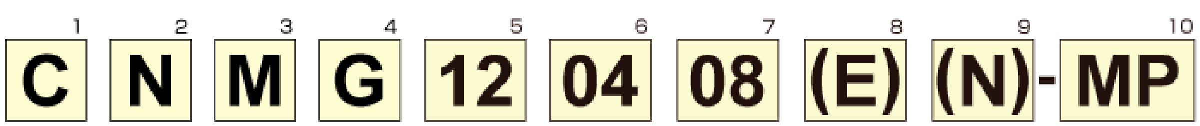

Fig. 1: Insert Identification

1. Insert Shape

Symbol	Insert Shape
H	Hexagonal
O	Octagonal
P	Pentagonal
S	Square
T	Triangular
C	Rhombic 80°
D	Rhombic 55°
E	Rhombic 75°
F	Rhombic 50°
M	Rhombic 86°
V	Rhombic 35°
W	Trigon
L	Rectangular
A	Parallelogram 85°
B	Parallelogram 82°
K	Parallelogram 55°
R	Round
X	Special Design

Fig. 2: Insert Shape

2. Relief Angle

Symbol	Normal Clearance
A	3°
B	5°
C	7°
D	15°
E	20°
F	25°
G	30°
N	0°
P	11°
O	Other Relief Angle
	Major Relief Angle

Fig. 3: Relief Angle

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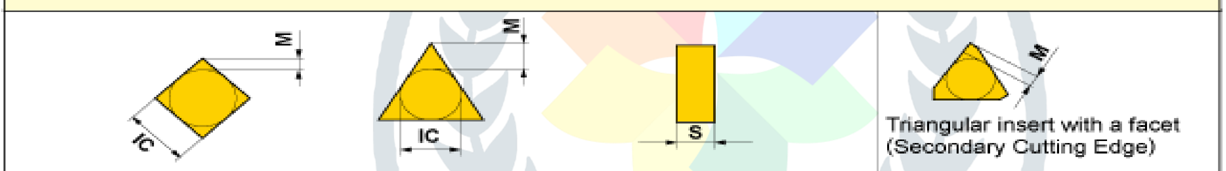
3. Tolerance Class



3. Tolerance Class

Symbol	Tolerance of Nose Height M (mm)	Tolerance of Inscribed Circle IC (mm)	Tolerance of Thickness S (mm)
A	±0.005	±0.025	±0.025
F	±0.005	±0.013	±0.025
C	±0.013	±0.025	±0.025
H	±0.013	±0.013	±0.025
E	±0.025	±0.025	±0.025
G	±0.025	±0.025	±0.13
J	±0.005	±0.05−±0.15	±0.025
K*	±0.013	±0.05−±0.15	±0.025
L*	±0.025	±0.05−±0.15	±0.025
M*	±0.08−±0.18	±0.05−±0.15	±0.13
N*	±0.08−±0.18	±0.05−±0.15	±0.025
U*	±0.13−±0.38	±0.08−±0.25	±0.13

The surface of insert with ★ mark is sintered.

Detail of M Class Insert Tolerance

●Tolerance of Nose Height M (mm)

D.I.C.	Triangular	Square	Rhombic 80°	Rhombic 55°	Rhombic 35°	Round
6.35	±0.08	±0.08	±0.08	±0.11	±0.16	—
9.525	±0.08	±0.08	±0.08	±0.11	±0.16	—
12.70	±0.13	±0.13	±0.13	±0.15	—	—
15.875	±0.15	±0.15	±0.15	±0.18	—	—
19.05	±0.15	±0.15	±0.15	±0.18	—	—
25.40	—	±0.18	—	—	—	—
31.75	—	±0.20	—	—	—	—

●Tolerance of Inscribed Circle IC (mm)

D.I.C.	Triangular	Square	Rhombic 80°	Rhombic 55°	Rhombic 35°	Round
6.35	±0.05	±0.05	±0.05	±0.05	±0.05	—
9.525	±0.05	±0.05	±0.05	±0.05	±0.05	±0.05
12.70	±0.08	±0.08	±0.08	±0.08	—	±0.08
15.875	±0.10	±0.10	±0.10	±0.10	—	±0.10
19.05	±0.10	±0.10	±0.10	±0.10	—	±0.10
25.40	—	±0.13	—	—	—	±0.13
31.75	—	±0.15	—	—	—	±0.15

