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Study of Parameters in Metal Cutting Process ReducingResonance effect

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Abstract
Researchers are continuously working on minimizing the cost occurring to obtain required quality and quantity of finished product within the international norms. Metal cutting is widely used for manufacturing of chips or debris .The authors studied and analyzed the various parameters that affects metal cutting .The paper concentrate towards the minimization of production cost further decreasing the chatter over workpiece and its subsequent effects .The different parameters were optimized by using six-sigma techniques and theirs effects on finished products were analyzed. The final desired surface finish of work piece through metal cutting were controlled by several factors which included spindle speed, frequency, vibration ,tool life etc. Chatter was caused by self induced vibration and the effect of high amplitude frequency and adversely affected at the resonance when the natural frequency and chip frequency were aligned It was observed that the chattering was highly effected by the spindle speed, at very low speed the chatter was almost negligible. In addition, the increase in spindle speed significantly decrease the chatter.

1. Introduction

Metal cutting is a process of removing excess material by shearing operation between cutting tool and workpiece forming desired shape and size. The motion responsible for cutting action is primary force or cutting force the path followed is called generatrix and the motion responsible for gradual feeding the uncut portion is termed as secondary or feed motion and the line generated is called as directrix. In this paper we are focusing to improve the productivity, accuracy, cost of production etc.

During metal cutting we observe that due to contact of workpiece and tool at certain time interval the process vibration is generated which is known as chatter, which is mainly due to primary and secondary tooth formation where both of their frequencies matches with natural frequency resulting in the phenomenon known as resonance. It reduces the surface finish hence affecting the productivity, tool life and also increases the cost.

Earlier it was observed that chatter is formed due to regenerative surfaces which tells the vibration marks on the workpiece left from the previous cut is solely responsible for chatter. According to regenerative theory, chatter arises in the system as a result of waviness left from the previous cut which the tool follows in the subsequent cut. But it had no explanation for the amplification of vibration amplitude, Taylor also suggested that element of chip formation occurred at low cutting speed where chatter is infrequently observed. Kuznestsov also considered that the periodic effect of built up edge formation can excite vibration. The root cause of chatter is still remains depatable. In this paper on

experimental basis authors have concluded that by giving the spindle speed variation which reduces the chatter and whole process is optimized by six sigma process. In the line that, this paper proposes the procedure where the six sigma method is employed to improve the eco efficiency in the machining process to reduce the chatter. This is done through a case study where DMAIC techniques are applied to a turning operation aim us to identify, quantify and improves process ecoefficiency measures. The application of six sigma principle on the case under analysis enabled a 22% reduction in the consumption of electric energy, a 15% economy in soluble oil, and a 5% in chip generation. According to Calia et al (2009) , the Motorola company created the six sigma methodology around 1986 as an attempt to increase its competitiveness against the Japenese companies in Electronics industry , santos (2010) informs that this initative was focussed on the total elimination of products defects and production mistakes were the central objectives, before adopting the six sigma, Motorola spent between 5 and 20% of its revenue to fix quality problems , which represented around US$ 900 million a year in expenses.After six sigma implementations that company saved about US$ 2.2 billions in four years(NAIR et ol) conceptually to provide wider possibilities of utilizations,mainly in relation to the strategic and managerial action required for its implementations. Thus this paper aims to answer the following research enquiry: Can the six sigma method is to be fitted to improve the chatter

occur during metal cutting and to improve the efficiency of manufacturing processes.? To respond this question a case study was performed where a modified version of DMAIC method was applied to a turning operations, where significant economy is obtained.

Fig 1: Schematic diagram of S.S.V at both ON/OFF condition.

2. Experimental Setup And Methodology

2.1 Experimental Setup

The main aim of this experiment was on the study of chips and monitoring of vibrations during different types of machining operations,turning operation was conducted on a cnc lathe whose specification were maximum operating power consumption was 43 KW, Main motor power was 4 KW, Linear guide ways and hydraulic tailstock were present spindle speed varied from 60-4500 RPM Spindle speed variation technique to suppress the vibration which is generation between w/p and cutting tool. Spindle speed variation is an important technique by which we can decrease the vibration, which result in chatter.

