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Cycle Time Reduction of VMC Machine

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ABSTRACT: Cycle time is the time required to deliver a product or service to a customer. Long cycle-times not only prevent prompt delivery of products/service to your customer, but also increase costs. One of the best ways to cut down on your cycle-time is to conduct activities in parallel and eliminate unnecessary waste time as demonstrated on the next slide.

Broadly speaking, an organization competes on the basis of quality, cost, flexibility and time. This factor is complementary, even symbiotic. Today's discriminating customer demands world class quality at a competitive price. When all the leading companies in an industry achieve a high-level quality, a focus on quality alone cannot keep a company competitive.

Quality then becomes, an expected factor, which must be complimented by a faster response time and flexibility. In increasingly, cost and quality are viewed as residuals or outcomes of competing on the basis of time and flexibility.

In business, time is not infinite and limitless competing on the basis of time is defined to include the following: using time as a strategic weapon to identify market opportunity, responding to those opportunities before competitors do and eliminating non-value-added activities.

KEYWORDS: Cycle-Time, VMC, Tool Design & Manufacturing, Programming, Productivity

I. INTRODUCTION

In today's fast-moving world, it is very much significant for the manufacturing industries to fulfil customer's demands on time to ensure customer satisfaction. Thus, manufacture needs to find ways to reduce the cost of the product and the processing time along with the improved performance and quality of the product. Cycle time is the time required for performing various machining operations on the product at workstation. It is the total time elapsed for converting raw material into the finished product. It not only includes service time for machining but also comprises of the idle time or setup time between two consecutive operations.

Cycle time reduction is of highly essential today since long cycle time results in high inventories, high cost and loss of customer's goodwill. Cycle time can be considerably reduced by proper demand management. For this forecasting

techniques, can be used to determine the market demand and accordingly plan the manufacturing operations. Reduction in cycle time holds the advantages of reduced inventory, reduced cost and effective utilization of resources. With proper communication between various concerned departments the idle time between two consecutive operations is reduced and thus ultimately reducing the cycle time. Just as cash flow is a direct measure of company financial performance, cycle time is a direct measure of process and equipment performance. In a mass production setting, cycle time improvements are driven by management with the goal of maximizing machine productivity. A key measure of cycle time performance is customer Satisfaction. Tact time is the average time between the start of production of one unit and end of that unit or the start of production of the next unit, when the production of organization starts to achieve the customer demands.

Cycle time is the total time from the beginning to the end of your process, as defined by the organization and their customer. In cycle time contents process time, during which a unit is acted upon to bring it closer to an output, and delay time, during which a unit of work is spent waiting to take the next action.

1.1 Advantages

1. Opportunities to Innovate
2. Better Positioning for Distribution Channels
3. Increased Productivity
4. Higher Customer Satisfaction
5. Profitability Advantages

II. PROBLEM DEFINITION

A real time Drop-Box (Gear Box Casing) is machined in VMC using various operations such as interpolation milling, drilling, grooving, reaming, chamfer and boring. A gear box is grooved using interpolation method by using end mill cutter which takes 15 minutes. This method is very time consuming and slow.

Solution: The above problem can be solved by manufacturing Plunge cutter. Plunge cutter can operate the grooving operation in seconds. So Samruddhi Industries has decided to manufacture Plunge cutter and reduce the cycle time.

III. LITERATURE REVIEW

1. A. Vtrivel, et al., [4] International Journal of Engineering Science and Management (IJRESM) 2018. The authors have mention that to minimize the cycle time there are two ways in which this can be achieved, the select can appropriate machine tools, cutting tools, Fixturing and machining order in way that it.
2. Ismail W. R. Taifa, et al., [1] Journal of Industrial Engineering and Management Studies (JIEMS) 2019. Cycle time is the one of the viable parameters which needs to optimized as much as possible manufacturing industry is trying to improve efficiency, cost base and customer responsiveness. Primary concern is on the way to perform cycle time reduction in manufacturing industry.
3. Sandesh K Wavhal, et al., [4] Lokmanya Tilak College of Engineering (LTCE) 2017. It is very much significant for manufacturing industry to fulfil customer's demands on time to ensure customer satisfaction. Thus, manufacture needs to find way to reduce the cost of the product and the processing time along with the improved performance quality of the product. Cycle time reduction is of highly essential today since long cycle time results in high inventories, high cost and loss of customer's goodwill.
4. R Shiva, et al., [5] IOP Conference Series Materials Science and Engineering (IOP) 2017. Lean manufacturing is the technique, philosophy using to eliminate hidden waste that present in the companies. It is most useful quality tools in manufacturing sector. The lean tools are successfully introduced for service industry to improve the quality service. The waiting time is reduced in future state with the help of automation tool.
5. Velliyangiri J, et al., [2] International Journal of Trend in Scientific Research and Development (IJTSRD) 2019. Abbreviate the machining time with the goal to build high rate of creation with the base expected time. Limit the process duration with no capital speculation and lessened work to do two techniques were produced all together to tackle the particular issues clear with organization being examined.
6. V. Ramakrishnan, et al., [1] International Journal of Applied Engineering Research (IJAER) 2017. Enhanced the overall productivity to meet the customer demand at right time. Lean tool like work standardization has been applied to eliminate non value added activities in manufacturing area. Developed proposed line balancing layout to increase the workers utilization.