Fig. 4: Tolerance Class

4. Chipbreaker and Clamping System									
Metric									
Symbol	Hole	Hole Configuration	Chip Breaker	Figure	Symbol	Hole	Hole Configuration	Chip Breaker	Figure
W	With Hole	Cylindrical Hole + One Countersink (40—60°)	No		A	With Hole	Cylindrical Hole	No	
T	With Hole		One Sided		M	With Hole	Cylindrical Hole	Single Sided	
Q	With Hole	Cylindrical Hole + Double Countersink (40—60°)	No		G	With Hole	Cylindrical Hole	Double Sided	
U	With Hole		Double Sided		N	Without Hole	—	No	
B	With Hole	Cylindrical Hole + One Countersink (70—90°)	No		R	Without Hole	—	Single Sided	
H	With Hole		One Sided		F	Without Hole	—	Double Sided	
C	With Hole	Cylindrical Hole + Double Countersink (70—90°)	No		X	—	—	—	Special Design
J	With Hole		Double Sided						

Fig. 5: Chip breaker and Clamping System

5. Insert Size							
Symbol							Diameter of Inscribed Circle (mm)
R	W	V	D	C	S	T	
	02		04	03	03	06	3.97
	L3	08	05	04	04	08	4.76
	03	09	06	05	05	09	5.56
06							6.00
	04	11	07	06	06	11	6.35
	05	13	09	08	07	13	7.94
08							8.00
09	06	16	11	09	09	16	9.525
10							10.00
12							12.00
12	08	22	15	12	12	22	12.70
15	10		19	16	15	27	15.875
16							16.00
19	13		23	19	19	33	19.05
20							20.00
			27	22	22	38	22.225
25							25.00
25			31	25	25	44	25.40
31			38	32	31	54	31.75
32							32.00

Fig. 6: Insert Size

6. Insert Thickness

*Thickness is from the bottom of the insert to the top of the cutting edge.

Symbol	Thickness (mm)
S1	1.39
01	1.59
T0	1.79
02	2.38
T2	2.78
03	3.18
T3	3.97
04	4.76
06	6.35
07	7.94
09	9.52

Fig. 7: Insert Thickness

7. Insert Corner Configuration

Symbol	Corner Radius (mm)
00	Sharp Nose
V3	0.03
V5	0.05
01	0.1
02	0.2
04	0.4
08	0.8
12	1.2
16	1.6
20	2.0
24	2.4
28	2.8
32	3.2
00 : Inch M0 : Metric	Round Insert

Fig. 8: Insert Corner Configuration

8. Cutting Edge Condition

Figure	Cutting Edge	Symbol
	Sharp Cutting Edges	F
	Round Cutting Edges	E
	Chamfered Cutting Edges	T
	Chamfered and Rounded Cutting Edges	S

Mitsubishi Materials omit the honing symbol.

