To Reduce the Assembly Time for CNC Lathe Machine

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Abstract: In modern industries when automated machines are considered as one of the most important constituent in enhancing the productivity. CNC machines are used in most of the industries to bring about an increase in the rate of production. A Kanban system is a means to achieve Just-in-time (JIT) production. It works on the basis that each process on a production line pulls just the number and type of components the process requires, at just the right time. Just-in-time techniques like Kanban could be implemented on the assembly of CNC Lathe machine at Industry. The aim of the project is to provide right parts to the assembly division at the right time in the exact quantity and also to reduce the time taken for the overall assembly time for the CNC lathe machine by using Kanban system and automated machines.

Keywords – CNC Lathe Machine, Kanban, JIT

I. INRODUCTION

Computer numerical controlled (CNC) lathes are rapidly replacing the older production lathes (multi-spindle, etc.) due to their ease of setting, operation, repeatability and accuracy. They are designed to use modern carbide tooling and fully use modern processes. The part may be designed and the tool paths programmed by the CAD/CAM process or manually by the programmer, and the resulting file uploaded to the machine, and once set and trialed the machine will continue to turn out parts under the occasional supervision of an operator. Machining can be done within .0001 inches as long as your tooling is sharp and the conditions of the spinning material on the lathe are set to optimize the cutting process. CNC lathes are not only accurate but can be run very fast. This leads to increased efficiency and more parts per hour. The CNC lathe can also change tools in a fraction of a second and can feed into the parts fast thanks to power motors seen on modern CNC lathes. Also, the accuracy contributes to less waste through human error.

TL 20 TYPE OF LATHE MANUFACTURED IN INDUSTRY

TL20 driven by a powerful 2 HP, 240V motor, this metal monster will tackle the toughest machining jobs with ease. D1-4 cam-lock spindle is the most reliable and accurate chuck and plate mounting system for lathes. Add an extra long foot brake and apron mounted switch control and you have precise, safe control when threading or working up close to those difficult shoulders. The Gear-head makes speed and feed changes fast.

Figure 1. TL 20 CNC Lathe Machine

Specifications of TL-20

Swing: 210mm
Swing over gap: 370mm
Swing over saddle: 180mm
Distance between centers: 914mm
Lathe spindle bore: 38mm
Spindle taper : MT5
Tail stock taper: MT3
Saddle feed range: 0.009 - 0.236mm/rev
Cross feed range: 0.04 - 1.2236mm/rev
Cross slide travel: 170mm

Compound travel: 75mm
Number of speeds: 18 steps
Lathe speed range: 65-1800 rpm
Range of threads (inches): 32 @ 4 TPI - 60 TPI
Lathe motor size (Single-phase, 240V): 1.5KW
Approximate shipping weight: 595kg

II PRESENT METHODOLOGY

CNC assembly process:

Existing system:

The present system is an example of batch production where the machines are made to customer orders and the demand of the market often fluctuates. It is characterized by fluctuating demand, short production runs of a variety of products and small to moderate quantities of any given product made to customer order. Jobs are sent through the system based on their processing requirements.

The assembly of the CNC lathe machine consists of major sub-assemblies, which in turn comprises of minor sub-assemblies. The major group of sub-assemblies for the CNC lathe machine comprises of:

- Structure Sub Assembly.
- Small Parts Sub Assembly set.
- Electrical Sub Assembly.
- Parts Sub Assembly

The major sub-assemblies mentioned above consist of minor sub-assemblies.

Procedure for the assembly of the CNC lathe machine:

Main base (z-axis:

As the base is manufactured it is transported to the assembly unit; where the final assembly is done. Tapping operation is performed to the holes on main base (Z-axis); to ensure for the smooth surface of the threads inside hole. After tapping operation, Guide ways are fixed to base. This gives linear motion in z-direction. Then ball-screw is aligned on the base and it is checked whether the diameter of ball-screw is exactly positioned to center axis or not. If not grinding operation has to perform for exact diameter and then it is again aligned on the main base. Dialing operation is performed.