The experiment was carried out in such a way that within 1.2 sec we gave variation to the speed of spindle 250 up and down range. Due to that the frequency of primary and secondary tooth doesn't match with natural frequency, due to that chatter is monitored and control and the optimization of this whole process is under control of six sigma process which is strictly a data driven approach and follows ways for eliminating defects. Hencekeeping the six standard deviation between the average and closest specification magnitude. It can be formulated from manufacturing to transactional and from product to service. Authors conducts an experiment in which they found following graphs and reading as shown.

This method was also used to get a combine result of business statistics and engineering to achieve appreciable results. In this process we use methods followed for production process known as DMAIC acronyms where the whole process is centered around definition, measurement, analysis, improvement and control.

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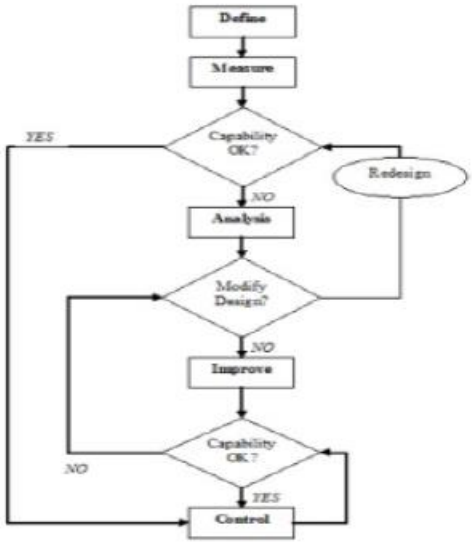

Fig 2: Flow chart of DMAIC Observations:

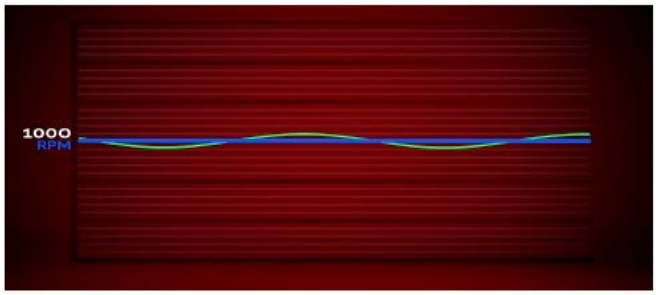

Fig.3: Speed v/s time graph to show low level resonance.
The graph shows the speed variation at 1000 rpm resulting in low level resonance. 2nd stage low level resonance is been observed when the speed is varied in second period upto 1000 rpm low level resonance is observed.

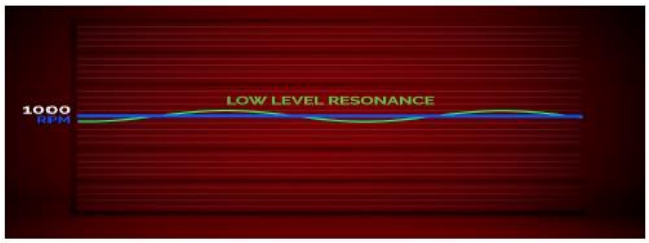

Fig.4: Speed v/s time graph to show 2nd stage low level resonance.

Table 1: Spindle speed variation (s.s.v) on without tailstock

W/P	L	D	Chatter
Cylindrical (Before Expansion)	7''(inches)	1.75''	-
Cylindrical (After Expansion)	7''(inches)	1.25''	Begins
Cylindercal (After Expansion)	7''(inches)	1.115''	Serious chatter

Table 2: spindle speed variation with tail stock

W/P	L	D	Chatter
Cylindrical	½''	10''	No Chatter and decent finish

3.Conclusions

1.) Due to spindle speed variation in very less time of 1.2 sec researchers have reduced the chatter.
2.) By controlling the chatter researchers have controlled various other machining factors such as tool life, work surface finish, machinability etc.
3.) Researchers have also followed 6-sigma technique to minimize the error to the minimum further obtaining a better condition.
4.) Errors have been minimized upto 1 error per 3.4 million parts which takes care of various other factors hence also effecting cost.

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