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Cycle Time and Cost Reduction of Ball Turning Operation of Cardan Shaft

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Abstract
The previous productivity of CNC used for ball turning was comparatively lesser which caused the use of running load on next operation that is Slot milling and thereby reducing its Overall Equipment Efficiency (OEE). Here we found the scope of improvisation in order to reduce the cycle time to increase the productivity. Previously insert of 0.8 mm radius was used which was later replaced by insert of 1.2 mm radius and also the number of strokes required to turn the ball were reduced to 2 from 3 reducing the cycle time from 30 seconds to 21 seconds.
Keywords –*CNC Machine, Cycle time, Cost, Productivity, Insert, OEE.*

1 Introduction

Cycle time is defined to be the time that happens from the time a task or series of tasks is initiated to the time a task is completed. Example, the cycle time is the time a shipping order is printed to the time it is loaded on the truck and the system is updated. An alternate definition would be is the time it takes to load, run, and unload on work piece.

Everything and anything that happens in a Computer Numerical Control (CNC) machining equipment can be divided in to four categories

1.) On-line, productive tasks
2.) On-line, non-productive tasks
3.) Off-line, non-productive tasks
4.) Off-line, productive tasks

These are the actual machining operations that occur during a CNC cycle. These are the ball turning, drilling, tapping, reaming, and any other machining operation that in some way furthers the completion of the work piece. To minimize the cycle time in these areas, there are two ways in which this can be achieved. One would be through careful process planning.

The process engineer must select an appropriate machine tool, cutting tools, fixturing, and machining order in a way that it matches the number of work pieces to be machined that will be based on the production quantity. The cycle time will be a reflection of the processes being used to machine work pieces.

If in the many times that your company's processes have already been developed and implemented before you begin your cycle time reduction program, then your second alternative is to optimize cutting operations for this would involve properly selecting cutting tool materials, feeds, and speeds to machine work pieces as efficiently as possible with the current process.

In Varroc Engineering Pvt. Ltd., Plant VII in Forging Business Steering Cardan shaft is one of the major products. It undergoes sequence of operations. It includes the forging process and heat treatment as well. In Forging the processes which are of major concern are as follows:

- Upsetting i.e. ball formation
- Ball turning
- Slot milling

During observation I came up with a conclusion that productivity of CNC used for ball turning is comparatively lesser which caused the use of running load on next operation that is Slot milling

and thereby reducing its overall equipment efficiency (OEE).

Here I found the scope of improvisation in order to reduce the cycle time to increase the productivity.

2 Study of Machine

The ball turning operation is carried out on CNC machine, which is provided by FANUC PVT.LTD. In this operation two inserts are used one having 0.8 mm radius and another having 0.4 mm radius which are used for rough & finish cut purpose respectively.

After operation product characteristics are:-

1. Product length 90.75-90.85
2. Ball centre length 87.25-87.55
3. Ball diameter 22.10-22.15
4. Radius R5 -R15
5. Chamfer at ball end face 0.4x45º
6. Angle 19º -21º

Hourly production of machine is 72 NOS

- Production per hour 72
- production in 8 hr 72 x 8 = 576 NOS
- production in one day 576 x 3 = 1728 NOS
- Here I found the scope of improvisation in order to reduce the cycle time to increase the productivity.

For reduction in cycle time I changed parameter of CNC like speed, feed & number of cuts from 3 to 2, but it was affecting on tool life. Production was increased but tool life decreased at the same time cost of operation was also increased, which ultimately increased the cost of product.

3 Tool History

Earlier

For rough operation:-In CNC for operation earlier 0.8MM insert of Sandvik coromant was used for rough operation, which was increasing the cost of operation and cost of product as well.

Cost of 0.8 mm insert: Rs 270

Tool life of 1 insert : 900 NOS

Operation cost for 1 job: Rs 0.3

For finish operation

For ball turning operation in CNC 0.4 mm insert was used for finishing operation.

4 Kaizen Idea

4.1 Problem Status

1) More cycle time i.e. about 30 second.
2) Set up time & tool adjustment time is more.
3) Three cut or pass in rough cut operation.
4) After every 150 NOS, Set up & tool adjustment is required.

4.2 Kaizen

1) By reducing cycle time.
2) By reducing cut or pass of operation.
3) By reducing Set up time & tool adjustment time

5 Selection of Insert

We choose negative type of insert made by carbide having AL2O3 coating with 1.2 mm radius instead of previous 0.8mm radius of rough operation. Above insert provide by TEAGU –TEC PVT.LTD.