Figure 2. Main Base (Z – axis)

Table – 1 Main Base (Z – Axis) assembly time

S.NO	OPERATION	
1	**Tapping the main base**	
2	**Travel time for main base from entrance to asser**	
3	**Guide ways**	**26m**
4	**Ball screw**	
	(i) Initial aligning	**12m**
	(ii) Inspection	**15m**
	(iii) grinding	**4h**
	(iv) aligning	**10m**
	(v) dialing & fixing	**21m**
5	**drilling & reaming**	**4m**
6	**Aligning x-axis sub-assembly on main base**	**20m**

X-axis sub-assembly:

Tapping operation is performed to the x-axis base and it is followed by air cleaning. Guide ways are fixed to the X-axis base which gives transverse motion to the work piece. Again tapping operation is performed to the holes of guide ways Then ball-screw is aligned on the base and it is checked whether the diameter of ball-screw is exactly positioned to center axis or not. If not grinding operation has to perform for exact diameter and then it is again aligned on the X-axis base. It is then followed by dialing and pinning operation. The x-axis sub-assembly is mounted on the main base (Z-axis) and pinning operation is

performed to fix it on main base. Telescopic cover is fixed at the end of X-axis sub-assembly.

Figure 3. X-axis sub-assembly

Table – 2 X-axis sub-assembly time

S.NO	OPERATION	TIME
1	Tapping base of X-Axis sub assembly	34m
2	Air cleaning	1m
3	Guide ways	31m
4	Ball screw (i) Initial aligning (ii) Inspection (iii) grinding (iv) aligning (v) dialing (vi) fixing (vii) pinning	 5m30s 14m30s 3h 6m 26m 13m 10m
5	Cross slide mounting	2h
6	Travel time for x-axis sub assembly to main base(z-axis)	2m

Head stock:

Initially all the components of the head stock are assembled and then the balancing operation is performed. Once the balancing operation is performed then the assembled head stock is again dis-assembled. All the components are thoroughly cleaned and it is re-assembled. Then the completely assembled head stock is tested for 6h. After testing, if the head stock meets the desired qualities then it is transported to the assembly unit. This head stock is mounted on the main base and pinning operation is performed for fixing it on main base. Finally dialing operation is performed to ensure as it coincides with center axis.

Figure 4. Head stock

Table – 3 Head Stock Sub Assembly Time

S.NO	OPERATION	TIME
1	Assembly	1h30m
2	Balancing	1h
3	Disassembly & cleaning	2h30m
4	Re-assembly	1h2m
5	Testing	6h

Table – 4 Head Stock Mounting on Main Base time

S.NO	OPERATION	TIME
1	Travel time from entrance to main base	4m
2	Fixing head stock on main base	16m28s
3	Dialing	10m

Head stock mounting on main base:

The assembly time of Head stock mounting for the CNC lathe machine (TL20) is considered with all the operations mentioned below.

Tail stock:

All the components of the tail stock are thoroughly cleaned. After cleaning, the components are assembled in a sequential order. Once the tail stock assembly is finished; it is then tested for 2h for obtaining the desired qualities. The tested tail stock sub-assembly is transported to the assembly unit. It is mounted on the main base and it is aligned on it. Dialing operation is performed and then it is checked whether the center axis of tail stock is coinciding with center axis of head stock. If it is not coinciding with the center axis of head stock; then the tail stock is to be grinded and then it is again aligned on the main base. As once aligning is done, then dialing operation is performed for tail stock with respect to head stock.

Tail stock sub-assembly:

Tail stock mounting on main base:

The assembly time of Tail stock sub-assembly for the
The assembly time of Tail Stock sub-assembly for the CNC lathe machine(TL20) is considered with all the operations mentioned below.

Table – 5 Tail stock sub assembly time

S.NO	OPERATION	TIME
1	Cleaning	18m
2	Assembly	1h
3	Testing	2h

Table – 6 Tail stock mounting on main base time

S.NO	OPERATION	TIME
1	Travel time from entrance to main base	5m
2	Tail stock aligning	20m
3	Dialing	30m
4	Checking centre axis with respect to head stock	19m
5	Grinding	3h
6	Aligning & dialing	1h

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Turret is fixed; as it moves along the spindle axis and can hold six different tools for different machining operations.