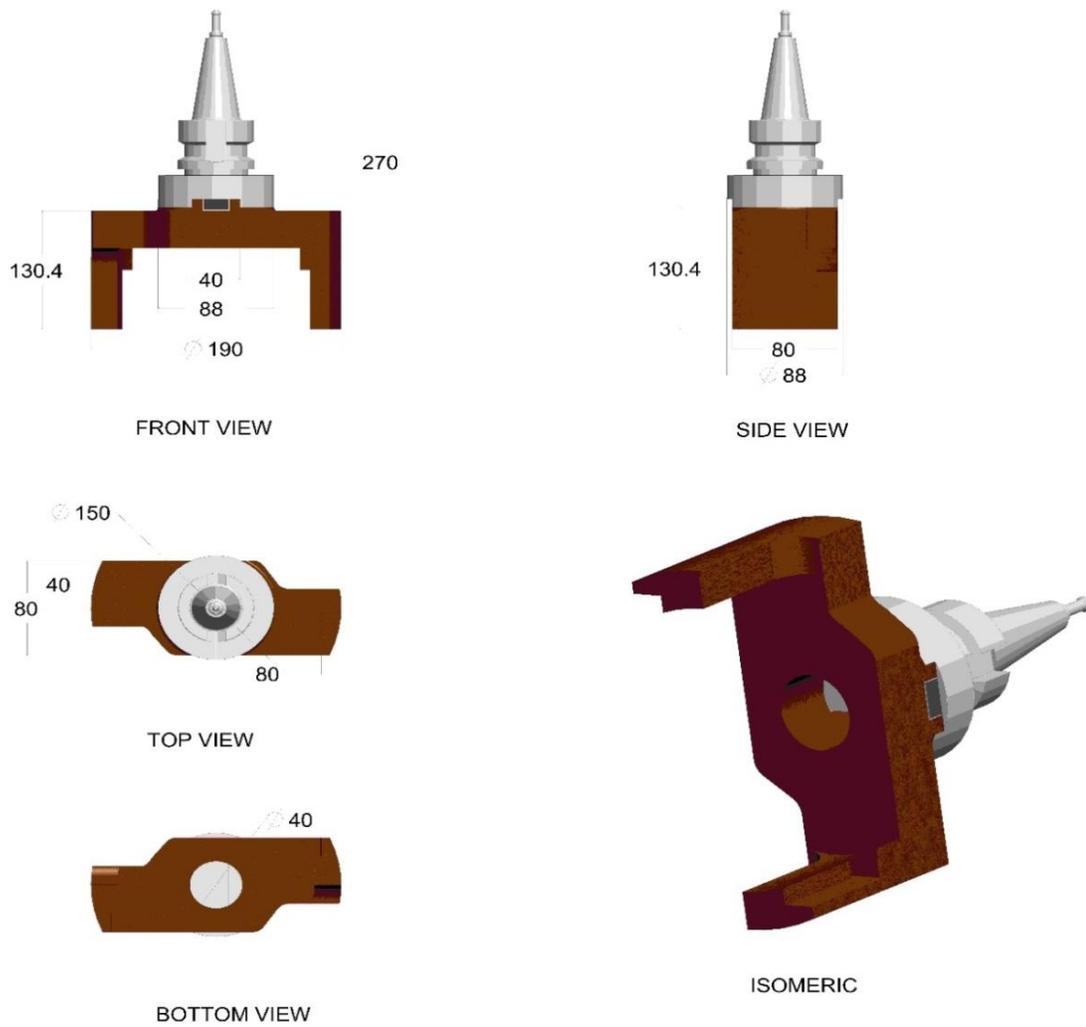
IV. DESIGN OF PLUNGE TOOL & CYCLE TIME CALCULATION

Tool design is a specialized area of manufacturing engineering comprising the analysis, planning, design, construction, and application of tools, methods, and procedures necessary to increase manufacturing productivity. The main objective of tool design is to increase production while maintaining quality and lowering costs. To this end, the tool designer must:

- Reduce the overall cost to manufacture a product by making acceptable parts at the lowest cost.
- Increase the production rate by designing tools to produce parts as quickly as possible.
- Maintain quality by designing tools to consistently produce parts with the required precision.
- Reduce the cost of special tooling by making every design as cost-effective and efficient as possible.