Fig. 9: Cutting Edge Condition

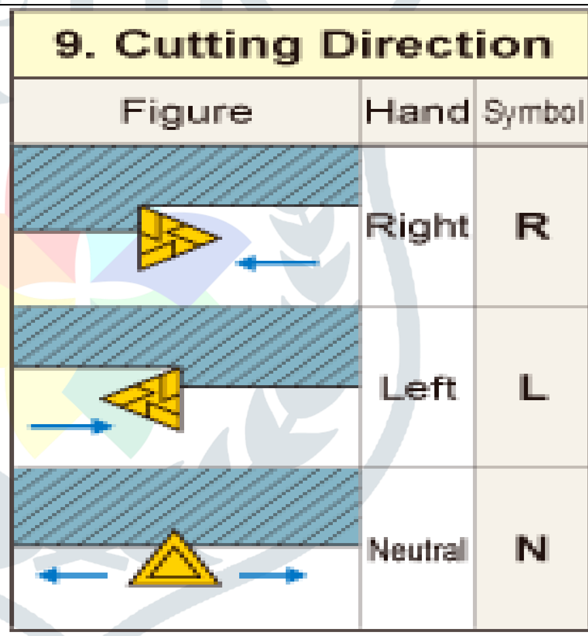


Fig. 10: Cutting Direction

Fig. 11: Chip Breaker

As it was observed in the Turning centers, the insert TNMG 160404 was used to perform the Outer Diameter Turning and the facing operation. The depth of cut was around 1.5 mm diametrically to get the final Outer Diameter. But as per the tool makers, less nose radius inserts are mostly used for precise finishing operations and used at places, where we require the same nose radius. For example, 0.2 mm nose radius insert is used to make a corner radius of 0.2mm and similarly 0.4 mm nose radius insert is used to make a corner radius of 0.4 mm. Just for Outer Diameter turning operations with required surface finish of 3.2Ra, an insert of 0.8 mm nose radius will work better that too with higher parameters and it will give better results as compared to the inserts having nose radius of 0.4mm.

0.8mm Nose Radius Insert 0.4mm Nose Radius Insert

Fig. 12: Inserts of Nose Radius 0.8mm & 0.4mm

Finally with the consultation of the Tool maker, TNMG 160408 insert was used instead of TNMG 160404 inserts for Outer Diameter turning & facing operations.

Also got an added advantage of the Cutting speed in using 0.8 mm nose radius inserts, over the 0.4 mm nose radius inserts, which were used previously. For 0.4 mm nose radius inserts, the recommended cutting speed was 320 meters/min, while for 0.8 mm nose radius inserts; the recommended cutting speed was a whopping 400 meters/min.

Fig. 13: Insert container of Nose Rad. 0.4 mm

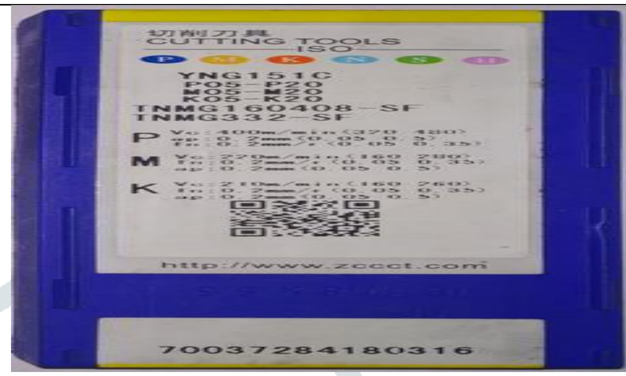


Fig. 14: Insert container of Nose Rad. 0.8 mm

Tool cost reduction data are presented in tables 1, 2 & 3.

Table 1. Insert Description & CPC

Use	**Insert Description**	**Price Per Unit (INR)**	**Life Per Edge**	**Cutting Edges Per Insert**	**Life Per Insert**	**CPC (Cost Per Component) INR**
Previously used insert	TNMG 160404	210	55	4	220	0.955
Presently used insert	TNMG 160408	210	105	4	420	0.5
				Profit / Insert		0.455

Table 2. Total Production Calculation

a	Total No. of Turning centres with same component or Operation	10	
b	Avg. C.T. (Cycle Time) in min per component	1.5	
c	Working minutes in a day (considering 21 working hrs)	1,260	
d	Production in a day per mc	840	(c/b)
e	Production in a day for 10 machines	8,400	(d*a)
f	Production in a month for 10 machines (considering 25 working days in a month)	2,10,000	(e*25)

Table 3. Total Profit Calculation / Unit

Previous cost for monthly Outer Diameter Turning	2,00,455	(f* Prev CPC)
Present cost for monthly Outer Diameter Turning	1,05,000	(f* Present CPC)
Total Tool cost saving per month	**95,455**	

3.2. PRODUCTIVITY IMPROVEMENT

Productivity of many components was increased by amending the programs at many a place.

Most of the places in the programs, it was observed that the tool movement was in linear interpolation, at non cutting movements. All the movements were thoroughly observed by running the programs in 'Dry Run" mode and at most places, linear interpolation "G01" was replaced by Rapid positioning "G00".