Figure 5. Turret

Table – 7 Guarding/Casing assembly time

S.NO	OPERATION	TIME
1	Travel time from entrance to assembly unit	5m
2	Aligning and fixing	8h

Tool disc is fixed to the tail stock. Outer casing or guarding operation is performed. Encoder is fixed along with head stock motor. Coolant motor, hydraulic motor is fixed.

Figure 6. Encoder

Figure 7. Hydraulic Motor

Table – 8 Time for Assembly of Hydraulic Motor and Piping

S.NO	OPERATION	TIME
1	Tool disc	20m
2	Checking height for tool disc	20m
3	Turret assembly	30m
3	Coolant motor	1.5d
4	Hydraulic motor	
5	Cylinder, tail stock, lining pipe	
6	LUBE	

Pipe lining operation is performed; through which coolant is passed. Lube, coolant is also fixed.

Electrical wiring:

Electrical wiring is laid for the entire machine. Time taken for the assembly of electric wiring may vary for person to person. In the following table times are mentioned for an experienced person and a normal (not experienced) person.

Table – 9 Time for Electric Wiring

S.NO	TYPE OF PERSON	TIME
1	Experienced person	8h
2	Not experienced person	2d

The assembly of CNC lathe machine is completed.

II PROPOSED METHODOLOGY

Problems relating to existing methodology for the assembly of CNC lathe machine:

There are many non-value added activities during the sub-assemblies and assembly of the machine. There is no particular procedure followed for the machine assembly, which results in increase of total assembly time and ineffective use of resources. The mounting or assembling of the guard items is not properly synchronized with the mechanical and electrical activities. There are no work cells or stations allotted to all the sub-assemblies as identified in the existing system.

The assembly operation of the sub-assemblies, which are not allotted work cells, is carried out during the assembly of the main machine. The material or parts for these sub-assemblies is stored in racks adjoining the main machine. There is lack of co-ordination between the assembly division and the material department. The material department is not informed about the commencing of the machine assembly for a particular work order and the parts are issued from the material department without informing the material in-charge, due to which the current status of the inventory is unknown. Semi finished products and supplies kept in the do not add value because they add to the cost of operation by occupying space and by requiring additional equipment. These parts or others kept as inventory is requiring additional manpower for operation and the quality of parts deteriorates over time. Grinding operation is performed with in 30minutes but as it is not located near the assembly plant it is taking about 4hours to complete the operation, then drastically affecting the time for the assembly.

Effective methods to reduce the assembly time for the CNC lathe machine:

Implementing Kanban system:

Kanban is one of the most successful techniques used all over the world. Kanban is scheduling system for lean and Just in Time (JIT) production. Kanban is a system to control the logistical chain from a production point of view, and is not an inventory control system. Kanban is one method through which JIT is achieved.

a) ***Just in time*:** Lean manufacturing's essence lies in producing with as few people, as little inventory, and as little waste as possible. Lean ensures that each production stage processes exactly "what" "how much" and what exactly to do..and what to do in the next stage. In general, Lean strategy rests on four pillars just in time supply chain integration' cellular technology 'and Kaizen.

Most Lean Manufacturing initiatives focus on eliminating as much as possible these 7 kinds of waste in manufacturing:

Over Production, Waste of Motion, Excess Inventory, Production of Defects, Waste of Waiting

Waste of Transportation, Waste of over processing, Waste of Product, Waste of Skills/Workforce

Existing Method:

In the existing method of the CNC lathe assembly the assembly is not done in a sequence or procedure the workers used to walk a lot to the inventory, for each of the assembly part one after the other, instead of keeping all the

requirements beside the machine before assembly. If the workers does like this Assembly time of Lathe machine is increased, because a lot of time is getting wasted during the transportation.