Tool Specifications:

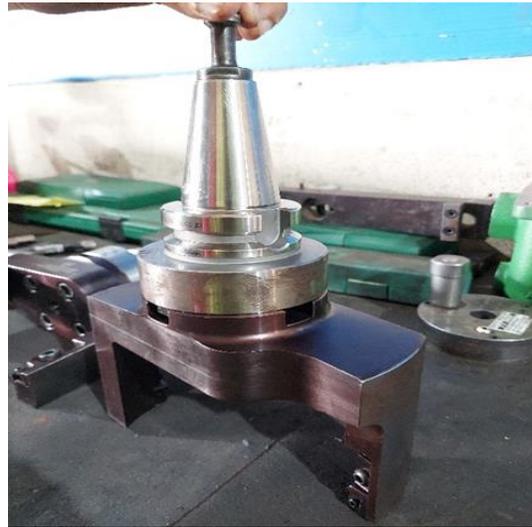
- Tool Length/Height = 130.04 mm Tol. ± 0.20
- Total Width = dia. 190 Tol. -20
- I.D of Tool = 146.9 Tol. ± 0.05
- Collar Width = Dia 88
- Tool Flange Total Width = 80mm
- Tool Column Height = 32.58mm
- Insert to Insert Width = 155mm Tol ± 0.05
- Tool Material = High Speed Steel
- WRENCH = TKY15F
- Screw = TS4
- Insert = AEMW150308-SPL
- Adaptor = BT40



TITLE: SPL ROUGH GROOVING TOOL
SPECIFICATION: 155.55XW4.323 SPL.GROOVING TOOL
DRAWING NO: AVAU029000007
OPERATION: ASSY DRG

3DParametric Drawing of New Tool

Rough Grooving Cutter



Finish Grooving Cutter



Cycle Time Calculation of Old End mill Cutter tool

Cutting Speed (VC) – 35 m/min Load – 1%

R.p.m. – 2300 rpm

Here, Width = 4.8 mm (Grooving)

A) Cutting speed

$$V_c = \frac{\pi D n}{1000}$$

$$35 = \frac{3.14 \times 4.8 \times N}{1000}$$

$$= \frac{35000}{3.14 \times 4.8}$$

N = 2330 i. e 2300 rpm

B) Feed = 400 mm/min

$$= \frac{400}{2300}$$

$$= 0.17 \text{ rev/min}$$

C) Rough Grooving Formula, Time = $\frac{L \times \text{DOC}}{\text{FEED} \times \text{RPM}}$

$$= \frac{80 \times 4}{0.080 \times 1700} = \frac{320}{136} = 2.35 \text{ min}$$

$$\text{Finish Grooving} = \frac{80 \times 2.7}{0.1 \times 1800} = \frac{216}{180} = 1.20 \text{ min}$$

D) Cycle Time

Rough cut = 2 minute 35 seconds

Finish cut = 1 minute 20 seconds

Total time = 3 minute 55seconds

A VMC Programme was developed after this for Endmill cutter (Old)

New Cycle Time Calculation of Plunge Cutter tool

$$\text{Formula, Time} = \frac{L \times \text{DOC}}{\text{FEED} \times \text{RPM}}$$

Where, L = Length

D = Depth of cut

Feed = Distance travel by tool each revolution

RPM = Revolution per minute

A) Rough Machining Time (Grooving)

$$\text{Time} = \frac{156 \times 5}{12 \times 160} = \frac{780}{1920} = 0.40 \text{ min}$$

B) Finish Machining Time (Grooving)

$$\text{Time} = \frac{156 \times 5}{14 \times 185} = \frac{780}{2590} = 0.30 \text{ min}$$

C) Cycle Time

Rough cut = 40 seconds

Finish cut = 30 seconds

Total time = 1min 10seconds

A VMC Programme was modified after this for newly manufactured Plunge cutter (New)