At starting of the programs for every tool (i.e. for every N number) the tool was coming near the component first in X direction, and then it was travelling in Z direction to reach near the component. These two movements were replaced by a single Diagonal movement of the tool from the Reference position to near the component.

In most of the programs, 1st reference point was at a larger distance than the component. In this case, a 2nd reference point was established and during tool changing, the reference was done to the Secondary home position. Thus, G28 was replaced by G30, which reduced a significant time in the programs.

Table 4. Productivity Improvement by Amending Programs & Parameters

Previous Condition	**Present Condition**	**Remarks**
Linear interpolation G01	Rapid Positioning G00	Linear interpolation "G01" was replaced by Rapid positioning "G00" at most places
X Direction movement followed by Z direction movement	Diagonal movement	for every tool (i.e. for every N number), at the starting of the tool movement, X+Z movements were replaced by Diagonal movements
1st reference point "G28"	2nd reference point "G30"	G28 was replaced by G30, which reduced a significant time in the programs.
Lower Tooling Parameters	Higher Tooling Parameters	Lower Tooling Parameters were replaced by Higher Tooling parameters by having interaction with the Tool maker

Table 5. Productivity Improvement Results

a	Previous Production units per month	2,10,000	
b	Present Production units per month (After 10% Productivity improvement)	2,31,000	
c	Approx selling price of a component (INR)	100	
d	Previous Monthly Sales Turnover INR	2,10,00,000	(a*c)
e	Present Monthly Sales Turnover INR	2,31,00,000	(b*c)
	Increase in monthly Sales Turnover, INR	2,10,00,000	(e-d)
	INR Increase in monthly Profit (considering 10% margin)	**2,10,000**	

3.3. MANPOWER OPTIMIZATION

It was observed in most of the Turning centers that, the cutting time was 90seconds (Machining Time of 80 sec & 10 sec as loading & unloading) on an average, including the loading and unloading time. The Inspection time of the component was on an average of 15 seconds. The operator was idle for the rest 65 seconds. Therefore to optimize man power we utilize the rest 65 seconds of the operator.

Fig. 15: Two operators running two separate machines

Similarly in the 2 VMC's, the cycle time was 150seconds (Machining Time of 120 sec & 30 sec as loading & unloading) on an average, including the loading and unloading time. The Inspection time of the component was on an average of 20 seconds. The operator was idle for the rest 100 seconds.

Now it was proposed to run 2 machines by one operator and the very next week, the proposal came into action, thus reducing 6 manpower in a total, and saving was done for a cost of Rs.60,000 per month.

Fig. 16: One operator running two machines

4. RESULTS AND DISCUSSION

Methodologies	Items	Cost Saving (INR)
Methodology-1	Tool cost Reduction	95455
Methodology-2	Productivity Improvement	210000
Methodology-3	Manpower Reduction	60000
	TOTAL PROFIT PER MONTH	**365455**

From the above it has been observed that a total profit of Rs.3,65,455.00 INR has been made monthly by focusing over three major parameters, tool cost, productivity and man power. This proves that overall efficiency of industry has been optimized. Using proper tools can improve the productivity, quality of production and reduce the rejection of products. Improvement in quality product and minimizing the rejection of component enhances the manufacturing efficiency as a whole boosts up the industrial efficiency. Utilization of optimum man power by reducing idle hour is also a critical parameter which involves cost and reduces efficiency. Steps has been taken to utilize idle hour to reduce man power cost and to add in profit as well as enhance industrial efficiency.

5. CONCLUSION

Industrial optimization is a major concern in all industries. Present analysis concludes that overall efficiency of industry can be improved by

- Improving qualitative product by reducing rejection
- Utilization of proper tool to minimize time of production and quality of product
- Optimizing man power utilization by reducing or reutilizing idle hour
- Maximizing profit by reducing cost involved in every step of production

Overall profit calculated by taking steps over all these was found to be Rs.3,65,455.00 INR. which was a remarkable amount in medium standard industry and can further be improved by critical judgment over minute steps of each stage of production.

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