Modified Method:
So to avoid this wastage of time during the transportation we have implemented a new method using Kanban method. Here what exactly happening is we reduced the transportation time by making the worker go to the inventory store and get all the parts required and keep it in the machine surroundings; rather going each time to the store and wasting his energy and also waiting a lot of time which goes into allowance.

Implementation of automated machines:
Although there are many automated techniques for grinding, reaming and screw tightening operations; company is performing these operations manually which takes more time and energy for completing operation. By implementing these automated techniques same operations are performed in the less time and more accurately than it performed as manually. Some of the automated machines are suggested to implement for performing the operations more efficiently and to reduce time of operation.
Automated reaming, Automated tapping operation, automated screw tightening operation.

Comparison of existing method with modified method:
Time taken for the assembly of CNC Lathe machine is observed in both existing method as well as modified method is observed and compared

Table – 10 Time analysis for overall improved methods

Type of operation	Existing method with wastage	Existing method without wastage	Automated machine without wastage	Automated machine with wastage
Guide way pinning main base	**1hour 15min.**	**45 min.**	**17min.**	**22min.**
Guide way pinning x-axis	**1hour 3min.**	**31min.**	**14min.**	**19min.**
Reaming	**1hour 20min.**	**40min.**	**13min.**	**18min.**
Retapping for main base	**2hour 30min.**	**2hour**	**38min.**	**43min.**
Retapping for x-axis base	**1hour 5min**	**34min.**	**11min.**	**16.min**
grinding	**4hour**	**20min.**	**20min.**	**30min.**
Total time	**11hour 21min.**	**4hour 25min.**	**2hour 15min.**	**3hour 6min.**

Time taken for existing method with wastage : 11hours 21min
Time taken for modified method with wastage : 3hours 6min.
Time reduced : 8hours 25min.

Time analysis: Existing & Modified Method:
Following data is the times observed for the overall assembly of CNC Lathe machine before and implementing the Kanban and some automated machines.

Table – 11 Time for Overall Assembly of Existing & Modified Method

S.NO	TYPE OF OPERATION	Existing Method time	Modified method time
1	Main base	8 hrs	1 hr 49 min
2	X-axis	23 min	2 hr109 min
3	Head stock sub-assembly	12 hrs 2 min	12 hrs 2 min
4	Head stock mounting	30 min	30 min
5	Tail stock sub-assembly	3 hrs 18 min	3 hrs 18 min
6	Tail stock mounting	5 hrs 14 min	2 hrs 14 min
7	Hydraulic motor piping system	25 hrs 10 min	25 hrs 10 min
8	Electrical wiring	10 hrs	10 hrs
9	Outer casing	8 hrs 5 min	8 hrs 5 min
10	Allowance	48 hrs	36 hrs
11	Automated operations		3 hrs 38 min
	Total	128 hrs	108 hrs

time taken for overall assembly in existing method : 128hours
time taken for overall assembly in reduced method : 108hours
reduced time :20hours
for example :
company gets an order of **N** machines,
total time reduced : **N***20 = 20 **N** hours

By observing the above data we can conclude that the there is a time difference of 20hours for each machine by implementing modified method. The excess time taken for tapping, reaming and screw tightening operations is saved in the case of modified method. The grinding time is also saved as there is a decrease from 4 hrs to 30 minutes.

IV CONCLUSION

The following conclusion could be made from the project

1. The problems in the machine assembly due to the delay the delivery of machine parts could be identified and rectified.
2. The observations during the project revealed that some non-value added activities could be eliminated.
3. The movement of the guards during their sub-processes could be made easier by the implementing of the Kanban system, which would always be circulated with the machine items.
4. On observations, the time for the machine assembly could also reduced by proper sequencing of the various assembly activities. The critical activities of the machine guard during the machine assembly have also been identified, the delay of which could increase the total assembly time of the machine. The assembly sequence could also help to monitor the assembly progress of the machine against the plan.
5. By observing the present assembly process some operations are performed manually which can be replaced by automated machine.
6. Time reduced for the overall assembly of CNC lathe machine is about 20hours for one machine by implementing Kanban and some automated machines.

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