6 Changes in Program

For selected material I change parameter in program like feed, speed, and number of cut or pass, for reducing cycle time of ball turning machine.

7 Reduction in Cycle time

Due to change in parameters like speed and feed and reducing the number of stroke or pass the cycle time gets reduced. Following table indicates how productivity is increased after the Kaizen.

8 Comparative table of parameters before and after Kaizen

Parameters	Before Kaizen (using 0.8mm insert)	After Kaizen (using 1.2mm insert)
Cycle Time	30 sec	21 sec
Production (8 Hrs.)	576 NOS.	800 NOS
Insert Life At one corner	150 NOS	400 NOS
Total insert Life (at 6-corner)	900 NOS	2400 NOS
Insert Cost (1 pcs.)	Rs.165.24	Rs.197.81
Cost Of Operation (for 1 Nos.)	Rs.0.1836	Rs.0.069

9 Test to ensure that the quality of product is maintained even after changing the specification:-

9.1 Quality chart 1:-

Parameter	Sample 1	Sample 2	Tolerance
Run out error	0.07	0.073	0.1mm
length of sample	0.095	0.12	0.15mm

9.2 Quality chart 2 :-

Sample No.	Run out Error (Radius of Ball)	Length of sample
1	5.6	90.76
2	7.2	90.79
3	6.3	90.75
4	8.9	90.82
5	7.3	90.77

10 Benefits :

10.1 Cost Savings

10.1.1Before Kaizen

Parts to be produced in a shift : 576 NOS
Parts to be produced in a day : 576 x 3 = 1728 NOS
Parts to be produced in a month:1728 x 30
= 51840 NOS
After every 900 NOS insert was changed,
Thus total number of insert required in a month: 51840 ÷ 900 = 58 approx.

10.1.2 After kaizen

After every 2400 NOS insert is change
Thus total number of insert required in a month
1840 ÷ 2400 = 22 approx.
Requirement of insert decreased in a month :
58 – 22 = 36 Cost saving in a month due to insert = Requirement of insert decreased in a month X cost of one insert = 36 x 197.81 = Rs 7121.1
Cost saving in a year due to insert = 12 x 7121.16 = Rs 85453.92

10.2 Productivity increases :-

Before kaizen production in 8 hrs : 576 NOS
After kaizen production in 8 hrs : 800 NOS
Increase production in 8 hrs : 800 – 576 = 224 NOS
Increase production in a day : 224 x 3 = 672 NOS
Increase production in a month
:672 x 30 = 20160 NOS
Increase production in a year : 20160 x 12 = 241920 NOS
One operator produces 576 NOS in a shift
Manpower required to produce 241920 NOS
: 241920 ÷ 576 = 420
Remuneration of one labour: Rs 300
Cost saving due to increase in production in a year : 420 x 300 = Rs 126000

10.3 Time saving

10.3.1 Before kaize

After every 150 NOS we changed corner of insert and after using all insert corners i.e. after 900 NOS an insert was changed.
Time required for changing an insert for each corner : 5 min (for 150 NOS)
Time required for changing an insert for all 6 corners : 30 min (for 900 NOS)
Time required for changing insert in one month = Total number of insert used in one month X Time required for changing insert for all 6 corner= 58 x 30 = 1740 min (for 51840 NOS)
Time required for changing insert in one year
= 1740 x 12 = 20880 min (for 622080)

10.3.2 After kaizen

After every 400 NOS we change corner of insert and after 2400 NOS we change an insert.
Time required for changing insert in one year for 622080 NOS = 21.6 x 30 x 12 = 7776 min
Total time saving due to changing insert in one year = Time required for changing insert in one year before kaizen - Time required for changing insert in one year after kaizen= 20736 – 7776
= 12960 min
=216 hrs = 9 days

11 Results

Increased production in a year : 241920 NOS
Cost saving due to increase in production in a year : 126000 INR
Cost saving in a year due to insert : 85454 INR
Total savings for one machine:126000+85454
= 211454 INR
Total saving for two machine:211454 x 2 = 422908
Total time saving due to changing insert in one year : 12960 min=216 hrs = 9 days
Total time saving due to changing insert in one year for 2 machine : 18 days

Conclusions

1) Reduction in cycle time
2) Reduces cost of product
3) Productivity increases
4) Increases OEE of CNC machine

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