Operation Sheet

SAMRUDDHI INDUSTRIES														
A Face														
CUSTOMER : John Deere Pvt Ltd Pune														
PART NO. : SU 22405 Part Name: Drop Box DATE : 02/03/2021														
A Face														
Sr. No.	Dim/area To Be Machined	Tool Description	Job/ Tool Dia	Cutting Speed In M/min	Cutting Speed In R.P.M.	No. Of Teeth	Feed mm/Re.	Feed mm/Min	Tool Travel	No. Of Cuts	Cutting Time	B Axis Time	Tool/ Pos. Chan. Time	Total Time
Operation No 20 VMC Milling, Drilling														
1	Rough Milling(S)	Milling Cutter	63	178.038	900.00	5	0.1	450	460	2	2.0		0.08	2.1
2	Finish milling(S)	Milling Cutter	63	168.147	850.00	5	0.1	425	460	1	1.1		0.08	1.2
3	Dia-40 Gap milling Ref.	Milling Cutter	40	75.36	600.00	3	0.2	360	800	2	4.4		0.08	4.5
4	Dia-25 Gap milling Finish.	End mill	25	58.875	750.00	1	0.3	225	320	1	1.4		0.08	1.5
5	Dia15.0 Carbide Drill	Carbide drill	15	84.78	1800.00	1	0.15	270	20	4	0.3		0.08	0.4
6	Dia9.1 Carbide Drill	Carbide drill	9.1	60.0054	2100.00	1	0.15	315	20	2	0.1		0.08	0.2
7	Dia-4.5 End mill Ref	End mill	4.5	22.608	1600.00	1	0.1	160	180	2	2.3		0.08	2.3
8	Dia-4.8 End mill Finish	End mill	4.8	25.6224	1700.00	1	0.08	160	180	1	1.1		0.08	1.2
9	Dia-9.8 Boring Bar	B.Bar	9.8	36.9264	1200.00	1	0.1	120	20	2	0.3		0.08	0.4
10	All hole chamfer	chamfer tool	14.5	54.636	1200.00	1	0.2	240	180	1	0.8		0.08	0.8
11	Dia-.10P7 Carbide Reamer	Carbide Reamer	10	12.56	400.00	1	0.5	200	20	2	0.2		0.08	0.3
		0												2.0
														Total Time
														16.96
SAMRUDDHI INDUSTRIES														
A Face														
CUSTOMER : John Deere Pvt Ltd Pune														
PART NO. : SU 22405 Part Name: Drop Box DATE : 26/05/2021														
A Face														
Sr. No.	Dim/area To Be Machined	Tool Description	Job/ Tool Dia	Cutting Speed In M/min	Cutting Speed In R.P.M.	No. Of Teeth	Feed mm/Re.	Feed mm/Min	Tool Travel	No. Of Cuts	Cutting Time	B Axis Time	Tool/ Pos. Chan. Time	Total Time
Operation No 20 VMC Milling, Drilling														
1	Rough Milling(S)	Milling Cutter	63	178.038	900.00	5	0.1	450	460	2	2.0		0.08	2.1
2	Finish milling(S)	Milling Cutter	63	168.147	850.00	5	0.1	425	460	1	1.1		0.08	1.2
3	Dia-40 Gap milling Ref.	Milling Cutter	40	75.36	600.00	3	0.2	360	800	2	4.4		0.08	4.5
4	Dia-25 Gap milling Finish.	End mill	25	58.875	750.00	1	0.3	225	320	1	1.4		0.08	1.5
5	Dia15.0 Carbide Drill	Carbide drill	15	84.78	1800.00	1	0.15	270	20	4	0.3		0.08	0.4
6	Dia9.1 Carbide Drill	Carbide drill	9.1	60.0054	2100.00	1	0.15	315	20	2	0.1		0.08	0.2
7	Dia-156.0 OD Ref Cutter	Ref Cutter	156	117.562	240.00	1	0.06	14	5	1	0.3		0.08	0.4
8	Dia-156.0 OD Finish Cutter	Finish Cutter	156	122.46	250.00	1	0.1	25	5	1	0.2		0.08	0.3
9	Dia-9.8 Boring Bar	B.Bar	9.8	36.9264	1200.00	1	0.1	120	20	2	0.3		0.08	0.4
10	Dia-.10P7 Carbide Reamer	Carbide Reamer	10	12.56	400.00	1	0.5	200	20	2	0.2		0.08	0.3
		0												2.0
														Total Time
														13.30



V. RESULT AND ANALYSIS OF OLD & NEW TOOL

Old: To reduce the cycle time, we need to focus on the processes which requires maximum time for operation. So we selected tool End mill Cutter for time reduction. Tool Interpolation Groove 3 min 50 sec.

New: We reduced the cycle time, by focusing on the processes which required maximum time for operation. So we designed tool Plunge Cutter for time reduction. Tool Plunge Groove 1 min 10 sec.

VI. COMPARE OLD PROGRAMME AND NEW PROGRAMME CYCLE TIME

Old Programme Cycle Time	New Programme Cycle Time
16 min 96 sec	13 min 30 sec

(Total reduced cycle time is 4 min 6 sec)

VII. CONCLUSION

As per old program the cycle time of interpolation Grooving was 16 min 96 sec. We have changed the tool and the parameters like Depth of Cut, Speed, Feed, Cutting Speed and developed new program and reduced cycle time of Grooving Operation of Drop Box.

Our new program cycle time of plunge grooving is 13 min 30 sec. On this basis we have reduced successfully total cycle time of Drop Box by 4 min 6 sec.

This improved the productivity as well as reduced the time require. The production of Drop box is increased by 7 job per shift.

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